5.00 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

The Corps coordinated its evaluation of potential environmental effects from the Savannah Harbor Expansion Project with various experts within the Federal and State natural resource agencies through a series of Interagency Coordination Teams. These groups were formed around specific natural resources, as follows:

A. Wetlands
B. Water Quality
C. Fisheries
D. Sediment Placement
E. Groundwater

The agencies involved are those that must provide some type of approval or certification for the Project before construction could occur. This includes, for example, such agencies as the SC Department of Health and Environmental Control because of the Project's need to obtain a South Carolina water quality certification, and the GA DNR Coastal Resources Division because of the need to obtain concurrence in the District's Coastal Zone Management Consistency Determination, as well as the USEPA, US Department of Commerce, and the US Department of the Interior, who must approve the Selected Plan and associated mitigation plan. The intent of that coordination was to ensure that the SHEP study team; (1) conducted the necessary evaluations, (2) used evaluation tools that are acceptable to the agencies, (3) evaluated the alternatives under conditions determined by the agencies to be appropriate, and (4) developed the type of information the agencies would need to reach their decision about the project. The Corps sought to obtain incremental approval of the technical work that was conducted on the project to reduce potential lost effort and time. Copies of meeting records and decision documents are found in Appendix N.

The expected effects or impacts of the proposed harbor deepening alternatives, including cumulative impacts of the proposed action on significant resources, are described in this section.

5.01 <u>Wetlands</u>

5.01.1 Impacts from Excavation of Wetlands

5.01.1.1 Impact Identification. Approximately 15.68 acres of brackish marsh would be lost as a result of various excavation requirements of the project. The excavation requirements (in regards to the amount of wetlands that would be affected) for all five channel depth alternatives are the same. Figures 5-1, 5-2, and 5-3 show the six locations where brackish marsh would be excavated. The first two locations are in the SNWR where approximately 2.2 acres would be removed at Station 102+600 and 0.8 acres would be removed as part of the Kings Island Turning Basin expansion. The project would remove brackish marsh from two locations on Hutchinson Island where approximately 3.4 acres would be excavated at Station 88+000 and 0.8 acres at Station 70+000. The project also provides for removal of the Tidegate structure abutments on both the Georgia and South Carolina sides of the river. Removal of the Tidegate structure abutment on the Georgia side would result in the loss of about 7.63 acres of brackish marsh while about 0.85 acres would be lost on the South Carolina side of the River as shown below in Table 5-1.

Table 5-1. Wetland Direct Impacts

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**

The SHEP would require oxygen injection at three sites. These systems would include construction of support facilities on high ground (oxygen production facilities, etc.) as well as pipelines to withdraw river water and return oxygenated water to the river. Two of the injection sites are located on Hutchinson Island. Every effort would be made to avoid the discharge of fill material into estuarine emergent wetlands located at these sites. If this impact cannot be avoided, the Corps would determine the extent of impacts and provide appropriate mitigation. Restoration of Disposal Site 1S would provide an excess of wetland mitigation credits designated for use by other activities associated with the Savannah Harbor Navigation Project. These excess wetland mitigation credits should be more than sufficient to satisfy any wetland mitigation requirements associated with construction of the oxygen injection support facilities.

Impacts to non-tidal wetlands could occur from construction of the raw water storage impoundment that would mitigate for expected impacts to water quality at the City of Savannah's water intake in Abercorn Creek. Section 5.02.15 describes the impoundment that would be constructed. Although it would be located on high ground in an existing industrial park, construction of the storage impoundment including its pumping station and inflow and outflow pipes) could result in adverse impacts to a small amount of wetlands. Savannah District will conduct detailed surveys during the final design and follow the interagency-approved Savannah District Regulatory SOP to quantify the extent of any mitigation that may be needed. The Corps would coordinate the results of the SOP calculations with GADNR and the Federal natural resource agencies.

5.01.1.2 Mitigation. 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. Each of the proposed harbor deepening alternatives would result in the loss of approximately 15.68 acres of brackish marsh. USEPA recommended use of a salt marsh mitigation bank, the preferred choice of mitigation 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). As a result, the Corps explored 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 (Disposal Area 1S) within Savannah Harbor was identified as having the greatest opportunity to support the long-term success of a restored salt and brackish marsh system.

Disposal Area 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 (see Figure 1-1). 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 40.3 acres. The site would be restored by grading it down to an elevation that would allow the growth of *Spartina alterniflora* (i.e., +7.6 to +7.7 MLLW). These elevations were identified based on the elevation of adjacent marsh. Once the new elevations have been established, the site would be allowed to naturally vegetate. A 1.7 acre site adjacent to the 40.3 acre SHEP mitigation site was graded down by GPA several years ago as mitigation for work at their facilities. The SHEP wetland mitigation site and GPA's existing saltmarsh acreage (1.7 acres) would provide a contiguous 42 acre wetland. The Corps used the Regulatory SOP to determine the number of acres that would be required to restore to adequately compensate for the direct excavation impacts. The 15.68 acres of direct impact to brackish marsh equates to approximately 138 mitigation credits. Calculations derived from the SOP indicate that approximately 28.8 acres of restored marsh would be required to mitigate for the 15.68 acres of impact. A copy of the SOP calculation sheets can be found at the end of Appendix C. While the Corps intends to restore approximately 40.3 acres of brackish marsh at Disposal Area 1S, only 28.8 acres of the restored area would be required to satisfy the SHEP wetland mitigation requirements for the excavation areas. However, additional wetland mitigation credits may be required for minor impacts to wetlands associated with other aspects of the SHEP. Consequently, the remaining 11.5 acres of excess restored brackish marsh would be used to satisfy any additional wetland mitigation credits needed for the SHEP, or credited to the Savannah Harbor Navigation Project as "advance mitigation" and used when the need arises for small amounts of marsh mitigation to compensate for wetland impacts from approved O&M actions. Release of any excess credits for use on the Savannah Harbor Navigation Project (O&M) would not occur until after the long-term health/productivity of the restoration site is verified by the Federal Cooperating Agencies.

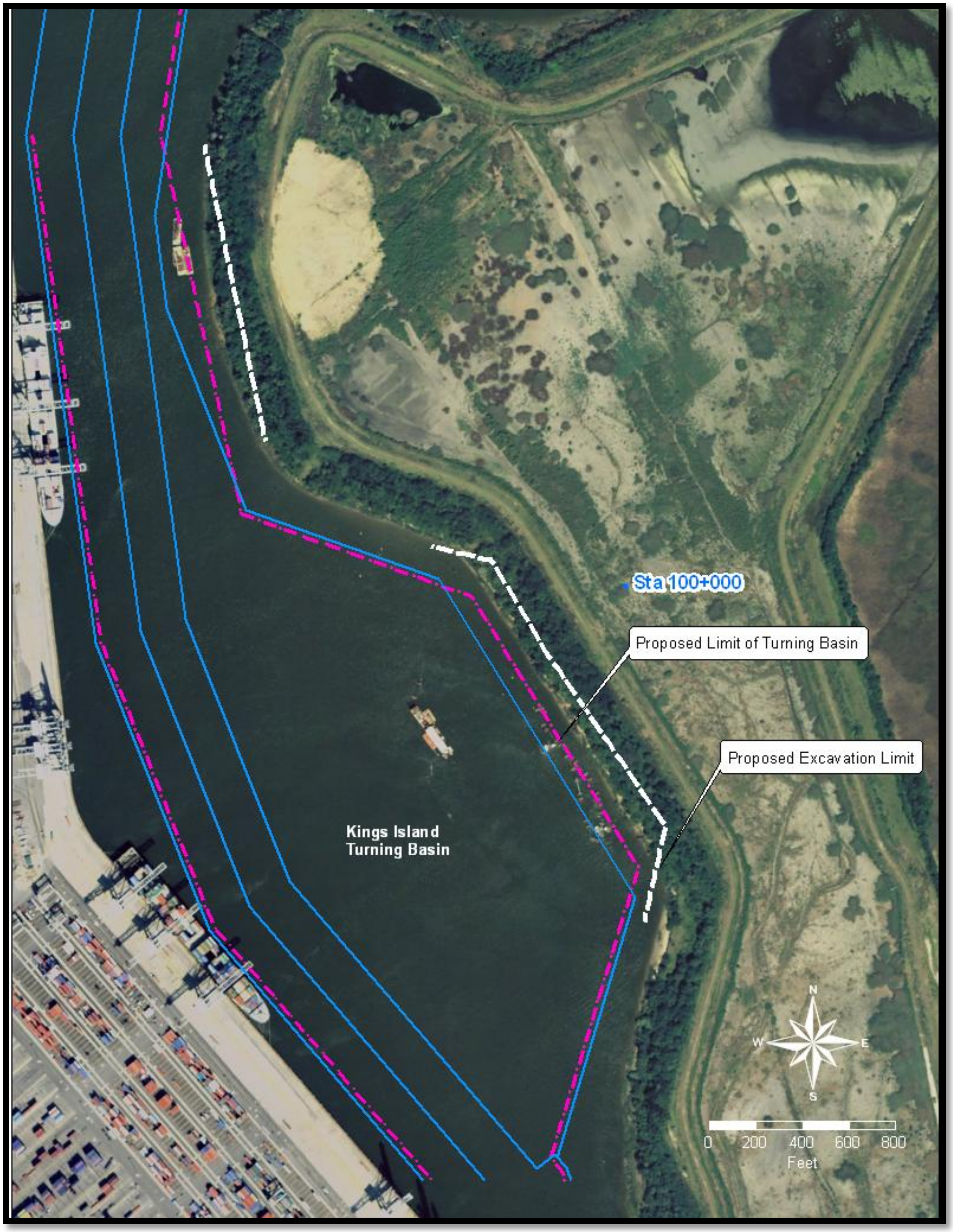

Figure 5-1. Excavation area at Kings Island Turning Basin.

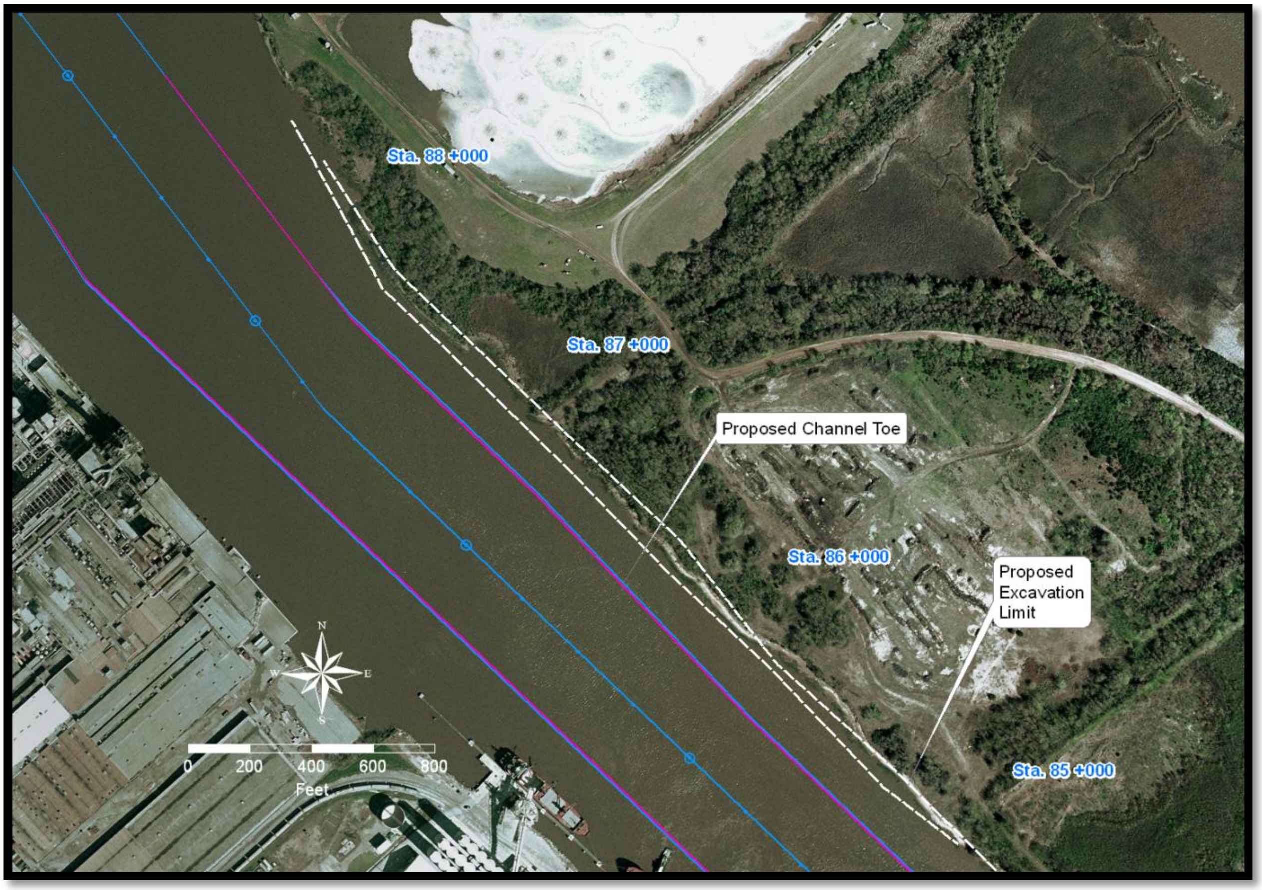

Figure 5-2. Excavation area on Hutchinson Island.

Figure 5-3. Excavation area at Tidegate.

Restoration of the Disposal Area 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 5-4). The Corps selected that elevation range after inspecting 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 40.3-acre site would be allowed to naturally vegetate. As requested by the USFWS, a “feeder creek” system would 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 Corps would let the site naturally revegetate, which is expected at the rate shown in Table 5-2. Re-vegetation success would be determined by comparing restoration site 1S to a reference marsh site in the vicinity.

Table 5-2. Revegetation Rates for Created 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 Corps would monitor the site for a period of seven years, and the success of the brackish marsh would be based on meeting or exceeding the annual values defined for the percent of vegetative coverage for *Spartina alterniflora* shown in the above table. The marsh transects would be sampled twice annually (June and October). The Corps would provide annual reports of the performance monitoring to the Wetland Interagency Coordination Team (ICT) for review.

If the site does not revegetate at those rates, the Corps would plant *Spartina alterniflora* to provide the basis for subsequent growth across the entire site. The ICT would identify/recommend corrective actions, including planting requirements and associated sprig densities, which would achieve compliance with the reported percentages in the above table. The site would be monitored to assess the success of the marsh planting.

It is unlikely that invasive species (*Phragmites australis*) 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 restoration of wetlands at Site 1S would also include a monitoring plan for invasive species and an invasive species control plan that could be implemented if required. If invasive species are identified, they would be removed from the site via hand grubbing or another method approved by the Wetland ICT.

The marsh restoration site (Disposal Area 1S) is located within the SNWR. However, the Corps and the GA DOT still maintain a dredged material disposal easement on the site. The Corps and the GA DOT would relinquish this easement.

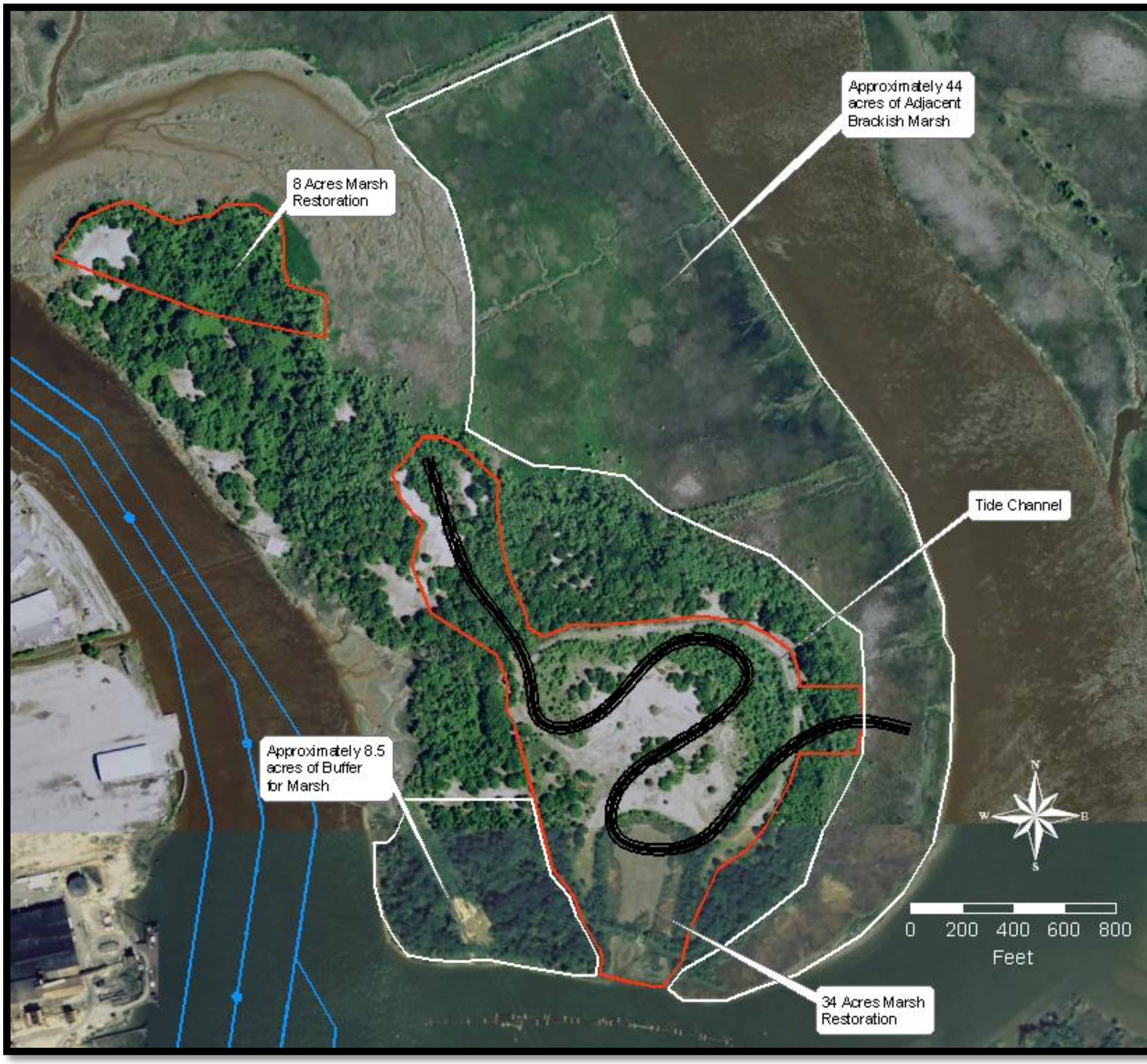

Figure 5-4. Restoration area at Disposal Area 1S.

5.01.2 Indirect Impacts to Wetlands

5.01.2.1 Procedures. Since tidal freshwater marshes were identified by the USFWS as the single most critical natural resource in the harbor, the Corps focused on identifying project impacts to that resource. The other natural resource agencies concurred with this priority. The majority of the tidal freshwater marshes presently occur between the Houlihan Bridge (GA 25) and the I-95 Bridge. 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.

The Corps used a state-of-the-art hydrodynamic model to identify impacts to wetlands and floodplains from the proposed project alternatives. The project initially attempted to apply a boundary-fitted hydrodynamic model (BFHYDRO) and a similar water quality model (WQMAP) to the Savannah estuary. GPA began this effort in Tier I with an extensive data collection effort in 1997. They supplemented that with a more extensive hydrodynamic and water quality data collection effort in 1999. After several years of effort to develop reliable and accurate models, the Federal Cooperating Agencies decided in 2004 that the BFHYDRO and BFWASP models did not meet the desired performance criteria. The agencies then decided that instead of investing further effort into improving those models, the project should consider using models that EPA had recently developed for its TMDL analyses. EPA had used the same field data that GPA had collected in 1997 and 1999 and applied it in a different set of computer models (EFDC and WASP). After a technical review of the structure and performance of the EPA TMDL models, EPA, USFWS, NMFS, SC DHEC, and GA DNR-EPD concluded that the EPA models would likely provide acceptable impact prediction tools, and the SHEP should pursue refinement of those models. The project then funded efforts to enhance the capabilities and accuracies of these EPA models.

The Water Quality Interagency Coordination Team assisted in the application of EPA’s model on this project. EPA, USFWS, NMFS, USGS, SC DHEC, GA DNR-EPD and the Corps agreed in 2006 that the enhanced model was suitable for use in evaluating potential impacts from this proposed harbor deepening project. ERDC performed an Independent Technical Review (ITR) of the model, focusing on the model grid representation, input parameters, and existing conditions calibration. The reviewer stated that the model was acceptable for impact evaluation purposes on this project. The ERDC ITR did not include analysis of the model programming but rather the application of the model to Savannah Harbor. The EFDC and WASP models are on a Corps’ "allowed for use" list of approved engineering models.

The Wetlands Interagency Coordination Team defined the conditions under which the hydrodynamic model should be used to identify project impacts to wetlands. This consisted of the use of average river flows (1997) during the months of March through October for the basic evaluation. Additional runs would be performed to evaluate the sensitivity of the results to different input conditions. Those sensitivity analyses include low river flows (2001 conditions) and sea level rise of 25 cm (9.84 inches) and 50 cm (19.69 inches). The results of those sensitivity analyses are included in the GRR Engineering Appendix. As a summary, the project would produce fewer impacts to wetlands under both drought flows with higher sea levels because those conditions would reduce the amount of tidal freshwater marshes that are available for impact by a harbor deepening project.

As part of the impact and mitigation modeling process, the Corps attempted to develop and use Marsh Succession Models. 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 a Marsh Succession Model 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 salinity information from the hydrodynamic model that had been processed by a Model-To-Marsh linkage (M2M) as input. 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 produced salinity 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 titled "Simulation 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" in 2006 (Conrad et al, 2006) that described their M2M linkage and the report received an independent technical review within USGS. The report can be found as USGS Scientific Investigations Report 2006–5187.

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. An External Peer Review was conducted in 2007 by a three-member panel on both model 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 from which the M2M makes its extrapolations results in the linkage not being sensitive to changes in salinity 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 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 (MSM) could still to be used to check the predictions of wetland vegetation distribution resulting from use of the hydrodynamic model. The following paragraphs discuss that comparison.

To compare the results of the USGS MSM to the EFDC hydrodynamic models, one needs to compare similar thresholds or categories. According to the USFWS, the most important impact criterion in the Savannah Estuary is a change from freshwater tidal marsh to non-freshwater marsh. A threshold of 0.5 ppt salinity is generally accepted as the differentiation between freshwater marsh and brackish marsh. Cowardin et al (1979) use the 0.5 ppt threshold to differentiate between estuarine and palustrine emergent wetlands. This criterion was adopted by the Wetlands Interagency Coordination Team and refined to be 0.5 ppt at 50% tile exceedance river flow.

In the USGS/USFWS MSM model, the most freshwater marsh category is "100% *Eleocharis montevidens*, *Galium tinctorum*, and *Sagittaria latifolia* (100% Elemo_Galti_Saglt)". It occurs in the range of salinity from 0 to <1.0 ppt salinity. This category is the closest to the EFDC Hydrodynamic model salinity outputs of 0.0 to 0.5 ppt. The following table shows the difference at various depths of the MSM model runs using the 100% Elemo Galti_Saglt category and the EFDC Hydrodynamic model runs using the 0.0 to 0.5 ppt category at 50% exceedance river flow with NO MITIGATION.

Table 5-3. Comparison of Salinity Impacts of the USGS/USFWS MSM to the EFDC Hydrodynamic Models with No Mitigation

	USGS/USFWS MSM Model	EFDC Hydrodynamic Model
Channel Depth Alternative	**Acres of 100% Elemo-Galti-Saglt Net Change at Average Flow**	**Acres of 0.0 to 0.5 ppt Net Change at 50% Exceedance Flow**
42-foot (Baseline)	2,231	4,072
44-foot	- 280	- 469.2
45-foot	- 485	- 967
46-foot	- 720	- 1,057
48-foot	- 962	- 1,212

The comparison shows that wetland impacts identified by using the EFDC hydrodynamic model are higher 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 conservative estimate than those produced by using the more technically-advanced Marsh Succession Model.

5.01.2.2 Impacts without Mitigation. 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 ATM (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 5-4. Marsh Distribution From MSM Model

Marsh Type	Acreage
Freshwater	3,269
Brackish	3,082
Saltmarsh	2,506

As discussed in previous paragraphs, the EFDC model was used during the SHEP study to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary as well as predicting how these species would change with the various channel deepening alternatives, was accomplished using a method where marsh salinity contour lines are extrapolated from the river into the adjacent marsh areas. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. Using this method and river salinities predicted by the EFDC model, Table 5-5 shows the distribution of wetlands that the Corps calculated for the estuary downstream of I-95.

Table 5-5. Marsh Distribution From EFDC Model for Average River Flows

Marsh Type	Acreage
Freshwater	4,072
Brackish	2,253
Saltmarsh	2,506

The Wetlands Interagency Coordination Team agreed that this marsh distribution acreage would be used as the baseline for the impact assessment of tidal freshwater marsh losses that could be caused by any of the harbor deepening alternatives under consideration.

All of the deepening alternatives would adversely impact tidal freshwater marsh. Model predictions indicate that deepening the harbor to 44, 45, 46, 47, or 48-feet without mitigation would result in the conversion of 551, 967, 1,057, 1,177, and 1,212 acres of tidal freshwater marsh, respectively (average flow, low sea level rise) to brackish marsh (Table 5-6). These numbers would increase with a rise in sea level.

Table 5-6. Summary of Project-Related Impacts without Mitigation

	---------------------- DEPTH ALTERNATIVES ----------------------				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Freshwater Wetlands	-551 acres	-967 acres	-1,057 acres	-1,177 acres	-1,212 acres

5.01.2.3 Mitigation – Flow Rerouting. Since the Cooperating Agencies identified tidal freshwater marshes as the single most critical natural resource in the harbor, the Corps focused on reducing project impacts to that resource. 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 conducted an extensive investigation of potential ways to reduce the impacts that were projected to occur with just a channel deepening (no mitigation). The team evaluated numerous potential alterations to water flow in the estuary, as a means of reducing salinity impacts to freshwater marsh. It analyzed a total of 38 alterations at 7 locations. Those locations are shown in Figure 5-5. 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.
Based on the effectiveness observed in the initial modeling and preliminary estimates of construction cost, the Corps ranked the 5 best stand-alone flow rerouting measures in their order of decreasing cost effectiveness, as shown below (Table 5-7).

Table 5-7. Flow Rerouting 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) the filling of 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 (Table 5-8). 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.

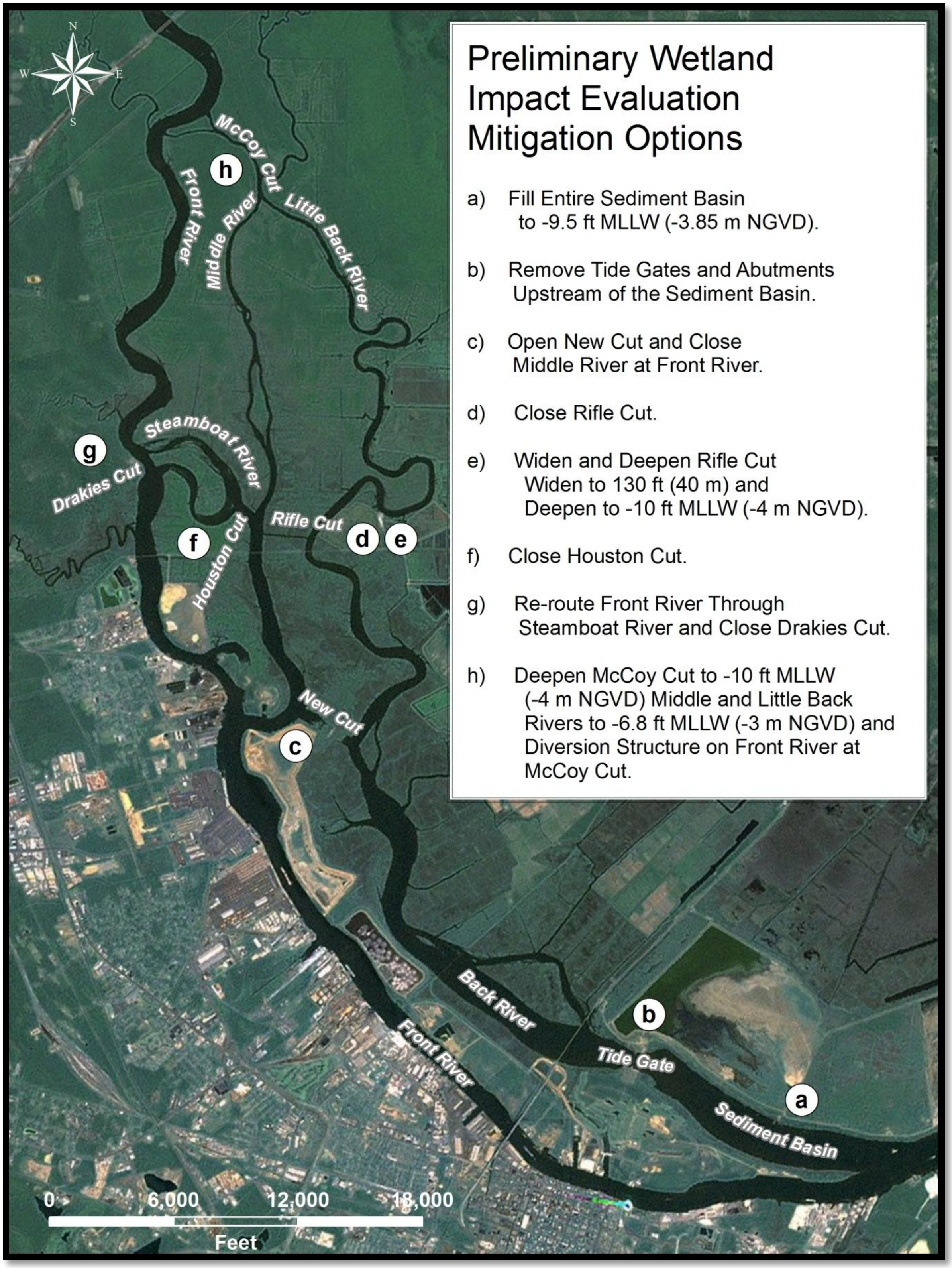

Figure 5-5. Potential flow-altering mitigation measures.

Table 5-8. Flow Rerouting 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 5-9).

Table 5-9. Wetland/Marsh Mitigation Evaluation
48-foot Deepening Alternative
Average River Flows
50% Salinity Exceedance Values

	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 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 then conducted additional modeling of the flow-altering components of the mitigation plans. The Corps' modelers developed additional plans to identify one 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 5-6 to 5-13 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 discussed below.

After coordination of these modeling results, the USFWS proposed an additional plan, which was designated as Plan 8. That plan is shown in Figure 5-14. 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.

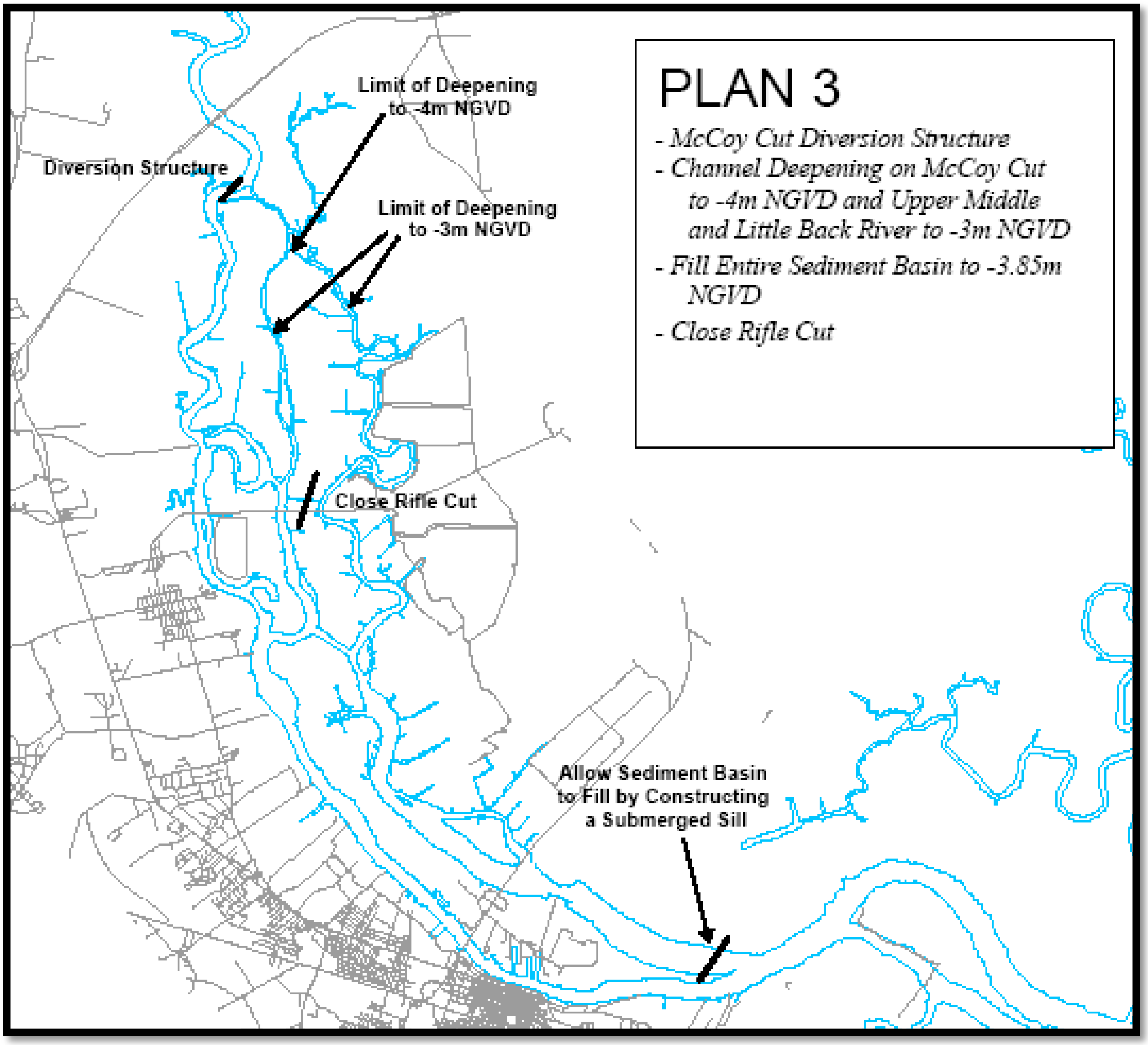

Figure 5-6. Potential flow rerouting Plan 3.

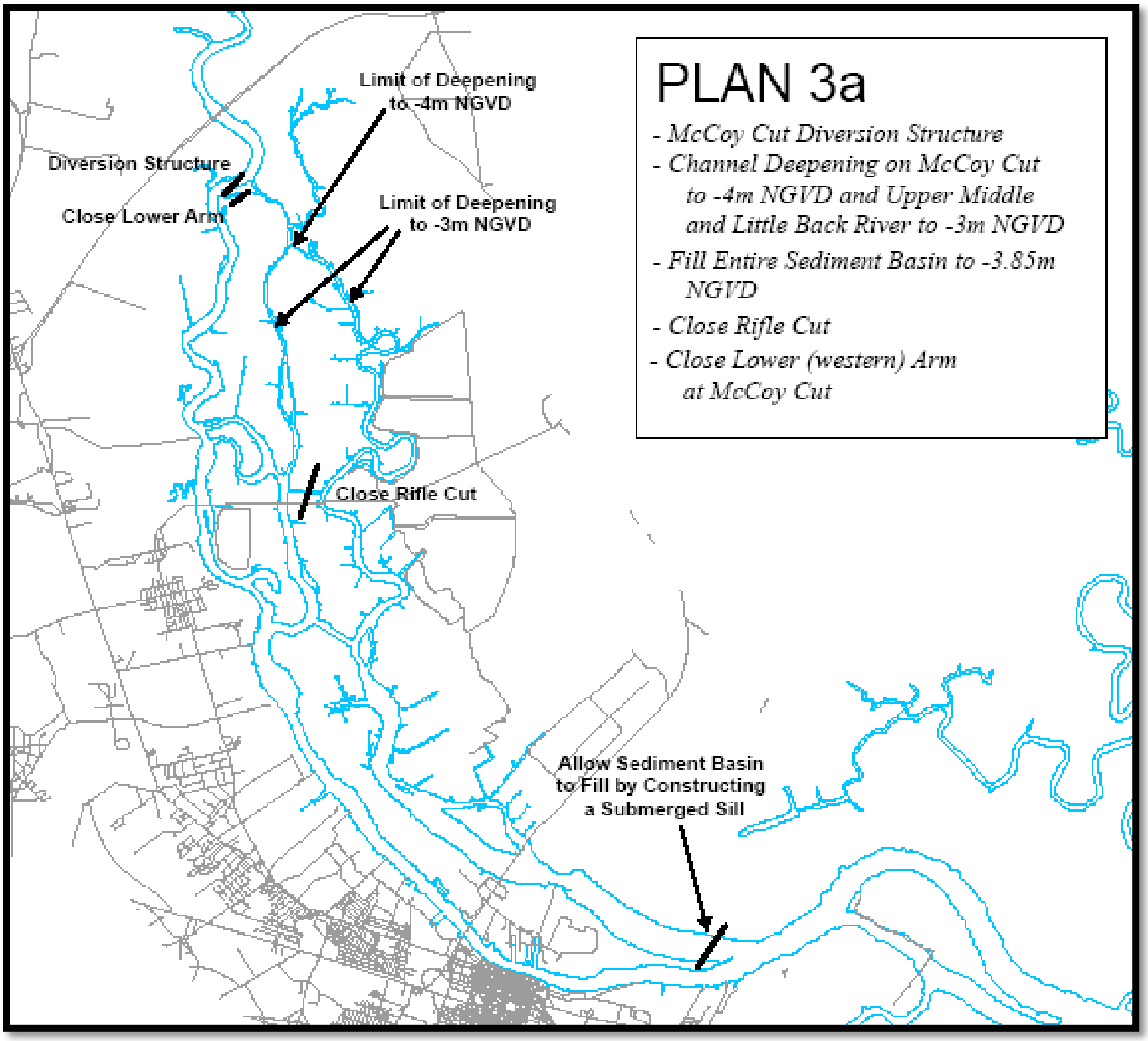

Figure 5-7. Potential flow rerouting Plan 3A.

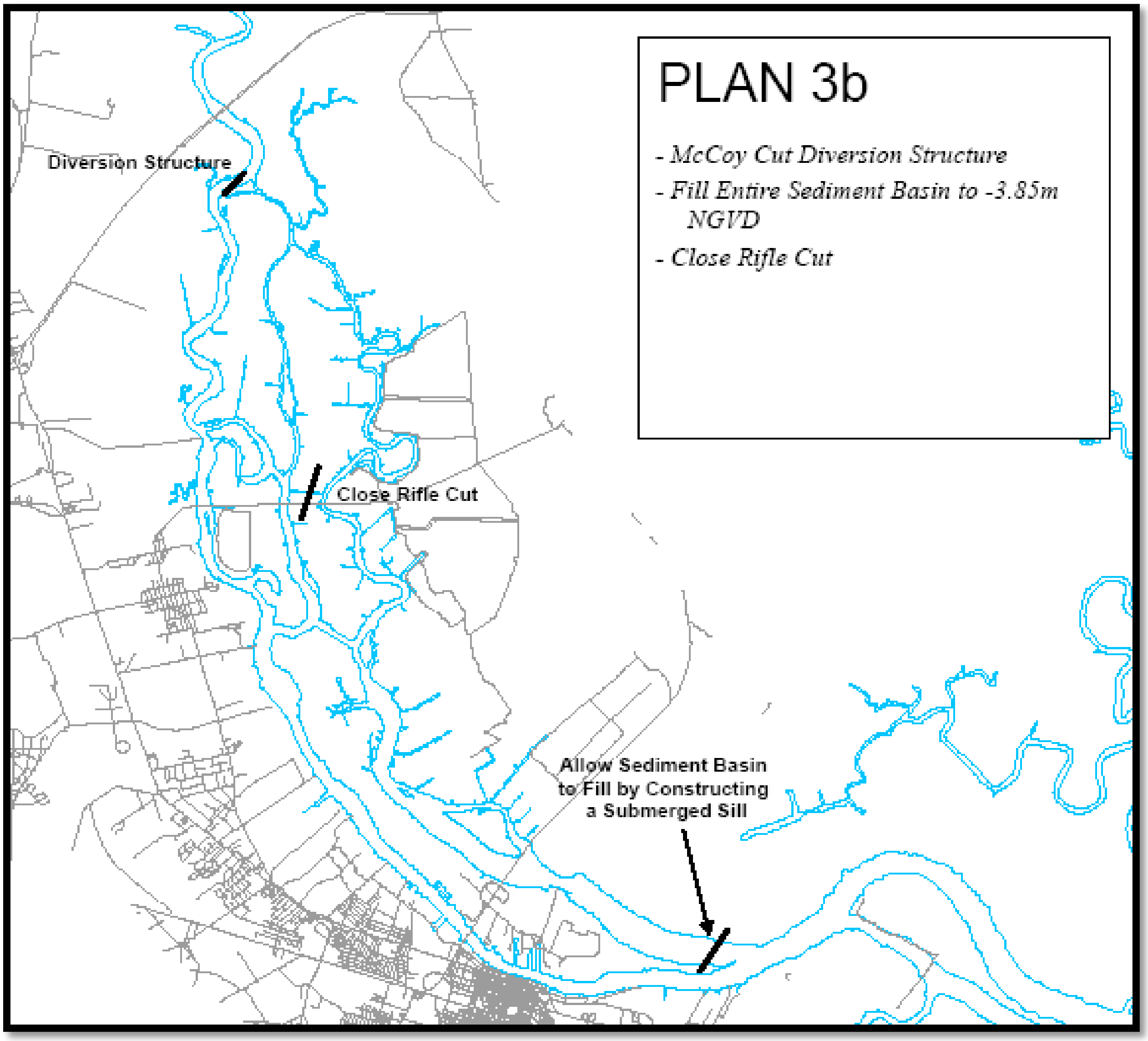

Figure 5-8. Potential flow rerouting Plan 3B.

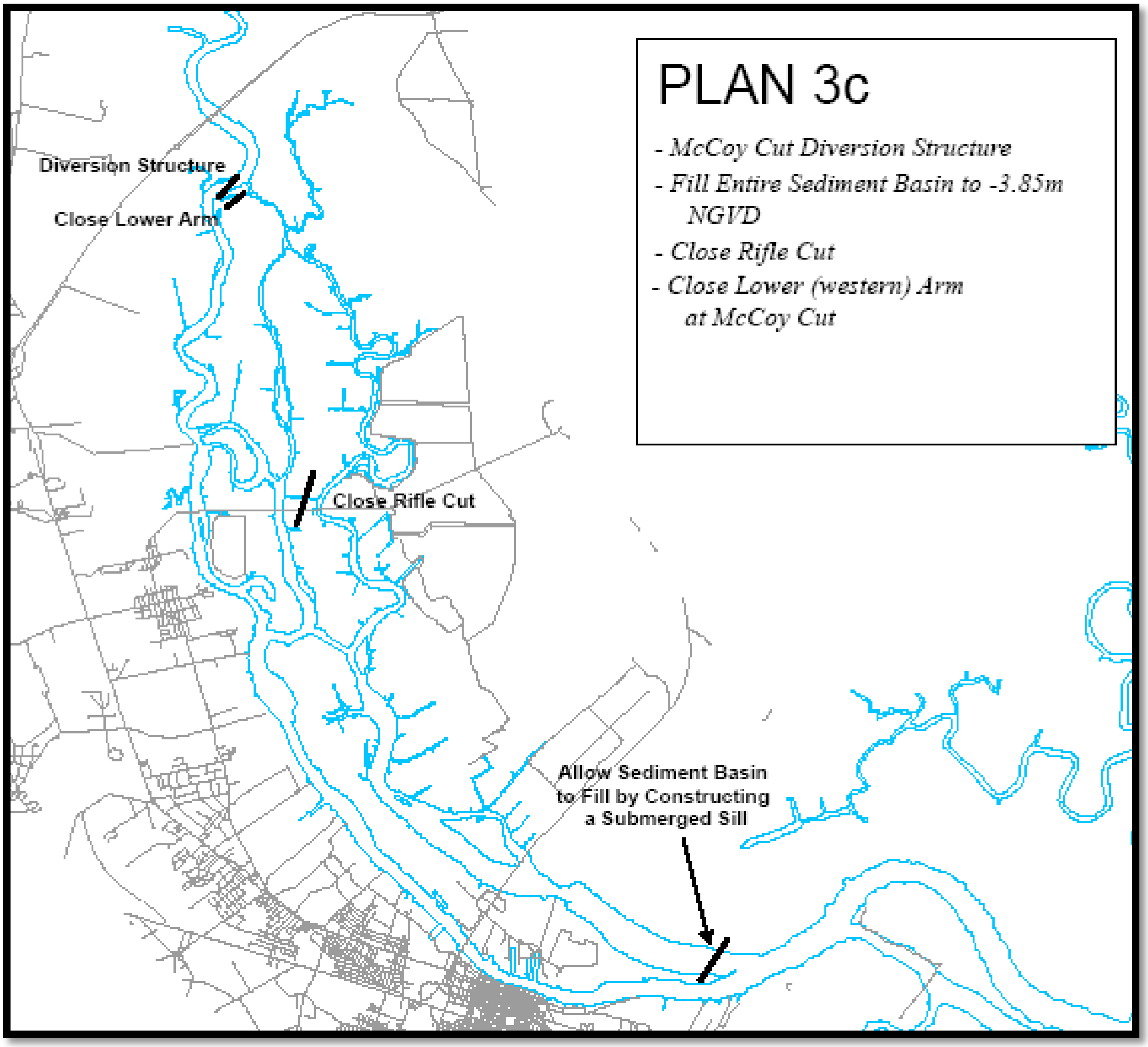

Figure 5-9. Potential flow rerouting Plan 3C.

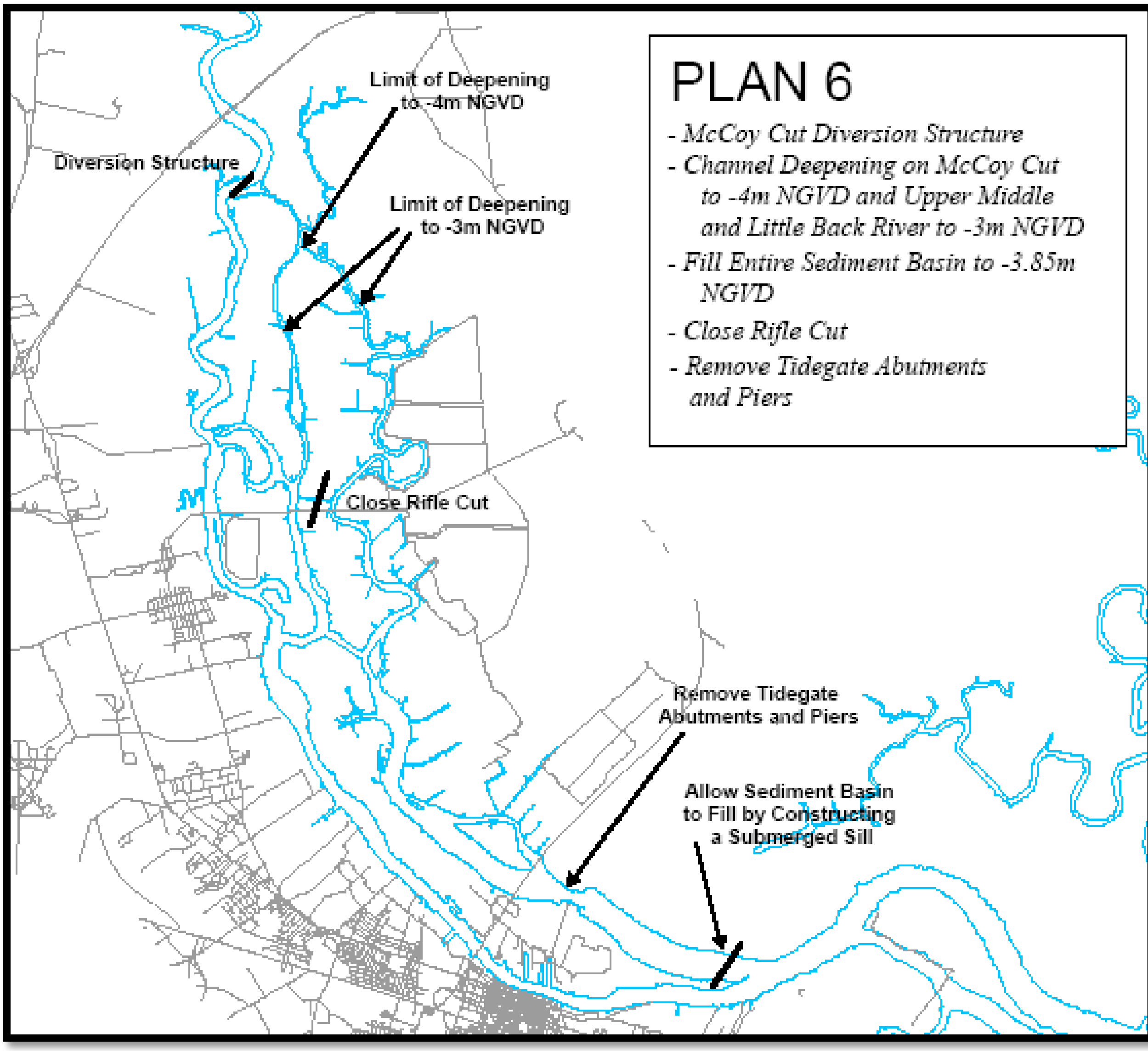

Figure 5-10. Potential flow rerouting Plan 6.

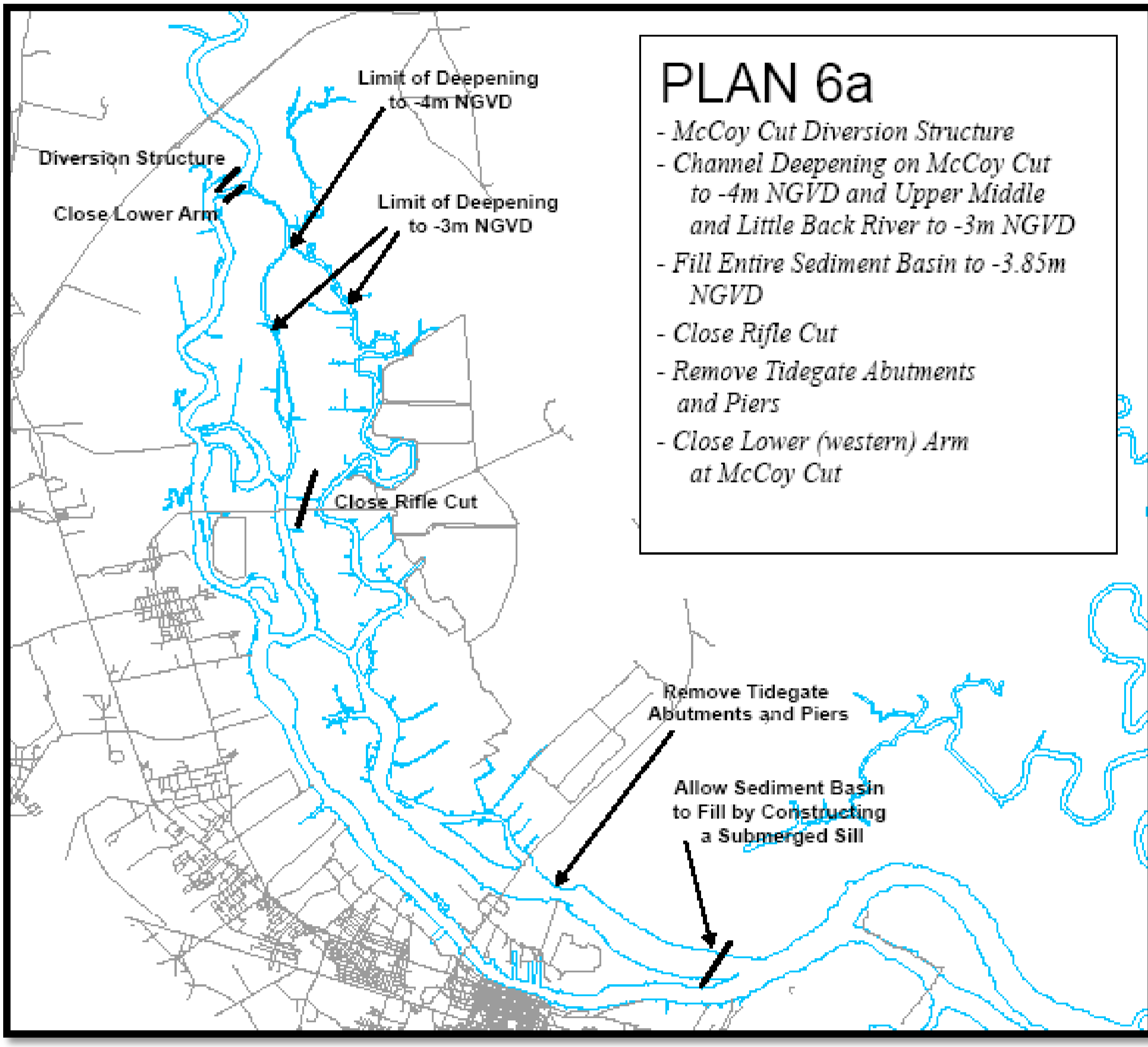

Figure 5-11. Potential flow rerouting Plan 6A.

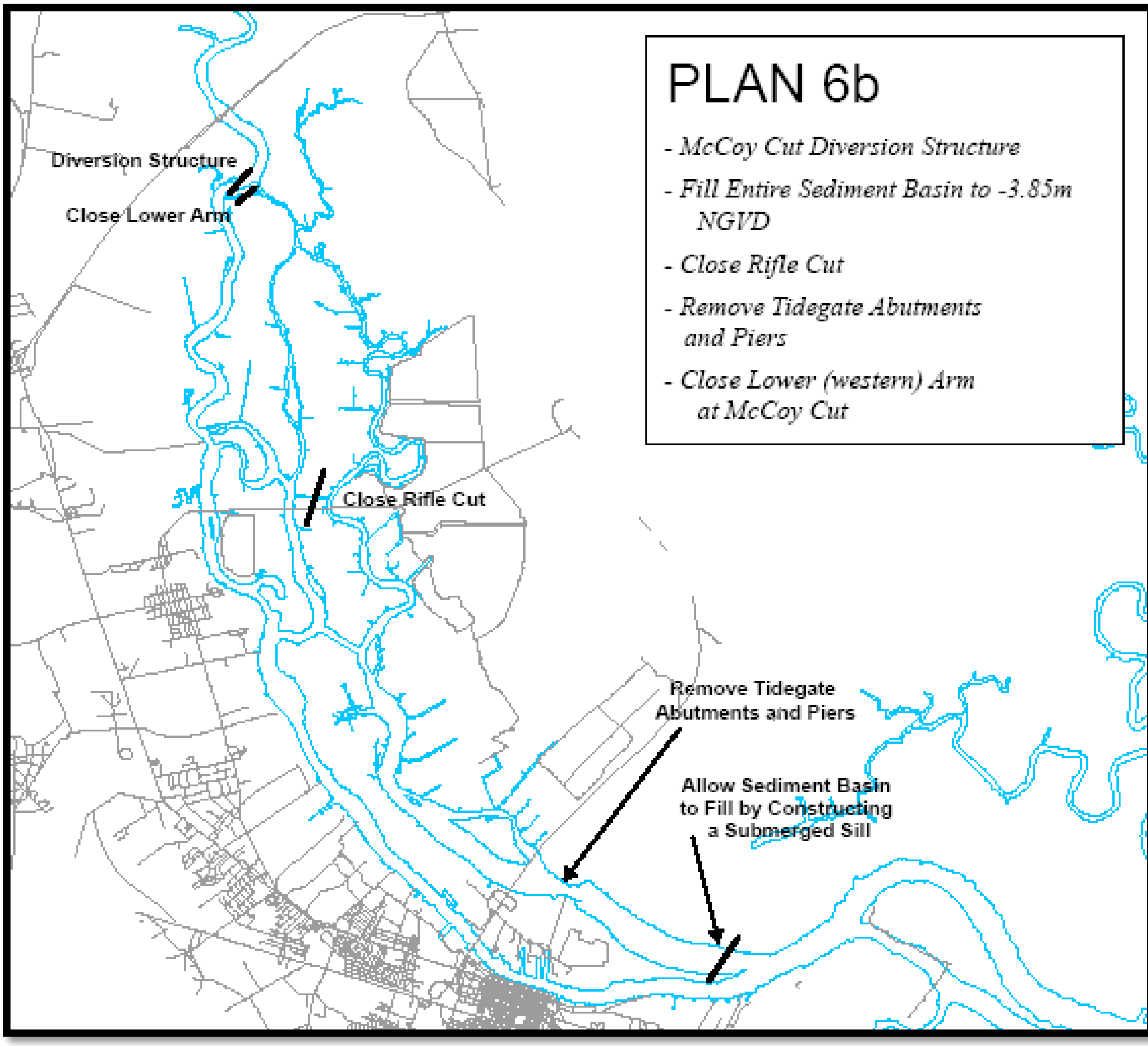

Figure 5-12. Potential flow rerouting Plan 6B.

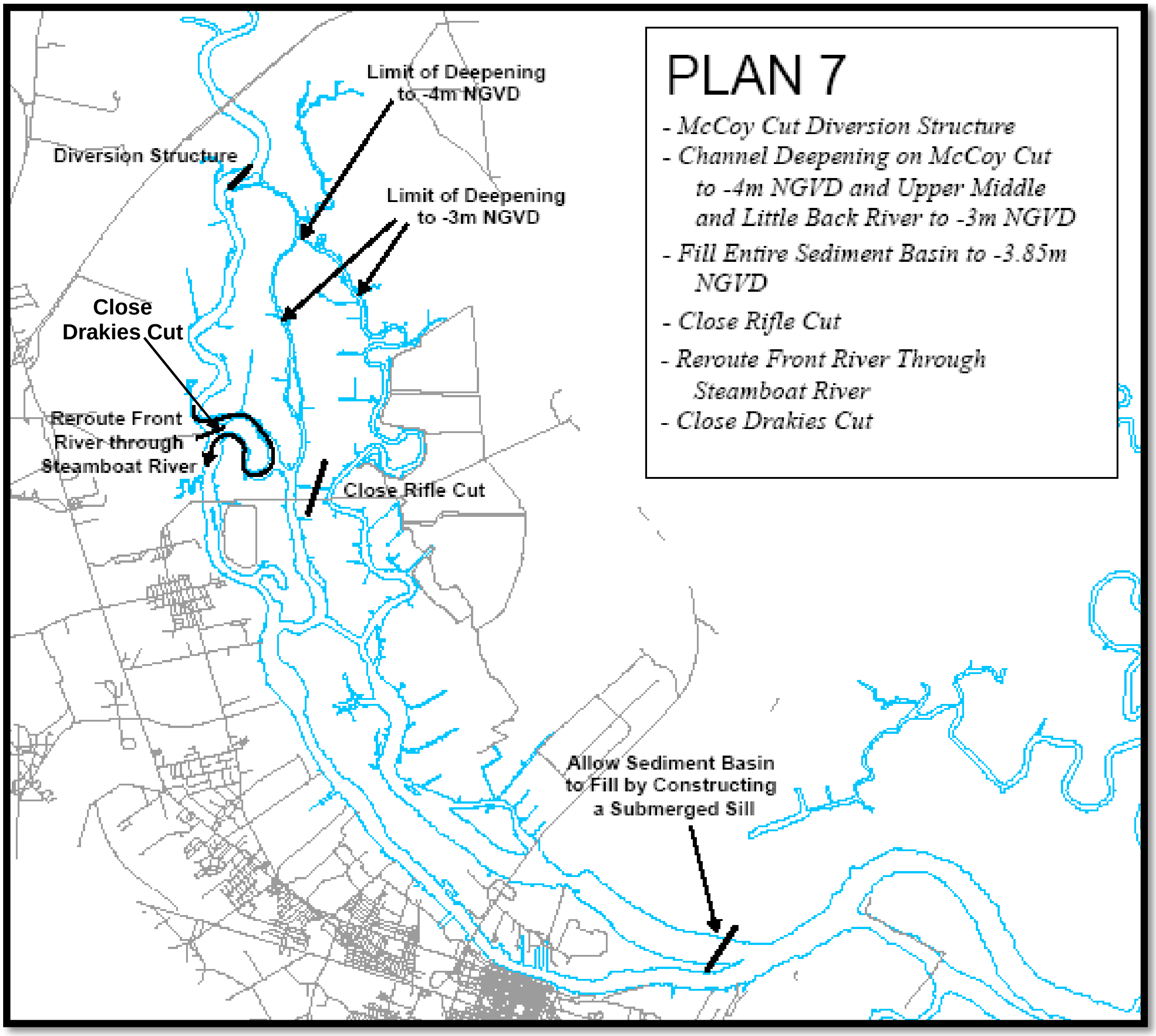

Figure 5-13. Potential flow rerouting Plan 7.

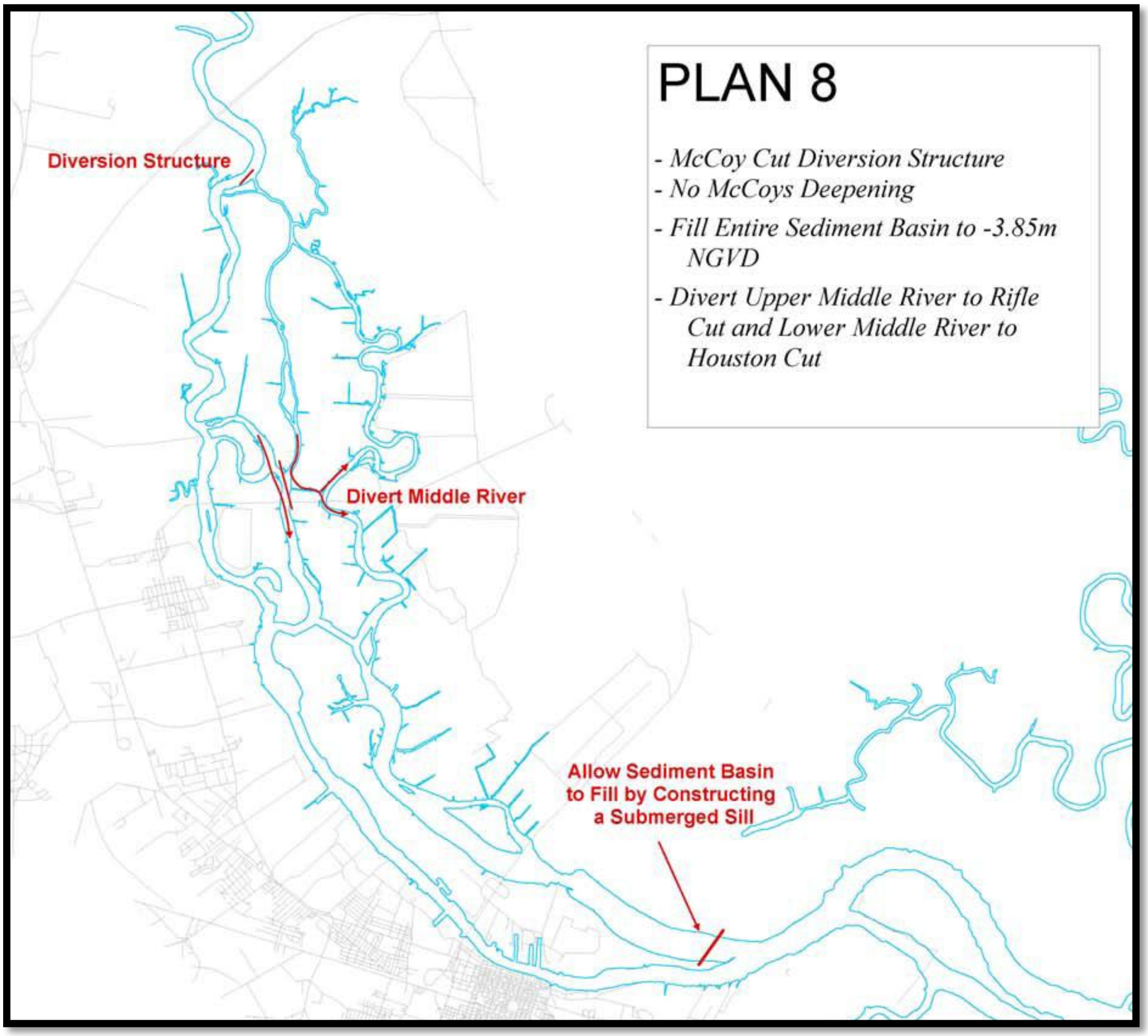

Figure 5-14. Potential flow rerouting Plan 8.

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 tables (Tables 5-10 through 5-14) using average river flows and 50% salinity exceedance values. Based on the cost effectiveness of the flow rerouting plans at reducing adverse impacts to freshwater marshes, Savannah District selected flow rerouting Plan 6B for the 44-foot depth alternative and Plan 6A for all the other depth alternatives.

Table 5-10. Wetland/Marsh Mitigation Evaluation - 44-foot Depth 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 5-11. Wetland/Marsh Mitigation Evaluation - 45-foot Depth 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 5-12. Wetland/Marsh Mitigation Evaluation - 46-foot Depth 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 5-13. Wetland/Marsh Mitigation Evaluation - 47-foot Depth 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 5-14. Wetland/Marsh Mitigation Evaluation - 48-foot Depth 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

The regional agency-coordinated preferred level of mitigation for the selected plan (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. The District, however, requested a waiver to deviate from Section 5, paragraph E-36.c.(1) of ER 1105-2-100 regarding how environmental impacts are computed. The Assistant Secretary of the Army (Civil Works) has granted the request for the policy waiver, allowing mitigation to be based on impacts expected to occur at the time of construction versus annualized impacts over the life of the project.

5.01.2.4 Additional Wetland Mitigation. As discussed in the previous paragraphs, indirect impacts associated with the proposed deepening would result in a vegetative shift in 223 acres of tidal freshwater marsh to brackish marsh with implementation of the selected plan (47-foot channel depth alternative) even with the flow rerouting. Approximately 740 acres of saltmarsh would also be impacted by the flow rerouting since more freshwater would be introduced into Little Back and Middle Rivers which could cause some areas of saltmarsh to shift to more brackish species. As previously discussed, the Corps used the EFDC model to evaluate both existing stream salinity levels and salinity levels that would occur with the various channel deepening alternatives in place. However, the EFDC model does not directly predict marsh salinity. Consequently, determining the existing wetland species composition in the estuary, as well as predicting how these species would change with the various channel deepening alternatives was accomplished using a method where riverine surface salinity levels are extrapolated across the adjacent marshes. This method creates contours that divide the marsh into 5 salinity categories: 0-0.5 ppt, which is considered freshwater, 0.6-1.0 ppt, 1.1-2.0 ppt, 2.1-4.0 ppt, and >4.0 ppt. In turn, distinctions between marsh types and acreage were defined based on the following salinity ranges: (0-0.5 ppt) Freshwater Marsh, (0.5-4 ppt) Brackish Marsh, and (>4ppt) Saltmarsh, as recommended by the Wetland Interagency Coordination Team.

The results of the functional assessment concluded that the differentiation between saltmarsh and brackish marsh recommended by the Wetland Interagency Coordination Team and used in the DEIS was constrained. The salinity range used in the SHEP to differentiate between brackish marsh (0.6-4 ppt) and saltmarsh (> 4ppt) was restrictive, given that brackish marsh salinities have been reported with a range from 0.5-10 ppt (NOAA, 2010) and in other estuarine systems from 0.5-17 ppt (Judd and Lonard, 2004). An earlier assessment of wetland vegetation coinciding with the salinity range reported for brackish marsh systems (i.e., 5-10 ppt) which occur within the area of potential effect, also supports those findings. The EFDC value for saltmarsh (> 4.0 ppt) is approximately 2.5 times less than that reported by NOAA (2010). Additionally, the NOAA (2010) range for brackish marsh includes areas determined by the EFDC model to be saltmarsh. When considering values reported in the literature, the acreage of saltmarsh conversion (740 acres) which was calculated using the EFDC model is a very inclusive value and includes existing vegetative areas that may not transition to brackish marsh following deepening because these areas currently exist within the salinity range of a brackish marsh (0.5-10 ppt). Thus, the salinity range used to quantify saltmarsh in the area of potential effect (i.e., > 4 ppt) may over-estimate the amount of saltmarsh in the system and under-estimate the amount of brackish marsh. As such, the described conversion of saltmarsh to brackish marsh, which could occur as a result of harbor deepening, would likely be much less if one takes into account vegetative characteristics for wetland environments with associated salinities that are more commonly associated with a brackish marsh (i.e., range between 0.5 and 10 ppt).

Given the wide range of salinity reported in literature for brackish marsh systems, the inherent variability in salinity that exists for all estuarine systems, and the modeling results that report post-deepening salinity concentrations consistent with the aforementioned range, Savannah District concludes that the 740-acre calculated conversion of saltmarsh to brackish marsh if the harbor is deepened to 47-feet is conservative, with actual vegetative shifts unlikely to be identifiable *in situ* in Savannah Harbor. That said, the District was inclusive in its assessment of the potential for project-related effects and elected to include the saltmarsh and brackish marsh conversion in its calculation of minor impacts.

The conversion of 223 acres of freshwater wetland to brackish marsh represents the only significant wetland conversion that is likely to be noticeable if the harbor is deepened to 47-feet as proposed. It is important to note that the ecological values of the impacted 223 acres of freshwater wetlands would not be completely lost. Instead, those acres would convert 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 5-15.

Table 5-15. 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 the table above, the only indirect effect the 47-foot project would have on the function of these wetlands systems would be associated with fish and wildlife habitat. All other elements of wetland function associated with predicted shifts in wetlands classification would be negligible as a result of the anticipated increase in salinity. It should be noted that areas of the Savannah Harbor identified as saltmarsh or brackish marsh support similar fish and wildlife species (Jennings and Weyers, 2003). Any anticipated conversion of saltmarsh to a brackish marsh system would have a negligible impact on the overall function of the wetland system. The Corps 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 after deepening will still be minor when considering the total function of the wetland and continued existence of some freshwater vegetation in wetland areas that would be classified as brackish marsh. For additional information pertaining to the functional assessment, please see Appendix C, Section VII Consideration of 2008 USEPA/USACE Mitigation Rule.

5.01.2.5 Mitigation - Restoration of Wetlands. Since there would be minor adverse effects to the fish and wildlife habitat function in 223 acres of tidal freshwater wetlands if the selected plan is implemented, an assessment was conducted to determine how to best mitigate for that impact. Once the extent of the impacts to wetlands was known, the Corps consulted natural resource agencies, the Stakeholders Evaluation Group, and other NGOs 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 5-15). These sites are within the Savannah River 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 that 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 USFWS 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 5-15. Potential wetland restoration and creation sites.

The USFWS acknowledged that the South Carolina lowcountry is rapidly developing, particularly with regard to large scale residential developments. Lands such as Tract B, 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. Corps' 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 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, Corps' 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 marshes are 2.5 miles ESE of the site. It may be that tidal freshwater marsh would not normally exist on the tract and could 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 require constant intervention to prevent the site from reverting to forested wetlands. As such, the site was removed from consideration for this project.

The Corps consulted the natural resources agencies, the Stakeholders Evaluation Group, and NGOs in an attempt to identify other sites in the Savannah River estuary that could potentially be used for restoration or creation of tidal freshwater marsh. No one could identify other suitable sites.

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.

5.01.2.6 Preservation of Wetlands. 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 Standard Operating Procedure for Compensatory Mitigation (SOP), which has 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 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). The team used the model salinity information and wetland classification to determine the acreage for wetlands of different types. 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.

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 either Freshwater or 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 identified Freshwater and Brackish marshes as being 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 plan would fully mitigate that alternative's indirect adverse impacts to wetlands.

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 in Table 5-16.

Table 5-16. Regulatory 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 48-foot alternative would result in 7,705 units of adverse indirect impacts to wetlands (SOP calculation sheets can be found at the end of Appendix C). 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 in Table 5-17.

Table 5-17. Preservation Needs for Wetland Impacts as Determined by SOP Calculations

Depth Alternative	Minimum Acres Needed
44-FOOT	0
45-FOOT	1,643
46-FOOT	2,188
47-FOOT	2,245
48-FOOT	2,683

Table 5-18 summarizes the results of the SOP calculations for the 47-foot alternative with flow altering plan 6A. The details of the SOP application for each depth alternative are shown in Appendix C. The units shown in the table are calculated through use of the SOP to quantify the amount of mitigation required and the counter-balancing environmental value of various mitigation actions.

Table 5-18. Summary of SOP Calculations for the 47-Foot Depth Alternative

	Freshwater	Brackish	Saltmarsh	Total
Impacted Wetlands				
Acres	223		740	
Units	2007		4736	6743
Restoration				
Acres		964		
Units		4048.8		4048.8 (60.0%)
Preservation				
Acres	2245			
Units	2694.2			2694.2 (40.0%)

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. 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 5-19. Proposed Land Acquisition Acreage

Channel Depth Alternative	Freshwater Wetland Impacts (Acres)	Required Wetland Acquisition (Acres)
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

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." This plan is being updated, and the USFWS has provided the Corps a Draft Map which reflects the latest approved expansion plan for the SNWR. The Corps proposes to acquire lands from the SNWR 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 SWNR has the authority to accept these lands, since the lands are already included in their 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 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 5-16. The project would acquire properties from the approved SNWR 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 Savannah National Wildlife Refuge and will lean heavily on the their identified priorities.

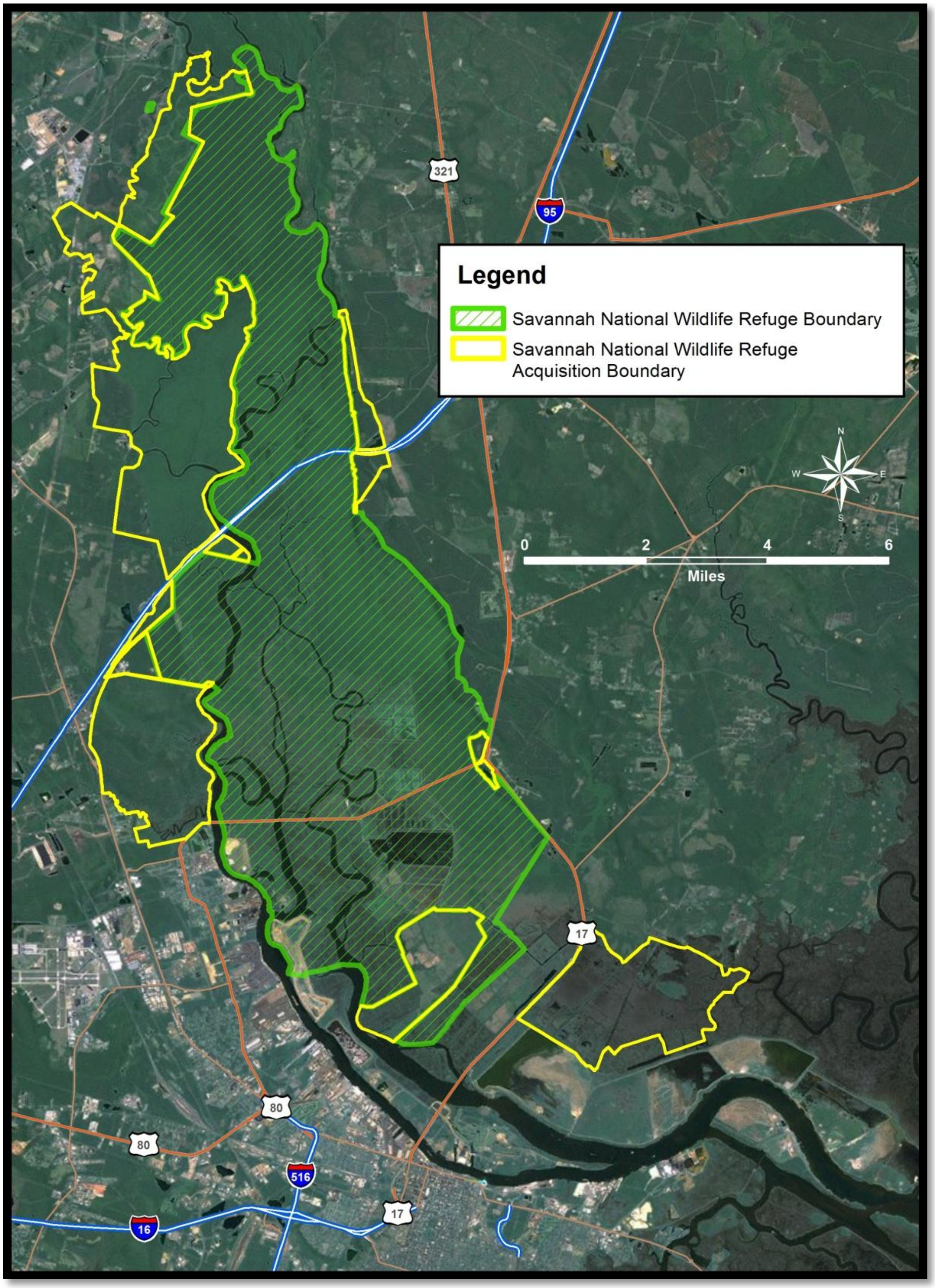

Figure 5-16. Approved refuge acquisition areas.

The Corps assessed the properties in the SNWR's Acquisition Plan to identify potential properties that could meet the wetland mitigation needs of the SHEP. This assessment (Consideration of 2008 USEPA/USACE Mitigation Rule) is in Appendix C. The lands proposed for preservation consist of bottomland hardwoods, maritime forest and uplands dominated by deciduous forest and regrowth. The bottomland hardwoods are classified as palustrine, forested, broad-leaved deciduous wetland systems that are both temporarily and seasonally flooded. Preserving these areas would ensure wildlife habitat is protected in perpetuity. Moreover, the additional lands would buffer the SNWR from future threats of development such that changes in land use would not occur immediately adjacent to existing areas of the Refuge that do contain estuarine emergent wetland characteristics. Thus, the acquisition and preservation of 2,245 acres of wetland and upland buffer would provide a functional replacement for the minor conversion of the only wetland function (i.e., fish and wildlife habitat) that would be expected as a result of the 223 acre freshwater to brackish marsh conversion.

5.01.2.7 Monitoring and Adaptive Management. Due to the unique nature of the impact (i.e., vegetative conversion), the Corps would also monitor to quantify the magnitude of the marsh conversion that does occur. If impacts to tidal freshwater marsh exceed those expected, funds would be available to purchase additional lands for preservation (Adaptive Management Plan). A monitoring plan has been developed (See Appendix D) that would establish 12 marsh monitoring sites in transitional areas that are predicted to most likely experience a vegetative shift as a result of the SHEP. Figure 5-17 shows the location of these 12 marsh monitoring sites. The green line illustrates the existing 0.5 ppt salinity contour within the harbor. The pink line illustrates the 0.5 ppt contour with the 47-foot project and implementation of Flow Diversion Plan 6A.

Seven of the marsh monitoring sites have already been established and were monitored by the USGS Florida Fish and Wildlife Cooperative Research Unit. The five 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 versus exterior). One of the upriver sites and downriver sites would be used as a freshwater marsh and a brackish marsh reference site, respectively. The data collected from this monitoring would be used along with the hydrodynamic and water quality models to quantify indirect impacts to freshwater marsh and saltmarsh. These sites would be monitored during the one year of Pre-Construction monitoring, during construction and for ten additional years of Post-Construction Monitoring. The marsh sites would be characterized with respect to vegetation composition and compared to the reference marsh site. Tidal sample stations would also be installed at the sites which would 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.

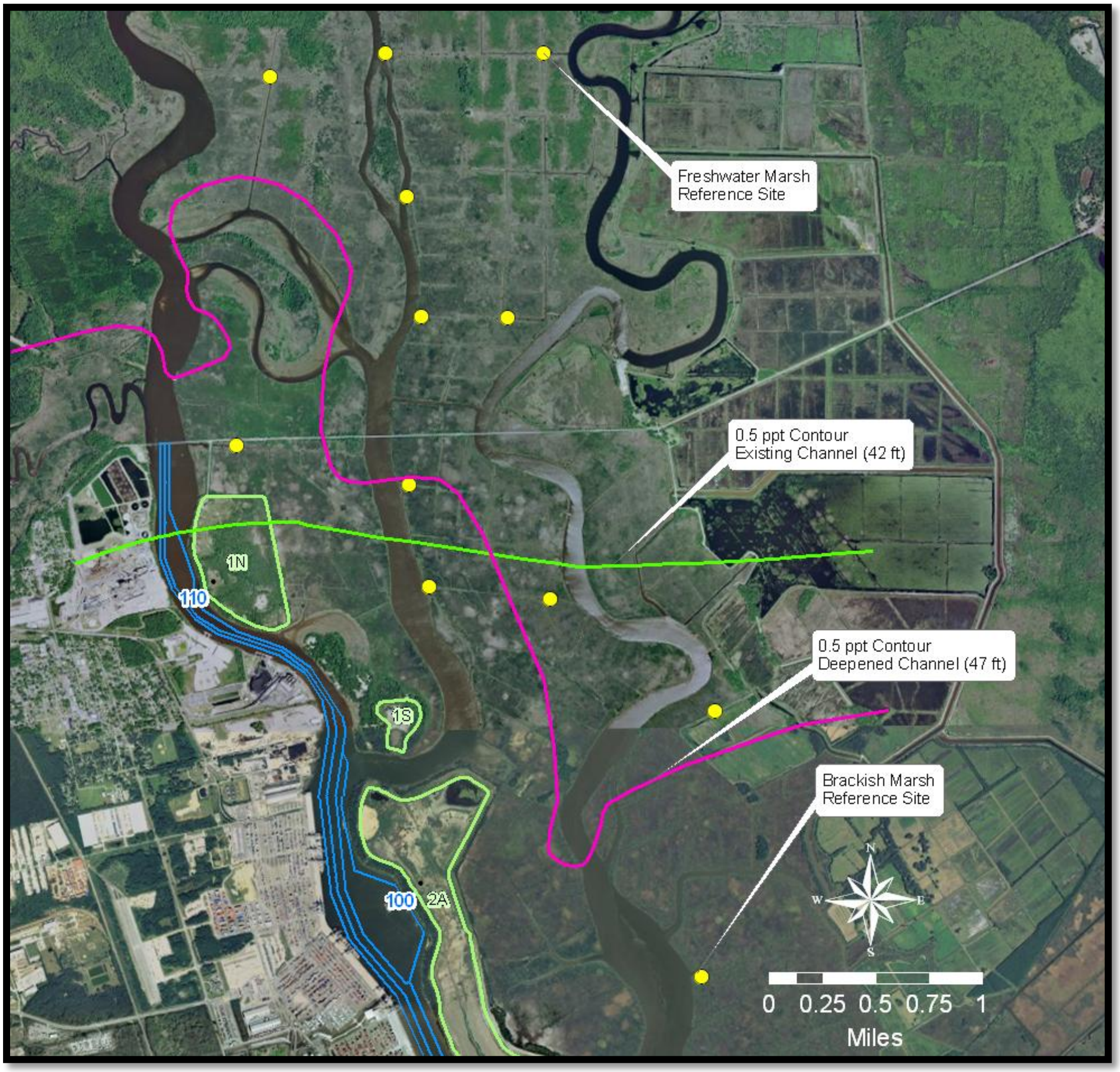

Figure 5-17. Proposed wetlands monitoring sites.

5.02 <u>Water Quality</u>

5.02.1 Dissolved Oxygen

Dissolved oxygen (D.O.) concerns relating to harbor deepening can be divided into three issues: (1) as the channel depth increases, the ability of oxygen to reach the river bottom decreases, causing lower average levels of dissolved oxygen at the bottom, and (2) as the channel prism enlarges, additional saltwater is moved to the upper portions of the harbor and into the estuary, decreasing the ability of those waters to accept oxygen from the air, and (3) as the channel prism enlarges, the average velocity decreases, reducing the mixing of oxygen throughout the water column. If dissolved oxygen concentrations decrease to unacceptable levels, it could have deleterious effects on fish and other aquatic organisms. Lower dissolved oxygen levels also reduce the ability of the estuary to handle the point- and non-point source loads of pollutants entering the estuary.

Another critical factor influencing dissolved oxygen levels in the estuary is the interaction of physical and biological processes. A decrease in dissolved oxygen levels typically occurs during summer months at the upper end of tidal rivers in Georgia and South Carolina. This is the combined effect of the reduced diffusion of oxygen into warm waters and the higher rate of uptake of oxygen from biologic organisms. The combination results in a drop in dissolved oxygen levels both during the summer and particularly during periods of slack tide. This condition is accentuated at the upper end of the navigation channel, where summer dissolved oxygen levels are generally low in the Front River between the Houlihan Bridge (Mile 21.5) and the junction with Back River (Mile 11.2).

The primary area of concern for dissolved oxygen is the Savannah River estuary. More specifically, it is the portion of the Savannah River between Fort Pulaski (River Mile 0.0) and the Seaboard Coastline Railroad Bridge (Mile 27.4). This section of the Savannah River estuary is the area that would be directly affected by the SHEP. Evaluation of impacts to the dissolved oxygen regime is critical, because this segment of the river is on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen.

Model studies conducted by EPA as part of its 2006 TMDL assessment for Savannah Harbor indicate that construction of the existing project (42 foot channel, turning basins, Sediment Basin, etc.) has impacted the dissolved oxygen regime. The model estimates that the dissolved oxygen concentration in Savannah Harbor is 1 mg/l lower because of project improvements that have been made since the baseline year and condition (i.e., 1854 and a 12-foot controlling depth). Model predictions from the SHEP studies indicate that further deepening will have additional impacts on the dissolved oxygen regime in Savannah Harbor.

Two models were used during the SHEP to evaluate the impacts of the deepening alternatives on the dissolved oxygen regime in Savannah Harbor. The Environmental Fluid Dynamics Code (EFDC) model was used to develop the hydrodynamic data and then linked to the Water Quality Analysis Simulation Program Version 7.0 (WASP7) to obtain the dissolved oxygen data predictions.

The study evaluated 26 spatial zones that extend from Clyo, Georgia (61 miles above Fort Pulaski) to the Atlantic Ocean (17 miles offshore from Fort Pulaski). Figure 5-18 shows the 26 zones which included 11 zones for Front River (FR), 6 zones for Middle River (MR), 3 zones for Back River (BR), 3 zones for Little Back River (LBR), 2 zones for South Channel (SC), and 1 zone for the Savannah River (SR). The South Carolina standards for dissolved oxygen were used to evaluate severity of impacts, because they were the most restrictive at the time of the study (daily average of 5 mg/l, with an instantaneous minimum of 4.0 mg/l, applied throughout the water column).

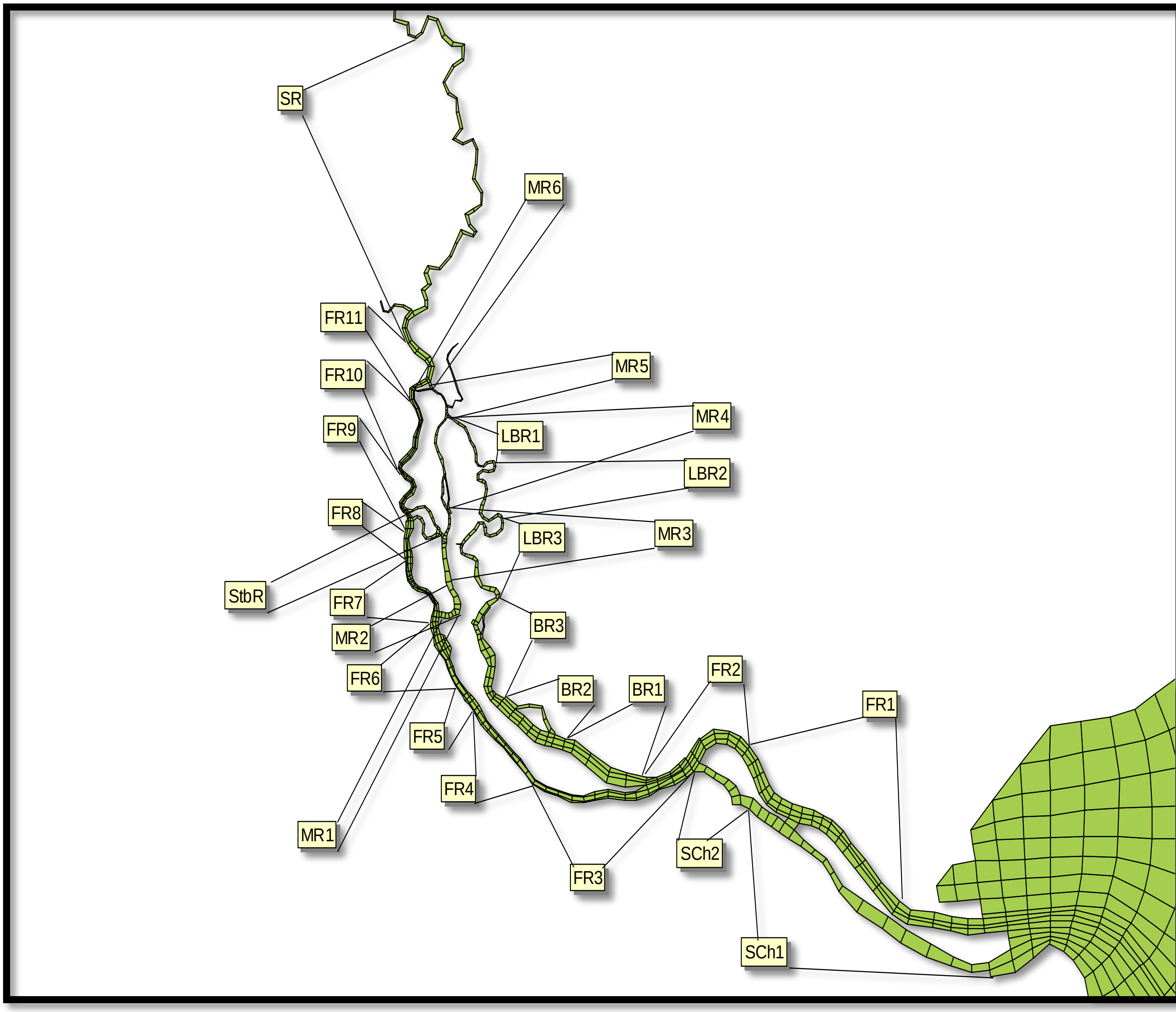

Figure 5-18. Spatial zones in dissolved oxygen study.

As specified by the Water Quality Interagency Coordination Team, the Corps conducted its basic dissolved oxygen impact analyses using average summer drought river flow conditions (August 1999). The interagency team also requested the Corps to evaluate the project's potential effects under other conditions, as sensitivity tests for the input conditions. These additional analyses included average flows in the river (August 1997), natural conditions (i.e., river depths prior to any harbor deepening), 2004 point source loads, and full permitted point source loads. The results of those analyses can be found in the GRR Engineering Appendix. However, as a summary, project impacts to dissolved oxygen were found to be higher under droughts than during average flow conditions.

The following two tables provide a summary of existing dissolved oxygen conditions for the estuary. The first table shows the average dissolved oxygen levels in each of the 26 zones that were modeled (Table 5-20). The second table shows the dissolved oxygen regime for the model grid cell with the lowest dissolved oxygen within each zone (Table 5-21). These data reflect dissolved oxygen levels in the bottom half of the water column, which should be lower than those for the entire water column.

Table 5-20. Average Dissolved Oxygen Levels under Existing Conditions

Zone Name	D.O. Concentration Percentiles (mg/L)								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	4.09	4.16	4.21	4.32	4.44	4.55	4.68	4.76	4.82
FR2	3.86	3.91	3.95	4.15	4.28	4.41	4.51	4.58	4.62
FR3	3.58	3.66	3.72	3.88	4.06	4.25	4.52	4.60	4.81
FR4	3.52	3.57	3.61	3.82	3.96	4.18	4.75	5.15	5.41
FR5	3.53	3.62	3.69	3.91	4.08	4.58	5.26	5.53	5.69
FR6	3.79	3.83	3.92	4.13	4.36	5.04	5.69	5.86	5.97
FR7	4.25	4.36	4.52	4.92	5.78	6.15	6.38	6.53	6.68
FR8	4.71	4.92	5.13	5.57	6.13	6.42	6.67	6.79	6.96
FR9	5.60	5.87	5.99	6.24	6.53	6.80	7.05	7.21	7.33
FR10	5.71	5.85	6.01	6.30	6.57	6.81	7.16	7.23	7.32
FR11	4.88	5.10	5.28	5.59	5.88	6.18	6.45	6.55	6.68
MR1	4.29	4.41	4.55	4.79	5.06	5.47	5.77	5.89	5.99
MR2	4.17	4.29	4.47	4.73	5.05	5.40	5.73	5.84	5.98
MR3	3.84	4.02	4.09	4.36	4.71	5.19	5.55	5.67	5.79
MR4	4.38	4.50	4.60	4.77	5.04	5.23	5.43	5.53	5.69
MR5	2.31	2.55	2.96	3.46	5.33	6.16	6.53	6.82	7.01
MR6	2.15	2.53	3.05	3.58	5.69	6.32	6.80	6.94	7.27
LBR1	4.29	4.49	4.58	4.79	4.98	5.18	5.29	5.44	5.56
LBR2	3.69	3.80	3.95	4.13	4.35	4.55	4.70	4.76	4.89
LBR3	3.52	3.56	3.63	3.77	3.93	4.08	4.22	4.31	4.42
BR1	3.42	3.47	3.52	3.77	3.90	4.06	4.24	4.32	4.42
BR2	3.17	3.25	3.34	3.47	3.65	3.83	3.96	4.11	4.19
BR3	3.36	3.41	3.46	3.52	3.63	3.74	3.84	3.87	3.90
SCh1	3.40	3.46	3.53	3.61	3.72	3.87	3.95	4.02	4.08
SCh2	3.84	3.94	3.99	4.11	4.26	4.38	4.48	4.53	4.63
SR	4.90	4.95	5.18	5.52	5.84	6.17	6.35	6.41	6.48
StbR	4.73	4.91	5.07	5.39	5.75	6.06	6.25	6.38	6.54

Table 5-21. Lowest Dissolved Oxygen in Each Zone under Existing Conditions

Zone Name	D.O. Concentration Percentiles (mg/L)								
	1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
FR1	3.86	3.93	3.99	4.13	4.3	4.43	4.56	4.62	4.69
FR2	3.56	3.66	3.74	3.91	4.1	4.28	4.46	4.52	4.91
FR3	3.36	3.47	3.5	3.71	3.9	4.14	4.59	4.9	5.48
FR4	3.34	3.43	3.49	3.74	3.91	4.23	4.78	5.14	5.36
FR5	3.45	3.55	3.68	3.88	4.1	4.7	5.26	5.51	5.68
FR6	3.55	3.66	3.78	3.95	4.19	4.8	5.55	5.78	5.95
FR7	3.98	4.06	4.14	4.4	4.86	5.93	6.22	6.34	6.48
FR8	4.48	4.62	4.9	5.41	6.09	6.43	6.71	6.83	7.11
FR9	4.72	4.87	5.22	5.62	6.24	6.57	6.83	6.99	7.18
FR10	4.31	4.78	4.95	5.32	5.91	6.43	6.68	7.01	7.21
FR11	4.17	4.7	4.93	5.24	5.66	6.14	6.49	6.64	7.13
MR1	4.22	4.34	4.47	4.72	5.05	5.51	5.81	5.93	6.19
MR2	4.01	4.13	4.3	4.6	5.02	5.47	5.73	5.84	5.98
MR3	3.68	3.88	3.94	4.16	4.47	4.95	5.66	5.93	6.28
MR4	3.87	4.02	4.11	4.37	4.59	4.87	5.04	5.15	5.39
MR5	1.49	2.04	2.41	3.05	4.97	6.23	6.56	6.89	7.11
MR6	2.11	2.49	3.01	3.51	5.61	6.35	6.8	7.06	7.32
LBR1	3.57	4.35	4.74	5.12	5.42	5.64	5.97	6.15	6.47
LBR2	3.68	3.86	3.97	4.15	4.38	4.59	4.77	4.86	5.24
LBR3	2.88	3.28	3.46	3.67	3.92	4.31	4.7	4.95	5.18
BR1	3.15	3.28	3.44	3.59	3.82	4.05	4.26	4.34	4.45
BR2	2.43	2.72	2.86	3.11	3.3	3.54	3.67	3.74	3.82
BR3	2.87	3.12	3.32	3.48	3.65	3.8	3.93	4	4.13
SCh1	2.25	2.41	2.53	2.68	2.88	3.3	3.69	3.8	4.08
SCh2	3.62	3.78	3.88	4.02	4.19	4.35	4.48	4.56	4.7
SR	4.69	4.74	4.97	5.31	5.62	5.97	6.11	6.16	6.23
StbR	3.83	4.19	4.53	5.01	5.66	6.16	6.47	6.62	6.81

From a general perspective, the model shows that harbor deepening without mitigation would result in insignificant (1-2%) increases in the percentage of the harbor's waters with violations of existing dissolved oxygen standards. There would be upstream shifts of lower dissolved oxygen zones in bottom and surface layers of the estuary as the channel deepening increases in magnitude. The studies also indicate that deteriorations of the lowest dissolved oxygen values along critical cells (the cell with the lowest dissolved oxygen concentrations during specified simulation period) of major parts of the estuary increase proportionately to the amount of deepening.

NOTE: The following data show dissolved oxygen levels without mitigation for D.O. but with the flow re-routing components of the harbor deepening alternatives. These data also reflect conditions in the bottom half of the water column (i.e., bottom 3 layers of the 6-layer model), where dissolved oxygen levels are lower. For the data shown in Tables 5-22 to 5-26, the Corps identified a decrease in dissolved oxygen as substantial when values reported in the 10th percentile Project-Baseline Difference category were reduced by 0.25 mg/l.

Table 5-22 shows the predictions for the dissolved oxygen regime deterioration for the 48-foot channel project (1999 drought conditions). The most dissolved oxygen deterioration would occur with the 48-foot channel project. Critical cells of Front River Zones FR6-FR8, and FR11, Middle River Zone MR1, Lower Back River Zone LB3, as well as critical cells in Back River Zones BR1-BR3 show a substantial decrease in dissolved oxygen levels, while dissolved oxygen would increase in Front River Zones FR2-FR5, FR9, FR10, Middle River Zones MR2-MR6, and Lower Back River Zones LBR1 and LBR2.

Table 5-22. Predicted Dissolved Oxygen Decreases - 48-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
FR1	0.8	0.5	0.0	0.0	-0.7	-0.9	-2.2	-2.4	-3.0
FR2	-0.8	8.5	8.8	7.4	5.6	4.4	3.4	3.5	-2.2
FR3	4.5	2.6	2.9	2.2	-0.5	-2.9	-5.7	-2.9	-4.7
FR4	5.1	3.8	2.9	1.1	-0.8	-5.0	-9.6	-8.0	-1.9
FR5	4.6	4.2	2.7	0.8	-1.2	-8.1	-13.9	-11.6	-10.0
FR6	1.7	1.1	-0.5	-0.3	-3.3	-10.8	-14.1	-11.6	-9.7
FR7	-4.5	-3.2	-3.1	-6.6	-11.9	-21.4	-11.7	-5.5	-3.1
FR8	-7.4	-8.0	-11.0	-15.0	-11.5	-7.2	-5.4	-4.2	-5.8
FR9	6.4	11.3	6.5	5.2	1.3	0.6	1.0	2.0	4.2
FR10	8.8	5.4	5.9	4.3	-0.2	-1.6	-1.3	-2.3	-0.8
FR11	0.2	-2.6	-2.4	-2.3	-0.2	0.0	-1.4	0.3	-2.8
MR1	-5.5	-5.3	-5.6	-5.9	-5.5	-9.1	-8.6	-8.1	-4.2
MR2	4.2	4.4	3.0	0.9	-2.4	-6.8	-5.2	-4.8	-4.8
MR3	12.8	10.6	11.9	10.6	9.2	3.0	-6.0	-7.3	-9.1
MR4	11.6	10.2	10.5	8.5	9.6	9.0	10.9	10.7	11.1
MR5	47.7	35.8	29.5	26.6	7.8	-0.6	-0.8	-1.6	-1.3
MR6	191.0	153.0	114.0	89.2	23.0	13.9	9.1	6.4	4.0
LBR1	14.0	10.8	7.6	7.2	7.0	8.2	5.9	6.2	3.6
LBR2	16.3	18.1	18.1	18.6	17.4	17.4	16.4	17.1	10.9
LBR3	-13.5	-19.5	-19.4	-18.0	-15.8	-16.0	-18.9	-21.2	-21.8
BR1	-43.5	-35.4	-23.3	-7.0	3.4	12.3	12.0	11.3	10.8
BR2	-40.7	-33.1	-29.7	-23.2	-13.9	-3.1	2.2	3.2	4.2
BR3	-41.8	-38.1	-38.9	-36.8	-32.9	-24.5	-15.5	-13.5	-11.1
SCh1	-7.1	-0.8	1.2	1.9	4.5	17.9	13.6	14.7	11.5
SCh2	-0.8	-2.6	-2.1	-1.0	-0.7	-1.1	-1.3	-1.5	-2.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-4.7	2.1	-0.9	0.4	-1.8	-3.1	-3.2	-3.9	-3.2

Table 5-23 shows the predictions for the dissolved oxygen regime deterioration of the 47-foot channel project. For the 47-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR7, FR8, and FR11, and Middle River Zone MR1, Lower Back River Cell LB3, as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR1-FR5, FR9, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

Table 5-23. Predicted Dissolved Oxygen Decreases - 47-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.5	0.5	0.3	0.2	-0.7	-0.9	-1.8	-1.9	-1.9
FR2	-2.8	7.9	8.6	6.9	5.6	4.4	3.6	3.8	-2.4
FR3	4.5	2.3	2.6	1.9	-0.3	-2.4	-4.6	-0.2	-2.9
FR4	5.1	3.5	2.6	0.8	-0.5	-4.5	-8.2	-6.0	0.6
FR5	4.6	3.1	1.4	0.0	-2.2	-11.3	-12.2	-11.8	-10.4
FR6	2.0	1.6	0.0	0.3	-2.9	-9.2	-11.7	-9.9	-8.1
FR7	-4.3	-2.7	-2.9	-6.4	-11.3	-18.7	-7.7	-4.3	-2.8
FR8	-6.5	-6.9	-10.2	-14.0	-9.0	-5.8	-4.9	-4.0	-5.6
FR9	1.1	6.2	2.9	5.5	1.9	1.7	2.5	3.0	2.5
FR10	8.8	5.4	5.7	4.3	-0.3	-1.7	-1.3	-2.3	-0.8
FR11	0.2	-2.3	-2.4	-2.5	-0.2	0.0	-1.4	0.3	-2.7
MR1	-4.7	-4.6	-5.4	-5.1	-5.0	-8.3	-7.6	-6.7	-3.7
MR2	4.5	5.1	3.5	0.0	-4.2	-7.5	-5.9	-5.5	-1.7
MR3	12.8	11.1	12.2	11.1	9.6	3.8	-5.5	-6.6	-8.1
MR4	12.1	10.2	11.2	8.7	9.8	8.8	10.5	10.5	11.1
MR5	47.7	36.3	29.5	26.6	7.8	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	13.7	10.8	7.8	7.2	6.8	8.0	5.9	6.2	3.4
LBR2	21.5	18.4	18.1	18.3	17.4	17.2	16.4	16.7	10.7
LBR3	-12.2	-18.9	-18.5	-17.4	-15.3	-16.0	-18.7	-21.6	-22.6
BR1	-46.3	-38.7	-26.5	-8.1	2.9	11.9	12.4	11.8	11.0
BR2	-43.6	-36.8	-32.5	-25.4	-15.2	-4.2	0.8	2.4	4.5
BR3	-44.6	-41.3	-41.9	-39.4	-35.3	-27.4	-17.3	-15.5	-13.1
SCh1	-4.0	-2.9	0.8	3.4	1.7	-4.5	-3.8	-3.2	-5.9
SCh2	-1.4	-2.6	-2.1	-1.0	-0.7	-1.1	-0.7	-1.3	-1.3
SR	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-2.6	1.9	0.2	1.2	-0.5	-2.4	-2.6	-2.9	-2.8

Table 5-24 shows the predictions for the dissolved oxygen regime deterioration of the 46-foot channel project. For the 46-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zone FR1, FR8, FR9, FR11, Middle River Zone MR1, Lower Back River Zone LBR3, as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR7, FR10, Middle River Zones MR2, MR3, MR4, MR5, MR6, and Lower Back River Zones LBR1 and LBR2.

Table 5-24. Predicted Dissolved Oxygen Decreases - 46-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
FR1	0.5	-0.3	-0.5	0.0	-0.7	-0.5	-1.5	-1.5	-2.1
FR2	-5.1	7.4	7.8	6.9	5.6	4.7	3.6	3.8	-2.0
FR3	3.9	1.7	2.3	1.9	0.0	-1.7	-2.8	2.0	-2.0
FR4	3.6	2.9	2.3	0.8	-0.5	-4.0	-6.9	-3.7	2.1
FR5	4.1	3.1	2.2	0.8	-1.0	-6.4	-9.9	-6.9	-5.8
FR6	2.3	1.6	0.3	0.8	-2.1	-7.5	-8.1	-6.7	-5.2
FR7	6.0	7.4	8.7	8.2	10.5	-0.3	1.0	1.7	9.4
FR8	-5.1	-6.3	-9.0	-12.4	-7.4	-4.5	-3.7	-3.2	-4.6
FR9	-6.1	-7.4	-10.2	-11.9	-6.9	-3.2	-2.8	-3.6	-2.5
FR10	8.8	5.4	5.5	4.5	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.8	-2.4	-2.5	0.0	0.0	-1.4	0.3	-2.8
MR1	-4.0	-4.1	-4.3	-4.2	-4.0	-7.8	-5.9	-5.4	-2.1
MR2	5.2	5.3	3.5	1.5	-1.4	-5.3	-3.7	-2.9	-3.3
MR3	14.1	10.3	11.4	11.5	9.2	3.2	-6.2	-8.4	-9.6
MR4	12.4	10.4	11.2	9.2	9.8	9.2	10.5	10.3	10.9
MR5	47.7	36.3	29.0	26.6	7.6	-0.6	-0.5	-1.6	-1.1
MR6	191.0	153.4	114.3	89.2	23.0	13.9	9.0	6.4	4.0
LBR1	12.6	10.6	8.0	7.0	6.8	8.0	5.9	6.3	3.2
LBR2	0.0	17.9	17.9	18.6	17.4	17.0	16.4	16.9	10.7
LBR3	-10.8	-18.9	-18.2	-16.9	-15.3	-16.0	-19.1	-21.4	-22.2
BR1	-48.6	-42.7	-29.9	-10.0	1.8	11.4	12.4	12.0	11.0
BR2	-48.6	-40.4	-36.4	-27.7	-16.1	-5.1	0.3	2.1	4.2
BR3	-47.7	-44.2	-43.7	-40.8	-36.4	-29.5	-19.1	-16.5	-14.8
SCh1	-5.3	-3.7	1.6	3.0	1.0	-4.2	-4.9	-2.6	-4.2
SCh2	-0.6	-1.1	-1.3	-1.2	-1.0	-1.1	-1.1	-0.9	-0.9
SR	-0.2	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
StbR	-0.8	2.6	1.3	2.0	-0.5	-1.3	-2.0	-2.4	-2.8

Table 5-25 shows the predictions for the dissolved oxygen regime deterioration of the 45-foot channel project. For the 45-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR7, FR8, FR9, and FR11, Middle River Zone MR1, Lower Back River Zone LBR 3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR6 and FR10, Middle River Zones MR3, MR4, MR5, MR6 and Lower Back River Zones LBR1 and LBR2.

Table 5-25. Predicted Dissolved Oxygen Decreases - 45-foot Depth Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	0.8	0.0	0.0	0.2	-0.5	-0.5	-0.9	-1.1	-1.5
FR2	-7.9	7.9	8.3	6.9	5.9	4.7	4.0	4.0	-1.8
FR3	3.9	1.7	2.3	3.0	0.5	-0.7	-2.0	2.4	-1.3
FR4	3.6	2.3	2.3	2.1	0.8	-1.9	-3.6	0.8	3.0
FR5	4.1	2.5	0.8	0.0	-1.7	-11.5	-8.4	-7.6	-6.7
FR6	2.3	2.2	0.8	1.5	-1.0	-4.8	-4.5	-4.3	-2.4
FR7	-3.0	-1.7	-2.4	-4.5	-8.2	-11.8	-3.4	-2.5	-1.9
FR8	-4.5	-5.4	-7.6	-10.2	-5.1	-3.6	-3.6	-2.5	-3.5
FR9	-5.3	-6.4	-8.8	-9.8	-5.4	-2.4	-2.3	-3.6	-2.5
FR10	8.8	5.4	5.5	4.3	-0.2	-1.9	-1.2	-2.3	-1.0
FR11	0.2	-2.3	-2.4	-2.5	0.0	0.0	-1.4	0.2	-2.7
MR1	-3.1	-3.2	-3.4	-3.4	-3.0	-6.4	-4.3	-3.5	-1.3
MR2	5.2	5.6	4.0	1.7	-0.8	-4.2	-2.8	-1.9	-2.8
MR3	13.9	12.1	12.4	11.5	10.3	4.6	-4.1	-4.9	-7.2
MR4	13.2	10.4	11.7	9.2	9.8	8.8	10.5	10.3	10.8
MR5	48.3	37.3	29.0	25.9	7.6	-0.6	-0.6	-1.6	-1.1
MR6	191.0	153.8	114.6	89.2	23.0	13.7	9.0	6.4	4.0
LBR1	12.3	10.8	8.2	7.0	6.6	7.8	5.7	6.2	3.1
LBR2	21.5	18.7	18.1	18.6	17.1	17.2	16.4	17.3	23.5
LBR3	-10.1	-17.7	-17.6	-16.9	-14.8	-15.5	-18.7	-21.4	-22.2
BR1	-53.0	-46.3	-33.7	-11.4	1.6	10.9	12.9	12.0	11.7
BR2	-51.4	-41.5	-38.1	-30.5	-17.6	-5.9	-0.3	1.6	3.1
BR3	-52.6	-47.1	-46.4	-42.5	-38.6	-31.6	-20.6	-18.5	-15.5
SCh1	-7.1	1.2	0.0	2.2	7.3	19.7	16.0	15.5	12.0
SCh2	0.0	-1.1	-0.5	-0.7	-0.5	-0.9	-0.9	-0.9	-0.4
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	2.3	3.8	2.4	2.4	-0.2	-1.0	-1.7	-2.0	-1.6

Table 5-26 shows the predictions for the dissolved oxygen regime deterioration of the 44-foot channel project. For the 44-foot channel, a substantial decrease in dissolved oxygen would occur in the critical cells of Front River Zones FR1, FR5-FR8, and FR11, Middle River Zones MR1, and MR5, Lower Back River Zone LBR 3 as well as Back River Zones BR1, BR2 and BR3. Dissolved oxygen would increase in Front River Zones FR2-FR4, FR9, and FR10, Middle River Zones MR2-MR4, and MR6 and Lower Back River Zones LBR1 and LBR2. The changes in dissolved oxygen profiles for the 44-foot depth alternative are considerably different from the other alternatives since the flow rerouting components are different with this channel depth alternative.

Table 5-26. Predicted Dissolved Oxygen Decreases - 44-foot Alternative (No D.O. Mitigation)

Zone Name	Relative Percent Difference from Existing Condition								
	1%	5%	10%	25%	50%	75%	90%	95%	99%
FR1	-0.3	-0.8	-1.0	-0.5	-0.7	-0.2	-0.9	-0.4	-1.3
FR2	-9.0	7.4	7.0	6.4	5.9	4.9	4.0	4.4	-1.8
FR3	3.0	0.9	1.4	2.4	0.8	0.0	1.3	3.9	-0.2
FR4	3.3	1.7	2.0	1.3	0.5	-1.9	-2.9	-1.8	0.9
FR5	3.2	1.7	-0.5	-0.8	-2.7	-11.1	-7.0	-6.0	-4.9
FR6	1.4	0.3	-1.1	0.5	-1.9	-6.0	-4.0	-2.9	-1.7
FR7	-2.5	-1.7	-1.9	-3.9	-7.2	-6.7	-2.6	-2.2	-1.5
FR8	-3.6	-4.1	-6.3	-8.5	-3.1	-2.0	-2.8	-2.5	-3.5
FR9	7.0	14.0	10.0	9.1	3.4	2.4	3.2	2.7	2.4
FR10	7.0	4.8	4.0	3.0	-1.0	-2.6	-1.6	-3.6	-1.1
FR11	-13.9	-12.8	-11.6	-9.0	-0.7	-1.1	-2.2	-1.7	-4.1
MR1	-2.6	-2.5	-2.5	-2.8	-2.6	-6.0	-2.6	-1.9	-0.6
MR2	3.7	4.1	2.1	0.4	-2.6	-4.2	-1.6	-1.0	-1.5
MR3	11.4	7.7	9.6	8.2	6.7	1.6	-7.4	-8.4	-9.6
MR4	-0.8	16.2	19.5	19.0	19.0	18.3	20.2	21.4	24.7
MR5	-6.0	-23.5	-24.5	-16.4	0.8	-1.9	-1.7	-2.5	-2.0
MR6	157.3	134.9	104.7	86.0	21.2	12.4	8.4	5.8	3.4
LBR1	-10.9	-3.4	1.7	2.3	1.5	2.7	1.8	2.3	0.6
LBR2	3.8	6.5	6.0	6.0	5.9	5.9	5.0	6.4	8.4
LBR3	-39.6	-41.2	-40.8	-35.1	-30.4	-28.8	-29.8	-30.7	-32.0
BR1	-70.5	-57.6	-49.1	-32.9	-19.1	-3.7	-3.3	-3.5	-3.1
BR2	-79.0	-72.1	-64.3	-46.9	-33.3	-29.1	-24.0	-21.4	-19.1
BR3	-75.6	-68.3	-66.6	-60.3	-54.8	-41.6	-28.8	-24.8	-22.3
SCh1	-3.1	-1.7	0.4	0.7	1.0	-3.0	-3.5	-1.6	-3.9
SCh2	0.0	-1.1	-0.8	-0.7	-0.5	-0.9	-0.9	-0.9	0.0
SR	-0.2	-0.2	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2
StbR	5.7	5.7	3.5	3.2	0.4	-0.6	-1.4	-1.1	-0.9

5.02.2 Mitigation for Impacts to 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 to minimize that adverse effect.

The Corps' studies indicate that oxygen injection is the most cost-effective method for raising dissolved oxygen levels in the harbor. Additional information about other alternatives that were considered is addressed in the MACTEC Report *Screening Level Evaluation of Measures to Improve Dissolved Oxygen in the Savannah River Estuary, Savannah Harbor Expansion Project and Savannah Harbor Ecosystem Restoration Study,* which is included in Attachment 3 of the Engineering Appendix of the GRR. Due to site-specific requirements, a land-based oxygen injection system was determined to be the most effective solution. The studies identified the use of Speece cones as the specific technique to inject oxygen into the water, although another land-based technique might be found later that could 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 Table 5-27. These systems would remove the incremental effects of the channel deepening alternatives.

Table 5-27. 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 general locations identified for these systems are shown in Figure 5-19. All three injection locations (near Georgia Power's Plant McIntosh, Hutchinson Island – west, Hutchinson Island – east) would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend into the authorized navigation channel. Figure 5-20 shows a typical layout for the oxygen injection facility. The systems would be operated to provide the needed amount of oxygen for that depth alternative during the months of July, August, and September. The Corps would begin to operate the systems on 15 June to allow the dissolved oxygen to be fully distributed throughout the estuary by 1 July.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the injection site increases. Removing the incremental adverse project effect at a great distance from an injection site requires large amounts of oxygen. This becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity (and cost) of maintaining numerous systems also increases. The oxygen injection system configuration is designed to remove the incremental effect of a deeper channel in 97 percent of the cells in the hydrodynamic model. The minor impact at distances away from the injection location is balanced by the higher dissolved oxygen levels that would occur close to where the oxygen is added. The Corps believes the 97 percent level of performance recognizes both the higher dissolved oxygen levels close to the injection sites and the limitations of the model at distinguishing small differences between different run conditions.

Staff from natural resource agencies initially expressed concern about the potential for fish toxicity from the super-saturated discharge of the oxygen injection systems. To address those concerns and others, GPA conducted a Demonstration Project in 2008 of the Speece Cone technology in Savannah Harbor. They contracted for operation of two cones for roughly 6 weeks during the peak of the summer DO season. The systems was designed and operated for temporary operation (from a floating barge rather than a permanent landside facility). Extensive monitoring was performed to identify and document the effects of the system operation. Resource agency staff made several visits to view the operation themselves. The data collected during the demonstration was compiled by MACTEC included in a 2008 report titled *Savannah Harbor Reoxygenation Demonstration Project*. In response to questions from the resource agencies, MACTEC provided an additional report in 2009 titled *Savannah Harbor Reoxygenation Demonstration Project, Supplemental Data Evaluation Report*. This report is included in the GRR Engineering Appendix Supplemental Materials #49. Page 4-1 states "Nearfield mixing zone monitoring indicated that the supersaturated water injected by the ReOx system quickly mixed with the river water reducing DO plume concentrations by almost two orders of magnitude within 5 seconds ..." Page 281-343 discusses "Total Dissolved Gases and Dissolved Oxygen / Dissolved Nitrogen Ratios in Preventing Fish Mortality". Dissolved nitrogen is identified as being the major component in gas bubble disease. However, since the proposed system will oxygenate water with pure oxygen, dissolved nitrogen levels will not increase. Therefore, the traditional fish mortality that occurs with deep injection would not be a problem with the D.O. system design envisioned for Savannah Harbor.

MACTEC also provided the results of additional water quality modeling in a 2009 report titled *Modeling of GPA's Oxygen Injection Demonstration Project, Savannah, Georgia*. This report is included in the GRR Engineering Appendix Supplemental Materials #50. The near-field plume was modeled and described in Section 4.2 of that report. As shown in Figure 4-4, the modeling indicated that the discharge plume diluted from its initial concentration of 140 mg/l to about 10 mg/l within about 15 feet. Since there are large tidal flows in the Savannah River, fish moving with the current would only spend only a few seconds in the dilution plume. Fish could selectively choose to hold their position in the plume, but they would be choosing to concentrate in a small area within a 100-foot wide river.

The visual inspections that MACTEC and resource agency staff performed during the Demonstration Project did not observe any fish mortality or fish in distress. On the contrary, abundant wildlife was observed in the vicinity of the injection site. After observing the Speece cone system in operation, State and Federal environmental agency staff did not express any further concerns about fish mortality. The state water quality certifications require installation and operation of the D.O. systems as a condition of the Water Quality Certification. NOAA Fisheries also requires installation and operation of the D.O. systems as a condition of their Biological Opinion.

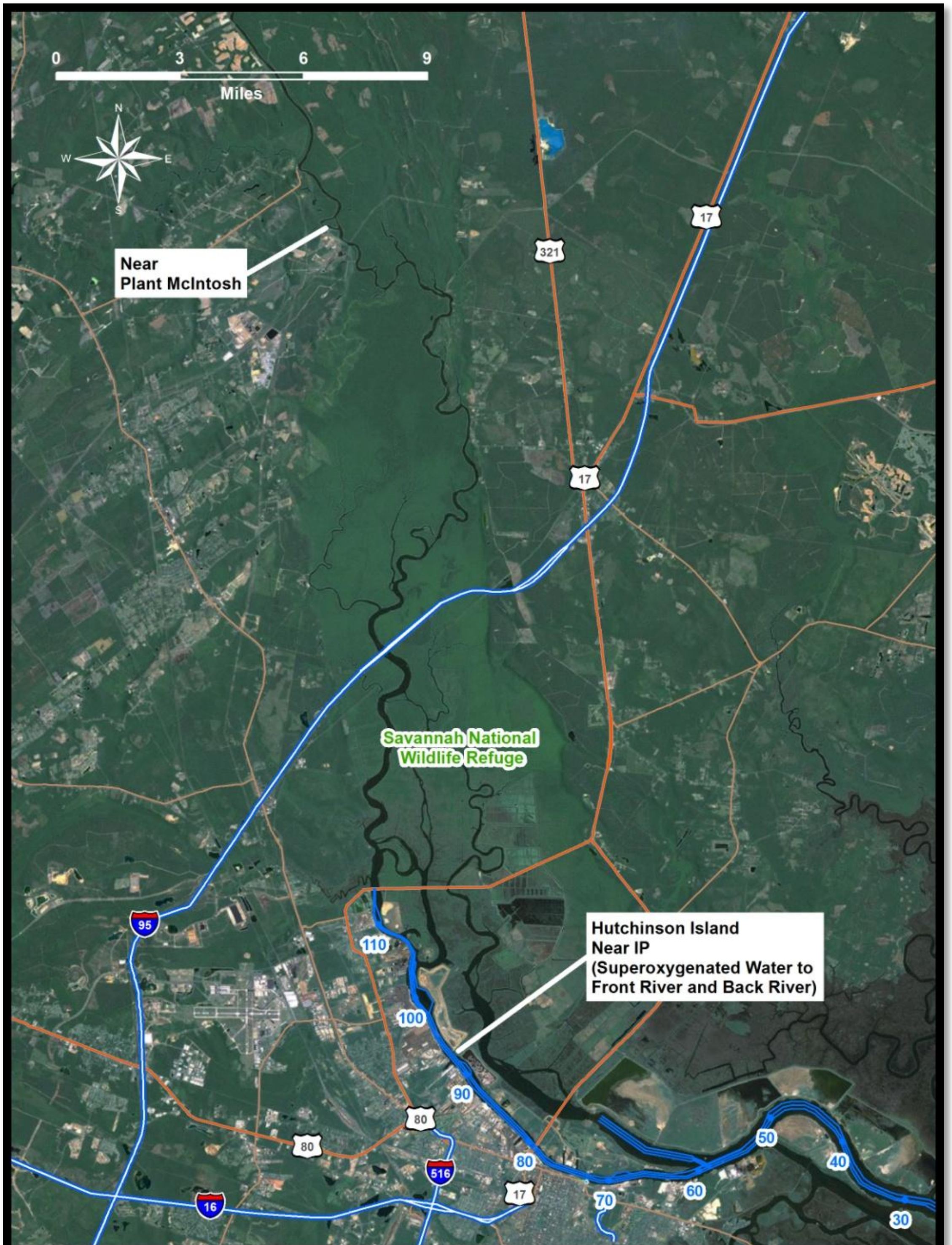

Figure 5-19. Locations for oxygen injection systems.

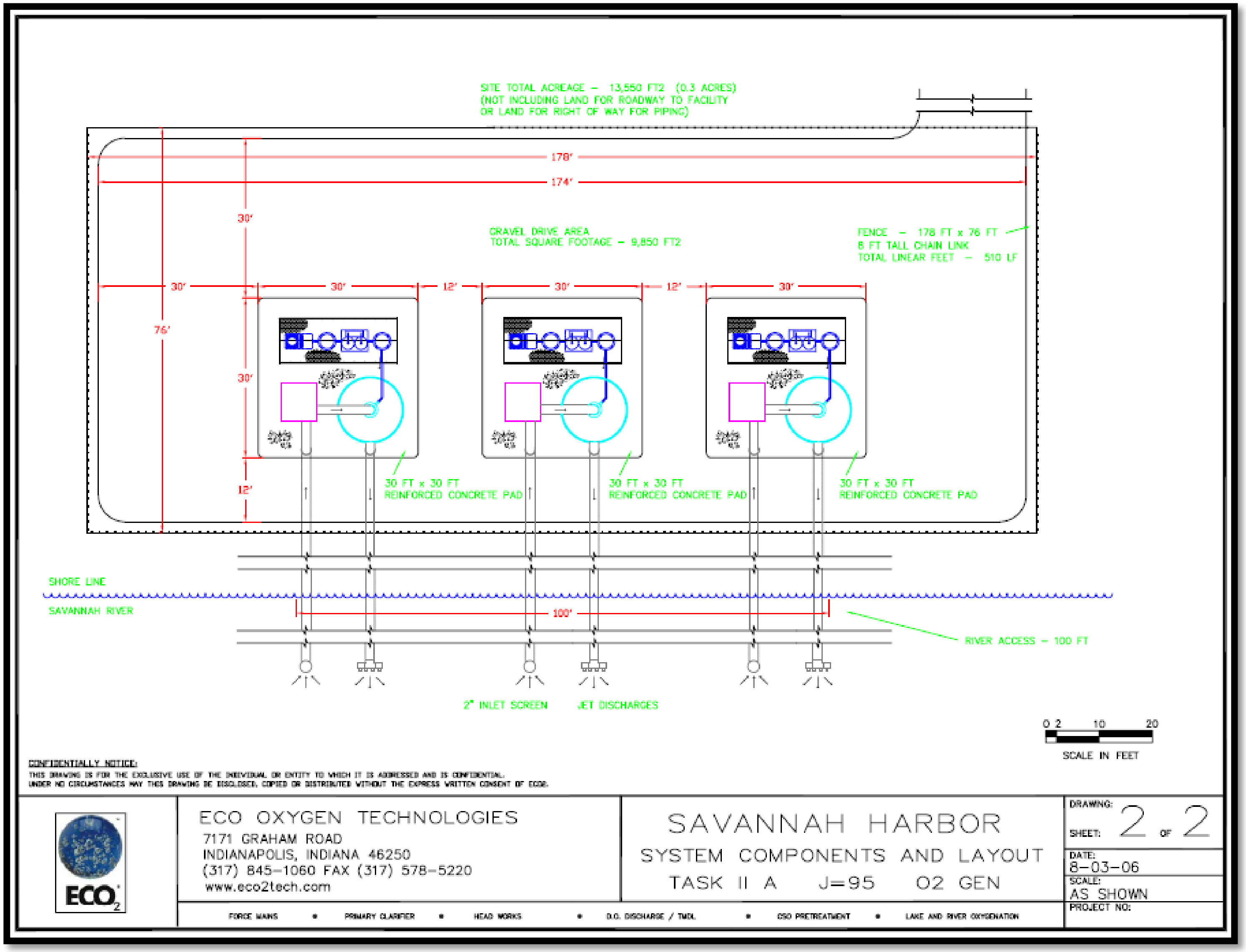

Figure 5-20. Layout of oxygen injection systems.

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 incidentally increase dissolved oxygen levels above their present levels over much of the harbor. Such improvements are a secondary incidental 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 in Table 5-28 shows the extent of the improvements that would occur:

Table 5-28. 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	98.0	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 dissolved oxygen levels.

5.02.3 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 (M&I) water treatment plant (Figure 5-21). 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 deepening limits. The City presently operates the plant at around 30 MGD. That rate has been increasing substantially in recent years as the western part of the County has grown rapidly.

Figure 5-21. 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 chloride.

Although most of the water supply from this intake is used 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 wells 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) secondary 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. 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) 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 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 Tier I phase of the project about whether additional harbor deepening would allow salinity to move upriver to the extent that chloride concentrations would increase to unacceptable levels at the City's water intake. Industrial users 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 customers 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 that study were to develop 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; and 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 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 chloride 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. Those documents also stated that, as a result of concerns expressed by the City of Savannah about the technical reliability of the impact prediction tool, the Corps would further evaluate this issue.

The District and GPA began an intensive campaign to collect additional chloride data. The additional data was 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.

5.02.4 Recent Data Collection

The Corps decided to collect 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 5-22 including:

A. Abercorn Creek (flows, water surface, chloride, temperature, and conductivity)

B. Bear Creek (flow, water surface, flow splits for Abercorn and Little Collis Creeks)
C. I-95 Bridge (water surface, chloride, temperature, and conductivity)
D. Houlihan Bridge (flow, water surface, chloride, temperature, and conductivity)
E. Plant McIntosh (water surface, chloride, temperature, and conductivity)
F. City Intake on Abercorn Creek (chloride)

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, 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.

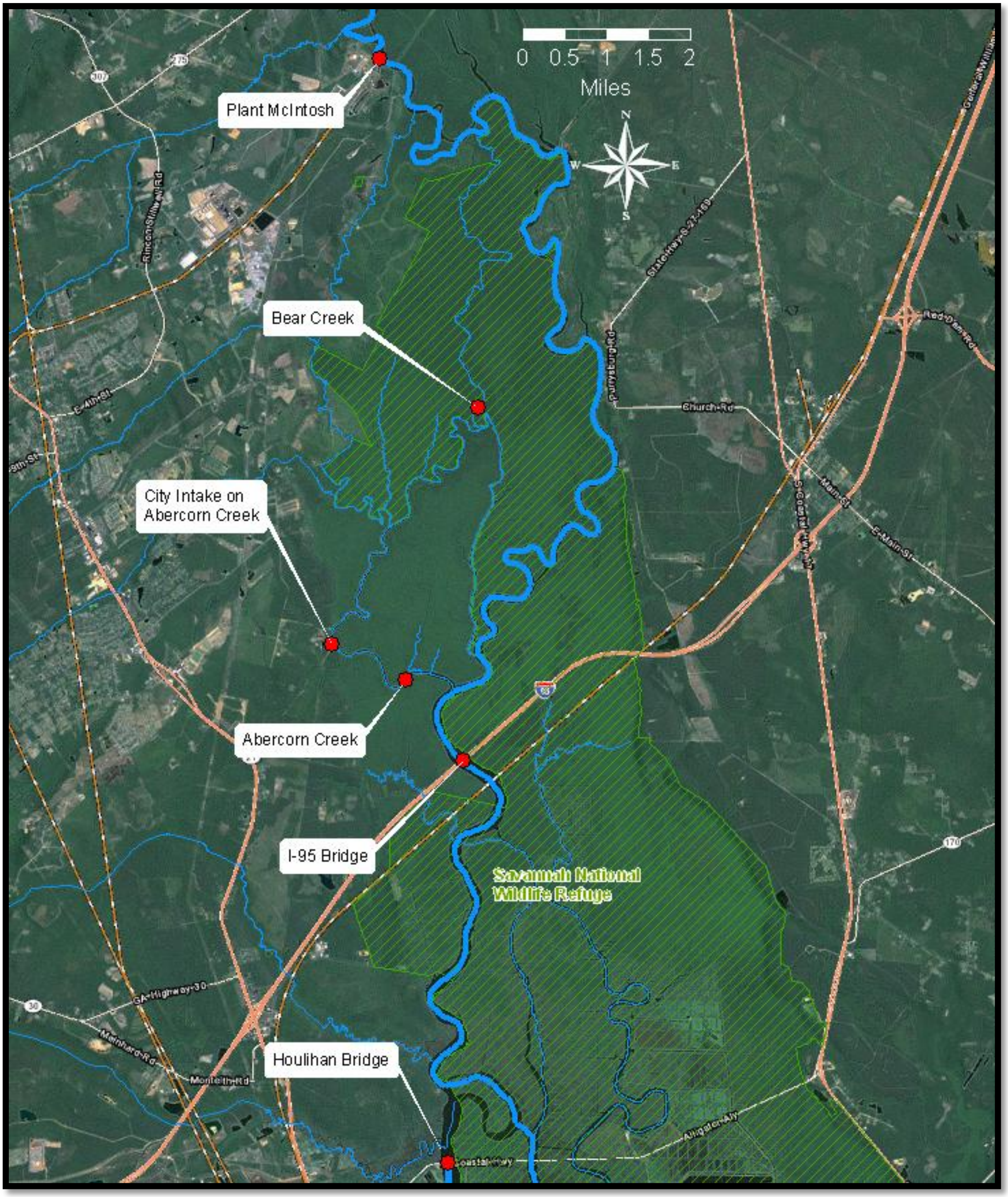

Figure 5-22. Chloride data collection 2009-2010.

5.02.5 Updated Modeling Methodology

The new modeling methodology, development and calibration, is described 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 GRR Engineering Appendix 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.

5.02.6 Technical Review

A Corps 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.

An Independent External Peer Review (IEPR) was conducted by Battelle, Inc on the chloride analysis. Comments from these rigorous reviews were incorporated into the modeling and analysis for SHEP impacts determination, and the reviewers concluded that the models were applied appropriately for this purpose.

5.02.7 Analysis of Daily Average and Maximum Chloride Concentrations

Table 5-29 summarizes the findings of the updated modeling effort. The 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 and corresponds to the magnitude and duration of impacts over a more representative period of time and river flow conditions.

Analysis of Table 5-29 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). The 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 5-29. 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.

5.02.8 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 5-30. 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 5-30. 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 5-31 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 5-31. 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%

5.02.9 Analysis of Hourly Chloride Concentrations and Durations

The City 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 M&I Water Plant process and the distribution pipelines, these hourly chloride projections are critical to the operation of the water plant and the quality of the water that it produces.

The EFDC model used daily chloride concentrations in its calibration process, which used data from 2001-2009. Since 2003, the City has analyzed the 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 5-23, 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 150 mg/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 40 mg/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 40 mg/l threshold has never been exceeded for even 1 hour under existing conditions.

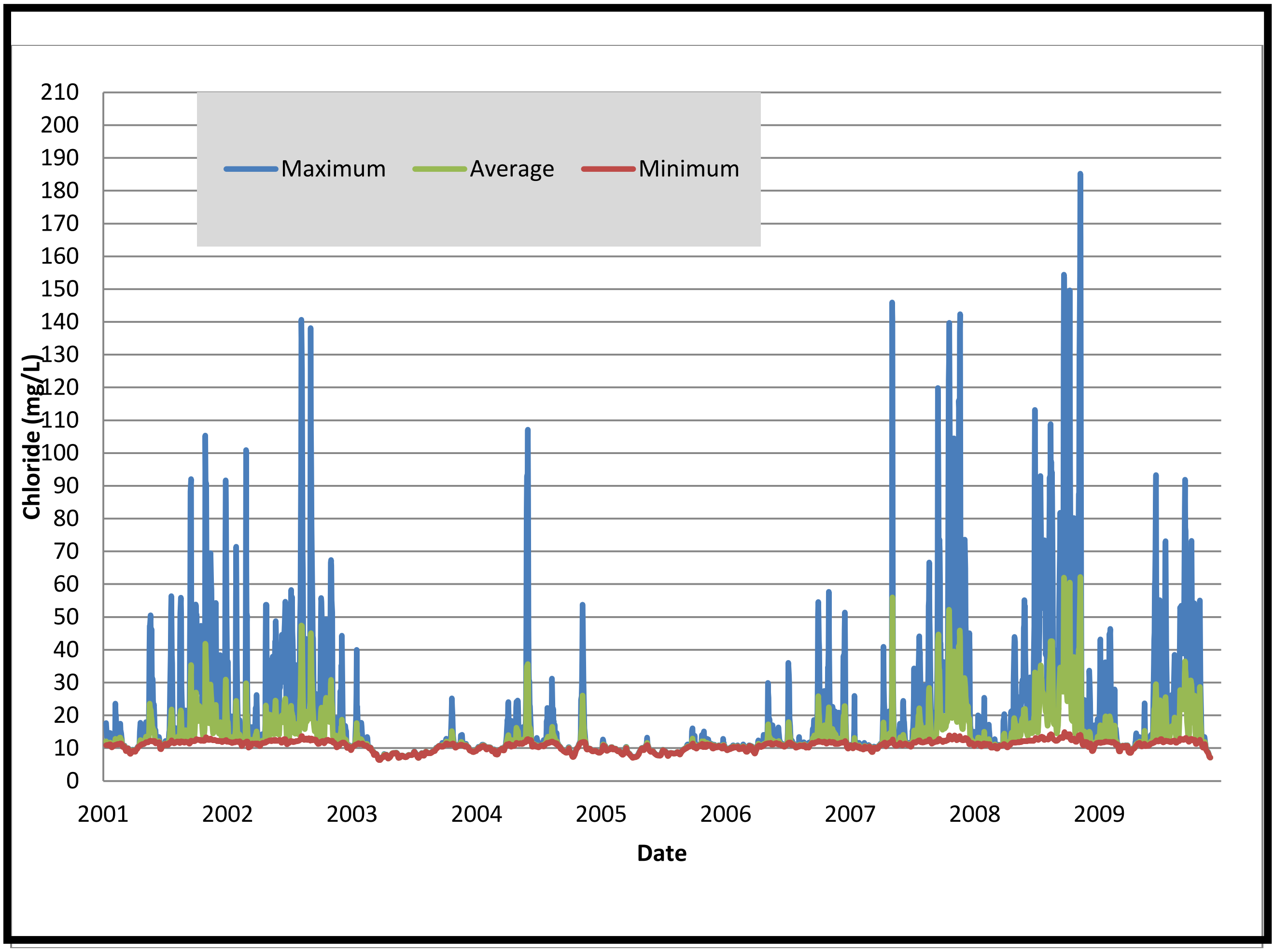

Figure 5-23. Hourly output from EFDC model for the 47 ft NED Plan.

5.02.10 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 62 mg/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 (MCL) by USEPA. 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).

5.02.11 Corrosion Concerns

The City also expressed concern with the impact that increased chloride concentrations 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 2011 comment 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. That report, completed April 29, 2011 is titled *Assessment of Chloride Impact from Savannah Harbor Deepening* and is included in the Engineering Supplemental Materials. The investigation included computer simulations (WatSim), which indicated that raising pH was a potential remedy for increased corrosion rate. The report recommended 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 could 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 could 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 its conclusions. Consequently, more detailed laboratory analyses were performed at the water treatment plant to 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. The report titled *City of Savannah Seawater Effects Study* dated November 2011 which is included in the GRR Engineering Appendix Supplemental Materials addressed concerns of the City's requirement for simultaneous drinking water standard compliance. It also presented evidence that there are two significant impacts to drinking water quality from increased chlorides – increased lead corrosion and formation of disinfectant byproducts (DBPs).

5.02.12 Lead Corrosion

Based on the laboratory analyses performed, lead corrosion is projected to increase considerably with increased chlorides, while copper and iron concentrations would 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.

5.02.13 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 the 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 the 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.

5.02.14 Industrial Water Supply Concerns

In 2008, the City of Savannah provided a letter with estimates of costs to industrial users if chlorides were increased to 50 mg/l. The costs were very high, but not considered to be representative since the increases to 50 mg/l are only projected to be occasional, not continuous.

5.02.14.1 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 they installed process water cooling towers. 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 represent 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 5-32). 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 5-32. 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 currently runs 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.

5.02.14.2 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 the GA DNR-EPD to require them 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 after they were originally installed. Therefore, the potential impact at IP is limited to a potentially reduced lifespan for the water distribution system.

5.02.14.3 Other Industrial Users. 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 City of Savannah's Plant. No data is available on these other users, but their chloride concerns can be expected to be similar, but on a smaller scale.

5.02.15 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:

5.02.15.1 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 a diversion structure at the mouth of Bear Creek 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.

5.02.15.2 Construction of Freshwater Storage Impoundments. 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 impoundments 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 to whether the volume of the supply will be sufficient for the duration the supplement is needed. Use of storage impoundments for blending water during intrusion events was not initially examined in detail. However, this alternative was retained for consideration should further analysis be required.

5.02.15.3 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.

5.02.15.4 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 amount 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 wells currently in place in its network. Construction would likely require locating and installing new wells and modifying the distribution network.

5.02.15.5 Freshwater Flow Supplementation. Instituting a variable drought plan release from Thurmond Dam. Corps analyses indicate that a large amount of water would be required to restore salinity levels to their present location in the estuary over a long period of time (such as in a multi-year drought). Substantial changes would also be required to the operation of those reservoirs, resulting in potentially large-scale adverse effects to existing users and environmental resources. Lower impacts would occur if those flows only occurred during a portion of the month to target the effects of the spring tides. This approach would also be difficult for water users such as the City of Augusta, Savannah River Site, and Plant Vogtle. As a result, the Corps dropped this measure from further consideration.

5.02.15.6 A combination of increased groundwater withdrawal and greater releases from Thurmond Dam, as described above.

5.02.15.7 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.

5.02.15.8 Replacement of individual plumbing fittings that are the source of lead contamination. It is very difficult to estimate the total number of homes 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 alternative would not address the DBP issue.

5.02.15.9 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.

5.02.15.10 Construction of a Supplemental Water Intake Pipeline. Constructing a new intake pipeline would permit fresh water to be taken 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.

5.02.15.11 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 GRR 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 M&I 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 City's treatment plant, the best solution to mitigate for impacts due to chloride increases with harbor deepening is to remove the influence of the increased seawater intrusion. This can be accomplished most cost-effectively 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 studied these potential mitigation techniques, including constructing either a raw water storage impoundment or holding tank 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 impoundment for raw water. The preliminary design was for an impoundment 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 Abercorn Creek.

The Corps identified six potential locations between the City's water intake and its treatment plant for siting a raw water storage impoundment. Those sites are shown on Figures 5-24 and 5-25. 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 Corps 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 5-26. Use of that parcel would ensure the site is available when needed. The Corps focused the final design and cost estimating work on that seventh potential location – the one owned by the GPA.

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 5-24. Potential water storage impoundment locations (#1-4).

- #5 Northwest of I-95 along Pipeline

- #6 Adjacent to and North of City's Water Treatment Plant

Figure 5-25. Potential water storage impoundment locations (#5-6).

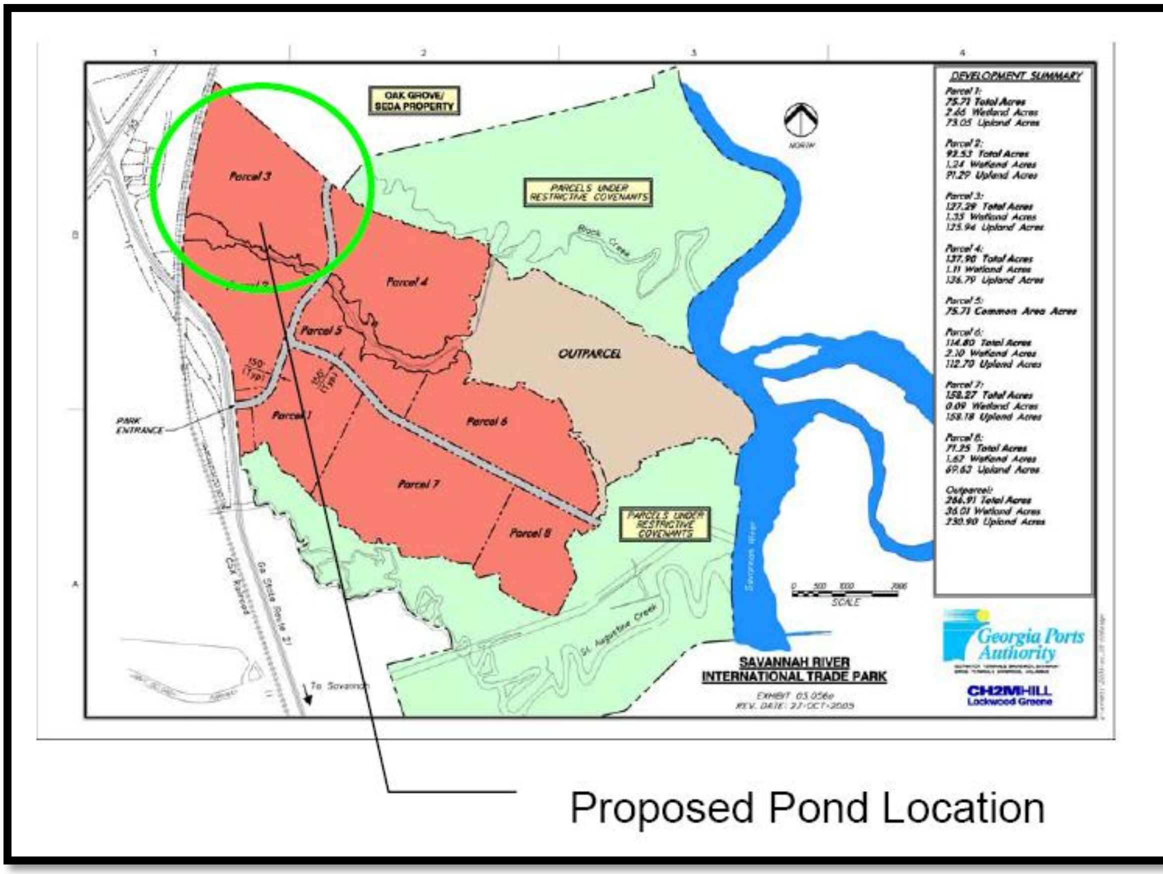

Figure 5-26. Potential water storage impoundment location (#7).

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 supplemental 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 5-27). 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 5-27. Potential pipeline locations.

Based on recent analyses, the storage alternative was determined to be the most cost-effective option to mitigate against both the increasing lead corrosion and the increasing DBP formation predicted with harbor deepening.

Design considerations for the raw water storage impoundment are:

A. The GA DNR-EPD, in the Section 401 Water Quality Certification for Savannah Harbor Expansion, stated that any mitigation remedy selected shall be based on the maximum plant capacity of 62.5 mgd. They also stated that any mitigation remedy shall be constructed in conjunction with the channel deepening.

B. 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-EPD's *Minimum Standards for Public Water Systems* published in May of 2000.

C. 20% of the storage volume will be unusable due to access limitations and sedimentation.

D. A performance goal of limiting the chloride concentration at the treatment 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 for an impoundment volume for each project depth are shown in Table 5-33.

Table 5-33. Proposed Raw Water Storage Impoundment Volumes Required for Each Project Depth Alternative

Project Depth	Recommended Usable Impoundment Volume, MG	Required Total Impoundment Volume, MG
44 feet	22.5	28.0
45 feet	30.0	38.0
46 feet	46.5	58.0
47 feet	77.5	97.0
48 feet	120.0	150.0

A conceptual site layout for the 47 foot depth alternative is shown in Figure 5-28. The raw water storage impoundment would be about 35 acres in size and cost 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 GRR Engineering Appendix Supplemental Materials.

A. 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).

B. A pump station containing four vertical turbine pumps to convey flow out of the impoundment and back into the raw water lines.

C. A mechanical mixer in the center of the impoundment to help maintain oxygen levels throughout the impoundment’s depth, reducing the likelihood of algae growth and the associated taste and odor issues.

D. A powdered activated carbon silo and feed system to be used on an intermittent basis during severe taste and odor episodes.

E. A 24” drain pipe to be used to empty the impoundment during periodic maintenance cleaning.

F. One or more in-situ chloride meters to be installed in Abercorn Creek to provide data for operational decision making.

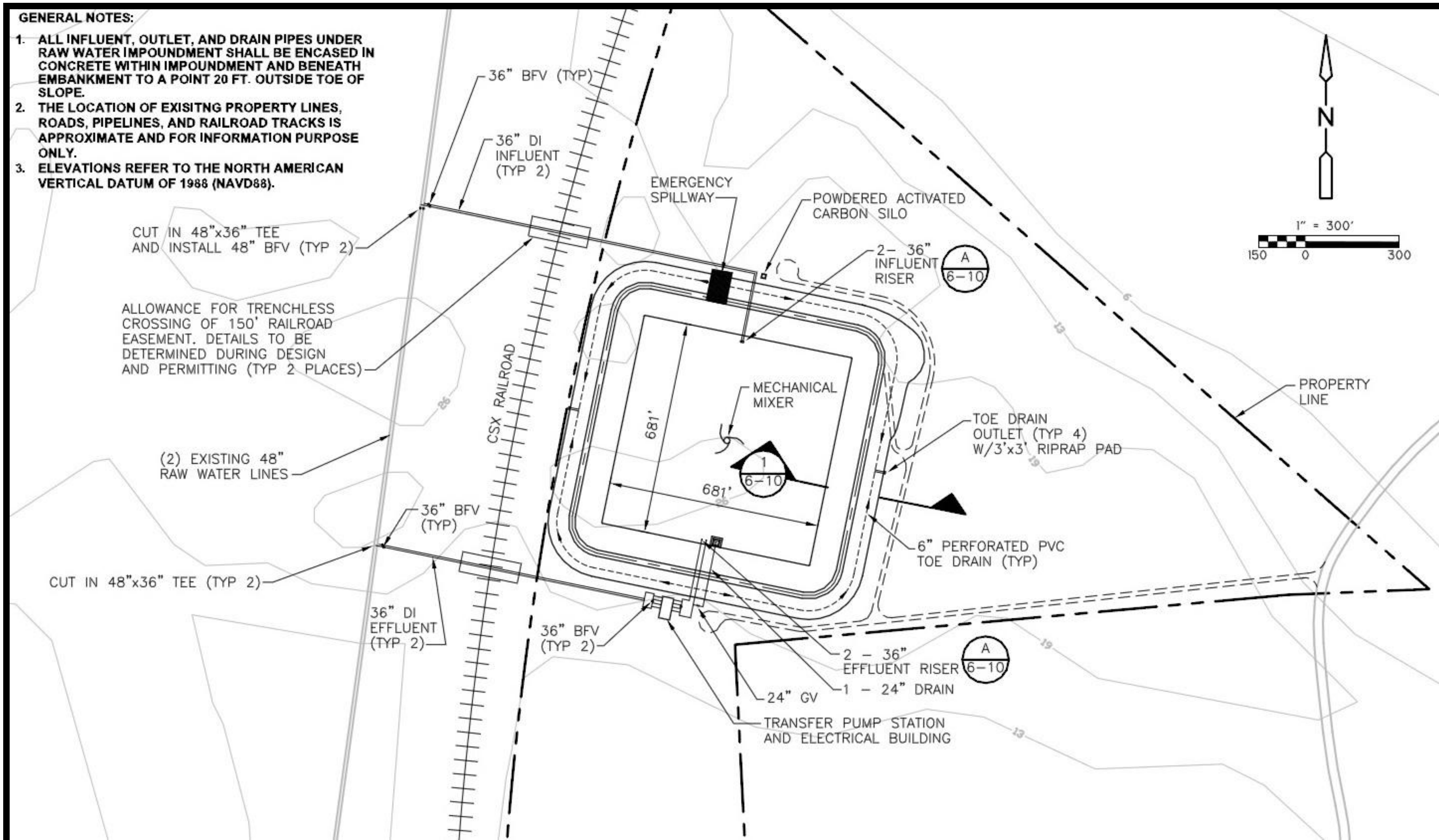

Figure 5-28. Raw water storage impoundment conceptual site layout.

Model predictions indicate that high chloride levels will occur diurnally, coincident with high tide.

An early warning system on Abercorn Creek would be required to provide data to the operator in a timely manner to know when valve and pump changes are needed.

Operation of the feature would require that water from the existing Abercorn Creek intake be used for treatment and pumped to the storage impoundment during occurrences of low chlorides. During occurrences of high chlorides, water from the impoundment will be pumped to the City's existing water treatment plant via the proposed pump station. During high chloride events at the intake, the intake pumps will be stopped and the plant will draw water from the storage impoundment, thereby avoiding the high chlorides occurring in Abercorn Creek. When chloride concentrations on Abercorn Creek return to acceptable levels during low tide, the storage impoundment can be refilled and made ready for use during the next high tide.

Based upon flow conditions experienced in November 2008, the worst-case event would require use of storage for 14 consecutive days. The total proposed storage volume represents only about 32 hours usage at plant capacity, but the chloride content of Abercorn Creek will rise and fall with each tidal cycle; therefore the impoundment will be partially refilled during low tide twice each day.

Operation and maintenance activities associates with this mitigation feature would be the responsibility of the City of Savannah.

5.03 <u>Fisheries</u>

5.03.1 Impacts to Fishery Resources

5.03.1.1 Overall approach. For potential impacts to fishery resources, Savannah District used the agency-approved hydrodynamic and water quality models coupled with definitions of acceptable habitat for critical and representative estuarine fish species. 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. The development and approval of the hydrodynamic and water quality models took from 1999 through 2005 and is described in detail in the Engineering Appendix that accompanies the GRR.

As those models were being developed, the Corps consulted with natural resource agencies to determine which estuarine fish species are critical in the estuary, which may be representative of a guild or group of similar species, and which may be sensitive to the physical changes expected to result from deepening the harbor. The Fishery Interagency Coordination Team identified the following species as being appropriate to identify potential project-induced impacts to fishery resources in the harbor:

A. Striped bass
B. Shortnose sturgeon

C. Southern flounder
D. American shad

The Team also requested the Corps evaluate project impacts on the following life stages:

A. Striped bass – spawning, eggs, and larvae
B. Shortnose sturgeon – adult winter, adult summer, and juvenile winter
C. Southern flounder – adult
D. American shad - adult

The habitat suitability criteria used in the model runs were defined and agreed upon by the Cooperating Agencies and the Fisheries Interagency Coordination Team, of which NMFS was a participating member. The criteria that the interagency team developed to define acceptable habitat for each of these species and life stages can be found in Appendix N.

The interagency team then defined the conditions under which the hydrodynamic and water quality models should be run to identify potential project impacts. The conditions consisted of river flow rates and time of year. Average river flows were determined to be most representative of conditions experienced over the long term. For some species, additional runs would also be performed with high (80% exceedance) and low (20% exceedance) river flows to ensure unusual impacts would not develop during those less-typical years.

The hydrodynamic and water quality models identified changes in salinity, dissolved oxygen, and velocity that would be expected throughout the harbor. Model cells that would change from acceptable to unacceptable habitat were identified as being adversely impacted by the project alternative. Tables were developed to quantify those changes and maps were prepared to show the location of the changes. This information was shared with the Fishery Interagency Coordination Team and is summarized in the following pages.

5.03.1.2 Impacts without Mitigation. The following table shows the impacts that would occur to fishery resources if no mitigation were included in the project. The values shown below are based on average river flows and use the 50%-tile salinity recorded for each model grid cell:

Table 5-34. Summary of Project-Related Fishery Impacts without Mitigation

	---------------------- DEPTH ALTERNATIVES ----------------------				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Fisheries	Loss (-) of Acceptable Habitat				
- Striped bass spawning	- 8.0 % (-83.0 acres)	- 12.2 % (-127.0 acres)	- 13.0 % (-135.0 acres)	-18.1 % (-188.0 acres)	- 19.7 % (-205.0 acres)
- Striped bass eggs	-9.7 % (-163.0 acres)	- 11.2 % (-188.0 acres)	- 15.9 % (-266.0 acres)	-20.5 % (-344.0 acres)	-24.5 % (-411.0 acres)
- Striped bass larvae	-13.5% (-76.0 acres)	- 18.6 % (-105.0 acres)	- 21.0 % (-119.0 acres)	-13.8 % (-78.0 acres)	- 13.8 % (-78.0 acres)
- American shad (Jan)	0 %	0 %	0 %	0%	0 %
- American shad (May)	0 %	0 %	0 %	0%	0 %
- American shad (Aug)	0 %	0 %	0 %	0 %	0 %
- Shortnose sturgeon adult (January)	- 0.5% (-20.0 acres)	- 0.5 % (-20.0 acres)	-0.8 % (-32.0 acres)	-0.8% (-32.0 acres)	-1.1 % (-44.0 acres)
- Shortnose sturgeon adult (August)	- 3.2 % (- 45.0 acres)	- 6.4 % (- 89.0 acres)	- 9.5 % (- 132.0 acres)	-13.3 % (-185.0 acres)	- 15.80 % (- 220.0 acres)
- Shortnose sturgeon juvenile (January)	-5.0 % (-86.0 acres)	-10.4 % (-179.0 acres)	-15.9 % (-274.0 acres)	- 19.0 % (-328.0 acres)	- 21.6 % (-373.0 acres)
- Southern flounder	- 0.3 % (-6.0 acres)	- 2.4 % (-45.0 acres)	- 2.4 % (-45.0 acres)	-7.8 % (-146.0 acres)	0.0 %

5.03.1.3 Measures to Reduce Impacts. After the expected impacts to these resources were identified, the Corps used the hydrodynamic and water quality models to evaluate ways to reduce those impacts. The flow re-routing plans previously described in Section 5.01 would reduce the predicted increase in upstream salinity levels that would occur with the SHEP which, in turn, would minimize adverse impacts to fishery habitat. The proposed mitigation plans also include the injection of oxygen at three locations which would also reduce adverse impacts to upstream fishery habitat. However, even with implementation of these two mitigation features, adverse effects to fishery habitat could not be totally removed.

The following table summarizes the impacts of the depth alternatives that would remain even with the flow re-routing plans and oxygen injection:

Table 5-35. Summary of Project-Related Fishery Impacts with Mitigation

	---------------------- DEPTH ALTERNATIVES ----------------------				
	44-Foot	**45-Foot**	**46-Foot**	**47-Foot**	**48-Foot**
Fisheries	Loss (-) or Gain (+) of Acceptable Habitat				
- Striped bass spawning	- 2.9 % (-30.0 acres)	- 9.2 % (-96.0 acres)	- 10.0 % (-104.0 acres)	-13.5 % (-140.0 acres)	- 16.1 % (-167.0 acres)
- Striped bass eggs	- 9.4 % (-157.0 acres)	+5.2 % (+87.0 acres)	0 %	-11.1 % (-186.0 acres)	-10.8 % (-181.0 acres)
- Striped bass larvae	-5.6 % (-32.0 acres)	+ 1.7 % (+9.0 acres)	+ 5.6 % (+32.0 acres)	-5.0 % (-28.0 acres)	-3.5 % (-20.0 acres)
- American shad (Jan)	-0.2 % (- 9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)	-0.2 % (-9.0 acres)	- 0.2 % (-9.0 acres)
- American shad (May)	- 0.2 % (-12.0 acres)	- 0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	- 0.2 % (-11.0 acres)
- American shad (Aug)	-0.3 % (-16.0 acres)	-0.3 % (-15.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)	-0.2 % (-11.0 acres)
- Shortnose sturgeon adult (January)	-3.9% (-153.0 acres)	- 4.6 % (-179.0 acres)	-6.2% (-240.0 acres)	-6.9 % (-266.0 acres)	- 8.4 % (-326.0 acres)
- Shortnose sturgeon adult (August)	+ 19.0 % (+ 260.0 acres)	+ 9.8 % (+ 134.0 acres)	+ 7.3 % (+ 100.0 acres)	+6.5 % (+ 89.0 acres)	+ 2.8 % (+ 39.0 acres)
- Shortnose sturgeon juvenile (January)	-6.7 % (-220.0 acres)	- 7.0 % (-231.0 acres)	-7.3 % (-238.0 acres)	-7.6 % (-251.0 acres)	-11.5 % (-376.0 acres)
- Southern flounder	+74.1 % (+1387.0acres)	+ 54.2 % (+1014.0acres)	+ 57.3 % (+1072.0acres)	+57.3 % (+1072.0acres)	+ 52.9 % (+989.0 acres)

This fishery impact information is shown in more detail in the tables on this and the following three pages.

Table 5-36. Impacts to Shortnose Sturgeon Habitat

WITHOUT MITIGATION						
	JUVENILES		ADULTS			
	January50%flows		January50%flows		August Avg flows	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-5.0%	**-86**	-0.5%	**-20**	-3.2%	**-45**
45 ft depth	-10.4%	**-179**	-0.5%	**-20**	-6.4%	**-89**
46 ft depth	-15.9%	**-274**	-0.8%	**-32**	-9.5%	**-132**
47 ft depth	-19.0%	**-328**	-0.8%	**-32**	-13.3%	**-185**
48 ft depth	-21.6%	**-373**	-1.1%	**-44**	-15.8%	**-220**

WITH MITIGATION						
	JUVENILES		ADULTS			
	January		January		August *	
	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)	IMPACTS (%)	IMPACTS (acres)
44 ft depth	-6.7%	**-220**	-3.9%	**-153**	19.0%	**260**
45 ft depth	-7.0%	**-231**	-4.6%	**-179**	9.8%	**134**
46 ft depth	-7.3%	**-238**	-6.2%	**-240**	7.3%	**100**
47 ft depth	-7.6%	**-251**	-6.9%	**-266**	6.5%	**89**
48 ft depth	-11.5%	**-376**	-8.4%	**-326**	2.8%	**39**

Table 5-37. Impacts to Striped Bass Habitat – Eggs

WITHOUT MITIGATION						
	EGGS					
	April20%flows		**April50%flows**		**April80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	-10.4%	**-100**	-9.7%	**-163**	-2.2%	**-50**
45 ft depth	-12.3%	**-118**	-11.2%	**-188**	-4.9%	**-111**
46 ft depth	-14.0%	**-135**	-15.9%	**-266**	-4.8%	**-108**
47 ft depth	-17.8%	**-171**	-20.5%	**-344**	-6.4%	**-144**
48 ft depth	-19.4%	**-187**	-24.5%	**-411**	-7.2%	**-162**

WITH MITIGATION						
	April 20%flows		**April 50%flows**		**April 80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	-22.3%	**-215**	-9.4%	**-157**	7.6%	**171**
45 ft depth	-17.6%	**-169**	5.2%	**87**	8.0%	**181**
46 ft depth	-7.8%	**-75**	0.0%	**0**	6.9%	**155**
47 ft depth	-12.1%	**-117**	-11.1%	**-186**	5.0%	**113**
48 ft depth	-4.6%	**-44**	-10.8%	**-181**	3.4%	**76**

Table 5-38. Impacts to Striped Bass Habitat – Larvae

WITHOUT MITIGATION						
	LARVAE					
	May20%flows		**May50%flows**		**May80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	38.0%	**76**	-13.5%	**-76**	-1.1%	**-11**
45 ft depth	56.4%	**113**	-18.6%	**-105**	-7.1%	**-71**
46 ft depth	99.5%	**199**	-21.0%	**-119**	-4.8%	**-48**
47 ft depth	105.8%	**211**	-13.8%	**-78**	6.6%	**66**
48 ft depth	104.6%	**209**	-13.8%	**-78**	6.0%	**60**

WITH MITIGATION						
	May 20%flows		**May 50%flows**		**May 80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	174.6%	**348**	-5.6%	**-32**	-13.7%	**-136**
45 ft depth	187.4%	**374**	1.7%	**9**	7.6%	**75**
46 ft depth	191.4%	**382**	5.6%	**32**	10.1%	**100**
47 ft depth	178.7%	**356**	-5.0%	**-28**	26.4%	**262**
48 ft depth	154.6%	**308**	-3.5%	**-20**	30.0%	**298**

Table 5-39. Impacts to Striped Bass Habitat – Spawning

WITHOUT MITIGATION						
	SPAWNING					
	April20%flows		**April50%flows**		**April80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	-7.6%	**-49**	-8.0%	**-83**	-6.2%	**-114**
45 ft depth	-10.9%	**-70**	-12.2%	**-127**	-6.6%	**-121**
46 ft depth	-12.7%	**-81**	-13.0%	**-135**	-12.8%	**-236**
47 ft depth	-14.3%	**-91**	-18.1%	**-188**	14.7%	**271**
48 ft depth	-16.9%	**-108**	-19.7%	**-205**	-17.3%	**-318**

WITH MITIGATION						
	April 20%flows		**April 50%flows**		**April 80%flows**	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 ft depth	-15.2%	**-97**	-2.9%	**-30**	-2.9%	**-53**
45 ft depth	-13.9%	**-89**	-9.2%	**-96**	-8.5%	**-156**
46 ft depth	-18.7%	**-120**	-10.0%	**-104**	-10.8%	**-199**
47 ft depth	-21.1%	**-135**	-13.5%	**-140**	-12.7%	**-234**
48 ft depth	-23.9%	**-153**	-16.1%	**-167**	-13.2%	**-242**

Table 5-40. Impacts to Southern Flounder Habitat

WITHOUT MITIGATION		
	August Average flows	
	IMPACTS (%)	**IMPACTS (acres)**
44 foot depth	-0.3%	**-6**
45 foot depth	-2.4%	**-45**
46 foot depth	-2.4%	**-45**
47 foot depth	-7.8%	**-146**
48 foot depth	0.0%	**0**

WITH MITIGATION		
	August Average flows	
	IMPACTS (%)	**IMPACTS (acres)**
44 foot depth	74.1%	**1387**
45 foot depth	54.2%	**1014**
46 foot depth	57.3%	**1072**
47 foot depth	57.3%	**1072**
48 foot depth	52.9%	**989**

Table 5-41. Impacts to American Shad Habitat

WITHOUT MITIGATION						
	May20%flows		May50%flows		May80%flows	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 foot depth	0.0%	**0**	0.0%	**0**	0.0%	**0**
45 foot depth	0.0%	**0**	0.0%	**0**	0.0%	**0**
46 foot depth	0.0%	**0**	0.0%	**0**	0.0%	**0**
47 foot depth	0.0%	**0**	0.0%	**0**	0.0%	**0**
48 foot depth	0.0%	**0**	0.0%	**0**	0.0%	**0**

	January50%flows		August Average flows	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 foot depth	0.0%	**0**	0.0%	**0**
45 foot depth	0.0%	**0**	0.0%	**0**
46 foot depth	0.0%	**0**	0.0%	**0**
47 foot depth	0.0%	**0**	0.0%	**0**
48 foot depth	0.0%	**0**	0.0%	**0**

WITH MITIGATION						
	May 20% flows		May 50% flows		May 80% flows	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 foot depth	-0.2%	**-12**	-0.2%	**-12**	-0.2%	**-12**
45 foot depth	-0.2%	**-11**	-0.2%	**-11**	-0.2%	**-11**
46 foot depth	-0.2%	**-11**	-0.2%	**-11**	-0.2%	**-11**
47 foot depth	-0.2%	**-11**	-0.2%	**-11**	-0.2%	**-11**
48 foot depth	-0.2%	**-11**	-0.2%	**-11**	-0.2%	**-11**

	January 50% flows		August Average flows	
	IMPACTS (%)	**IMPACTS (acres)**	**IMPACTS (%)**	**IMPACTS (acres)**
44 foot depth	-0.2%	**-9**	-0.3%	**-16**
45 foot depth	-0.2%	**-9**	-0.3%	**-15**
46 foot depth	-0.2%	**-9**	-0.2%	**-11**
47 foot depth	-0.2%	**-9**	-0.2%	**-11**
48 foot depth	-0.2%	**-9**	-0.2%	**-11**

Maps that show the locations of acceptable and unacceptable fishery habitats for these four representative species are shown on the following pages. Fishery habitat maps, except for American shad, are provided for the 42-foot channel (existing conditions), the 47-foot channel (Selected plan), and other alternative depths to show the range of impacts that would occur with a harbor deepening. Appendix P provides the fishery habitat maps for all four species and all alternatives considered.

The proposed harbor deepening alternatives would produce minimal adverse effects on habitat of American shad. Construction of the SHEP, regardless of depth and implementation of its associated mitigation plan, would have negligible impact on American shad habitat, ranging from -0.2 to -0.3 percent. These losses are within the accuracy of the models, so no further mitigation is warranted. Figures 5-29 and 5-30 show the locations of acceptable habitat for this species for existing conditions (August) and with deepening and implementation of the 47-foot channel, flow diversion, and oxygen injection. As impacts were shown to be negligible, these maps are representative of all three months simulated. Maps for all other scenarios are included in Appendix P.

Adverse impacts to Southern flounder would range between -0.3 and -7.8 percent without mitigation, with greater impacts predicted for the deeper depths. When the flow-altering and oxygen injection components of the mitigation plan are included, significant positive impacts would result to Southern flounder habitat. Improvements would range from 53 to 74 percent, with larger gains predicted for the 44- and 46-foot depth alternatives. The dissolved oxygen improvement systems would increase the portion of the harbor that is suitable as flounder habitat by up to 1,100 acres – a substantial increase and improvement. Figures 5-31 through 5-33 show the location of acceptable habitat for existing conditions, the 47-foot depth (Selected plan) and mitigation, and the 48-foot depth with its associated mitigation plan.

Substantial adverse impacts would remain to both Striped bass and Shortnose sturgeon habitat after the flow-altering and dissolved oxygen improvement components of the mitigation plan are included. The amount of habitat acceptable to Striped bass varies greatly with the amount of freshwater flow coming down the river. Suitable spawning habitat presently varies from 640 to 1,841 acres. Suitable egg habitat ranges from 961 to 2,256 acres, and suitable larval habitat ranges from 200 to 993 acres. When the flow-altering and oxygen injection components of the mitigation plan are included, adverse impacts to spawning habitat would range from -3 to -16 percent, with the impacts increasing with channel depth. Impacts to egg habitat were more varied, ranging from -11 to +5 percent. Impacts to larval habitat would range from -6 to +6 percent. Those impacts are based on average river flows. Mitigation for these remaining impacts is described in Section 5.03.2. Figures 5-34 through 5-42 show the locations of acceptable habitat for these various life stages.

Substantial impacts to Shortnose sturgeon would also remain after the flow-altering and dissolved oxygen improvement components of the mitigation plan are included. Impacts to juveniles would range from -7 to -12 percent. Impacts to winter adult habitat would range from -4 to -8 percent, with the adverse impacts increasing with channel depth. Impacts to summer adult habitat would range from +3 to +19 percent, with decreasing gains at deeper channel depths. Figures 5-43 through 5-48 show locations of Shortnose sturgeon habitat for adults and juveniles.

The adverse impacts that would remain to Shortnose sturgeon and Striped bass after the flow-altering and dissolved oxygen components of the mitigation plan are included are at the level that warrants further mitigation. The Fishery Interagency Coordination Team was queried about potential ways that habitats within the harbor could be improved for these two species. For Striped bass, structural modifications, such as timber or rock flow diverters, were discussed. The agency fishery experts could not identify any measure that they believed would improve habitats over the range of river flow conditions that are experienced. For Shortnose sturgeon, no measures could be identified within the estuary that would improve habitats.

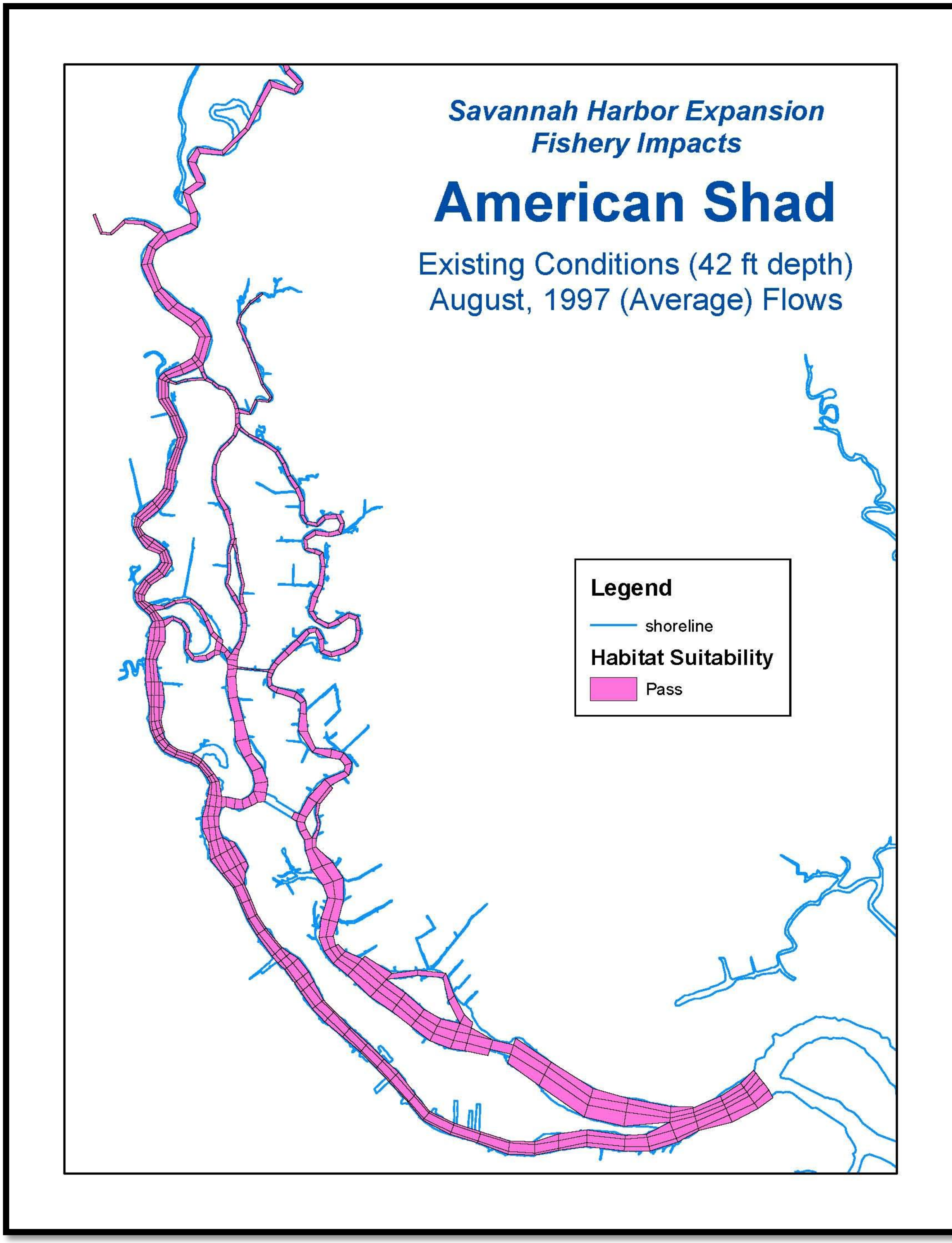

Figure 5-29. American shad habitat for existing conditions (42-foot channel).

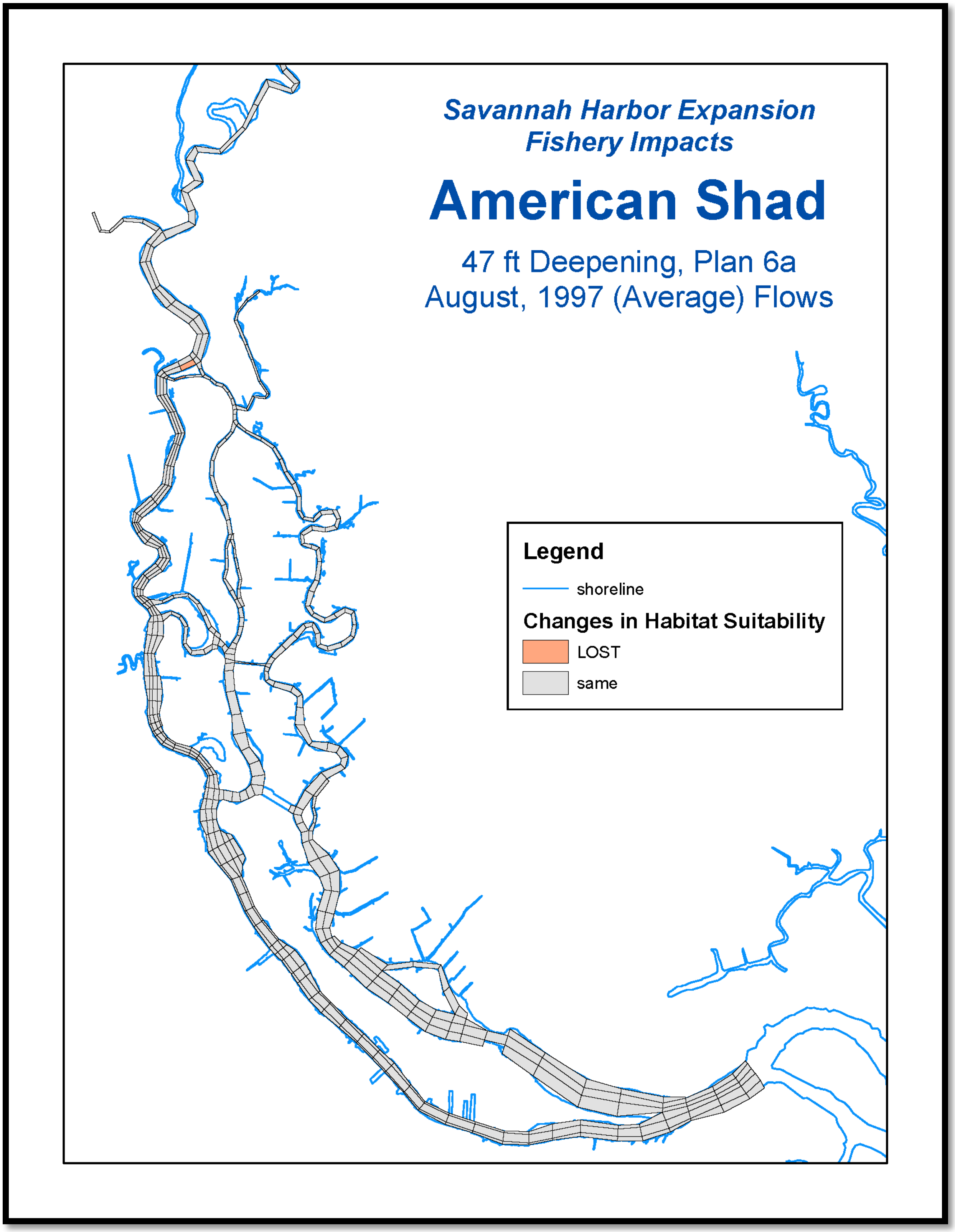

Figure 5-30. American shad habitat for the Selected Plan (47-foot depth alternative).

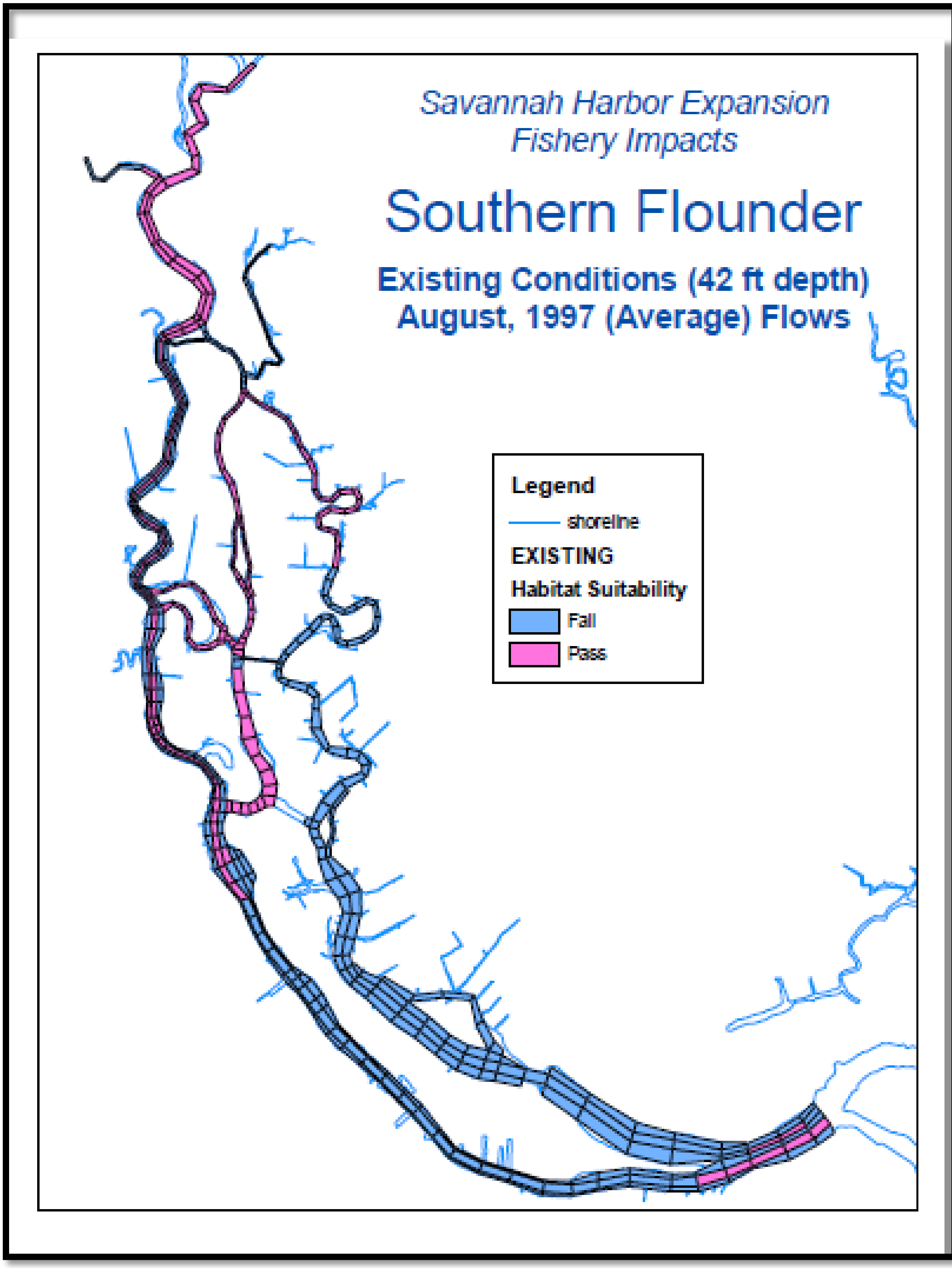

Figure 5-31. Southern flounder habitat for existing conditions (42-foot channel).

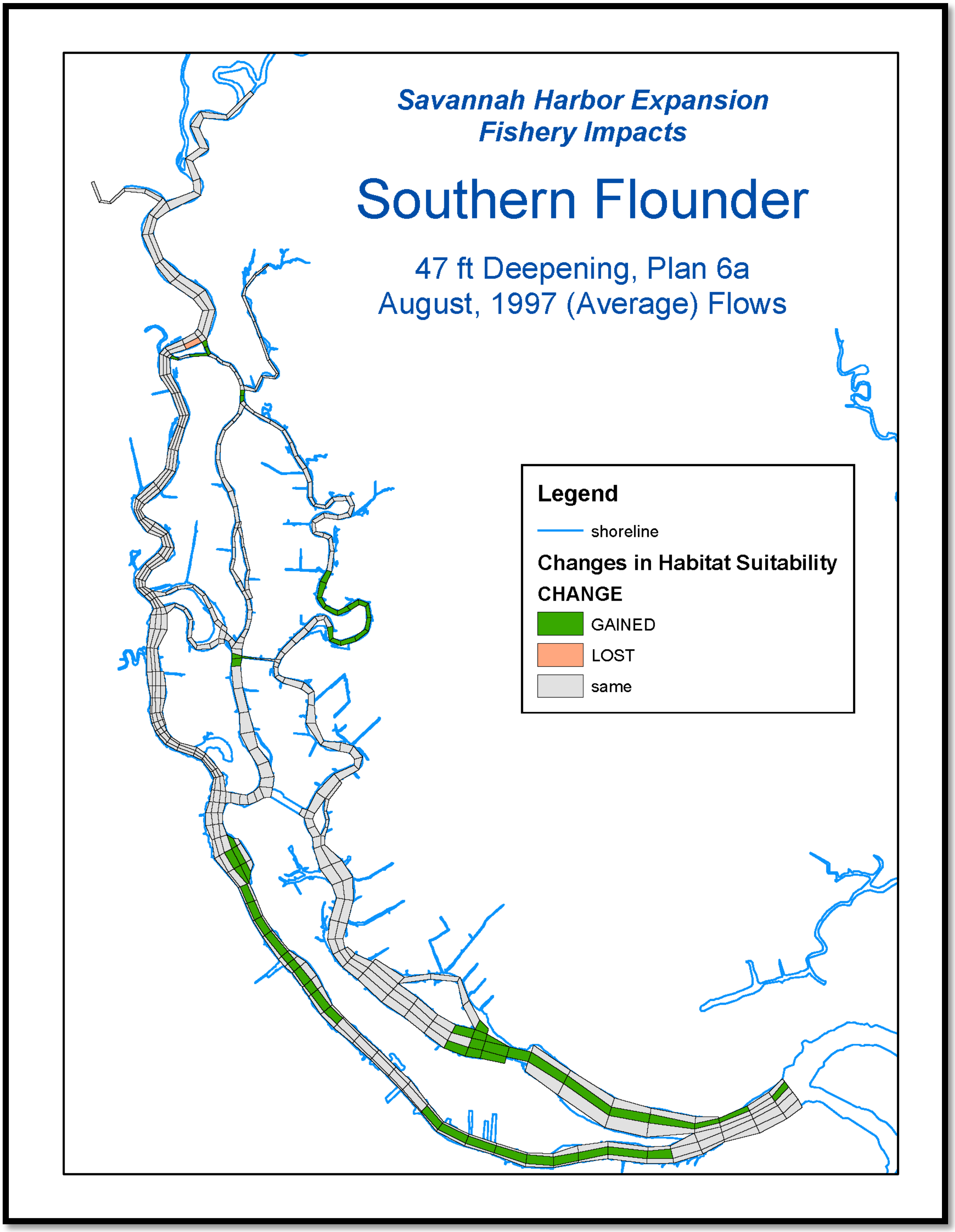

Figure 5-32. Southern flounder habitat for the Selected Plan (47-foot depth alternative).

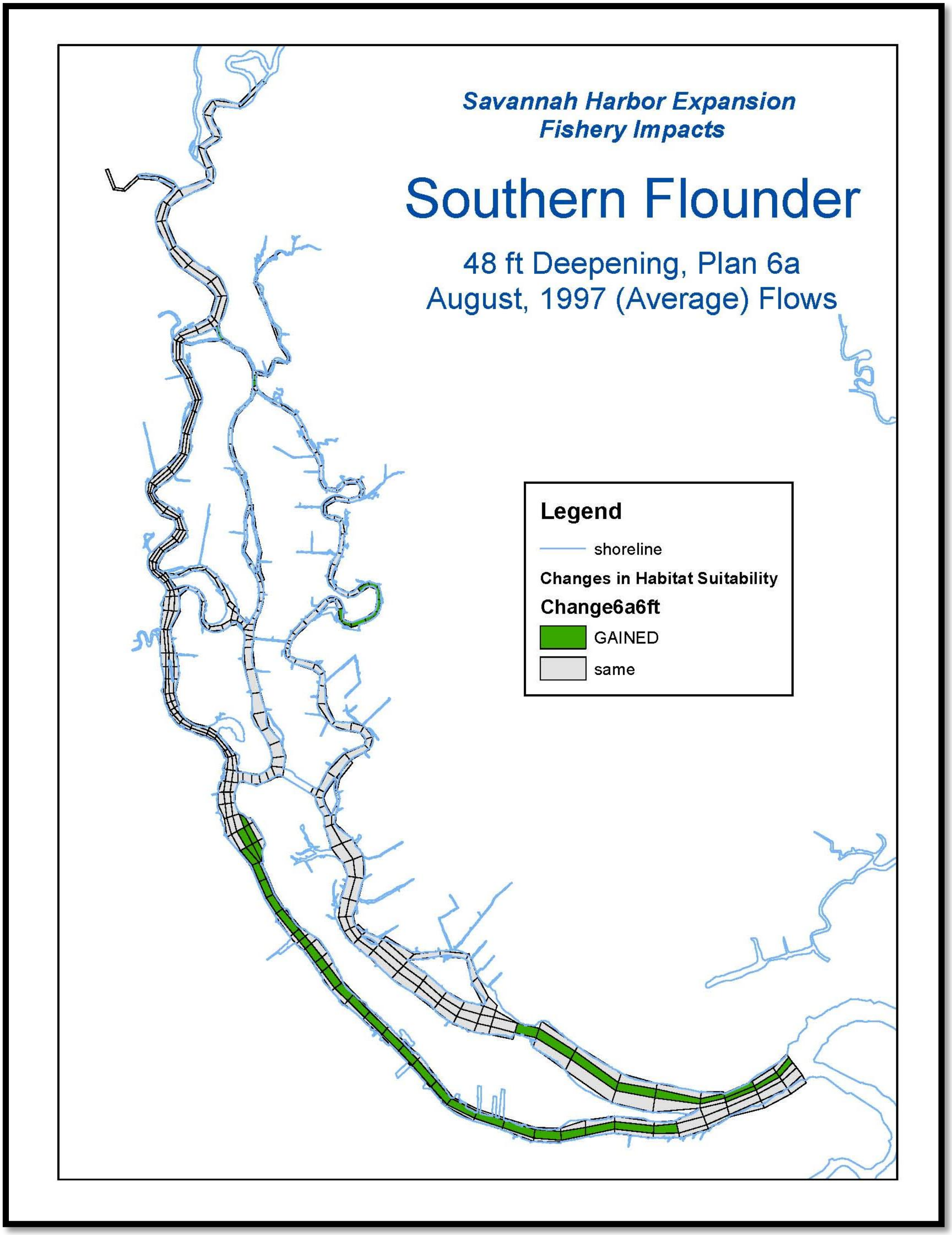

Figure 5-33. Southern flounder habitat for the 48-foot depth alternative.

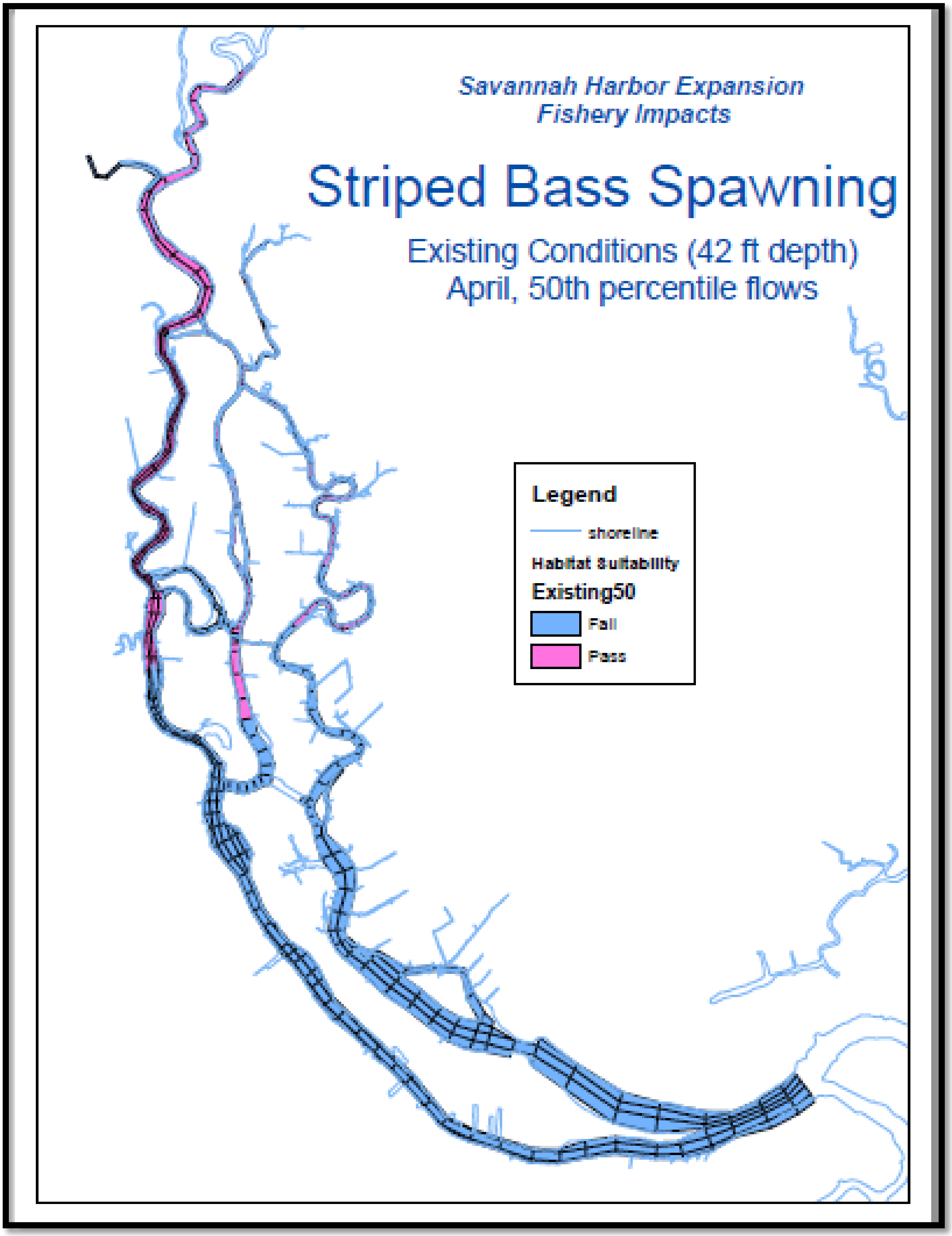

Figure 5-34. Striped bass spawning habitat for existing conditions (42-foot channel).

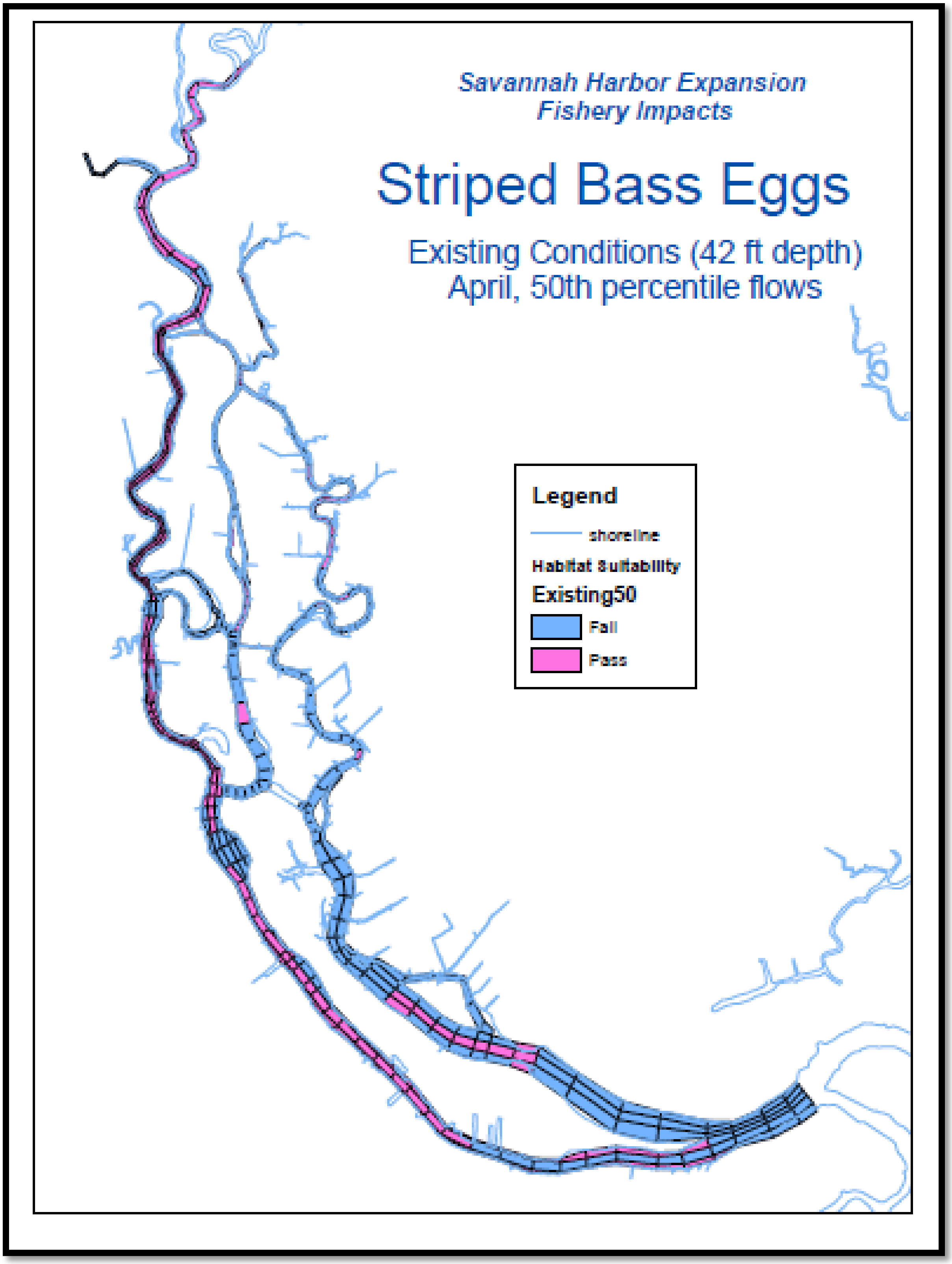

Figure 5-35. Striped bass egg habitat for existing conditions (42-foot channel).

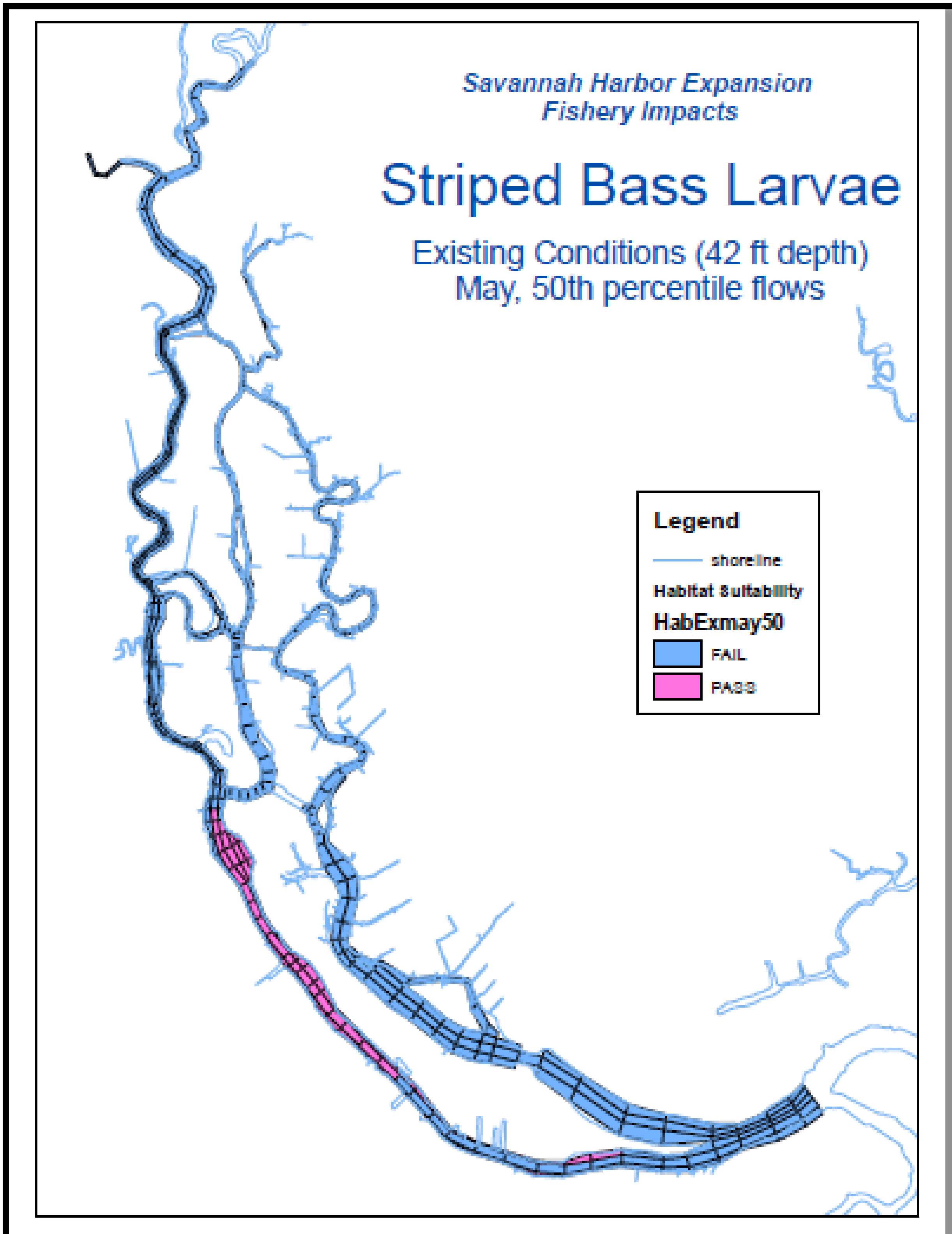

Figure 5-36. Striped bass larvae habitat for existing conditions (42-foot channel).

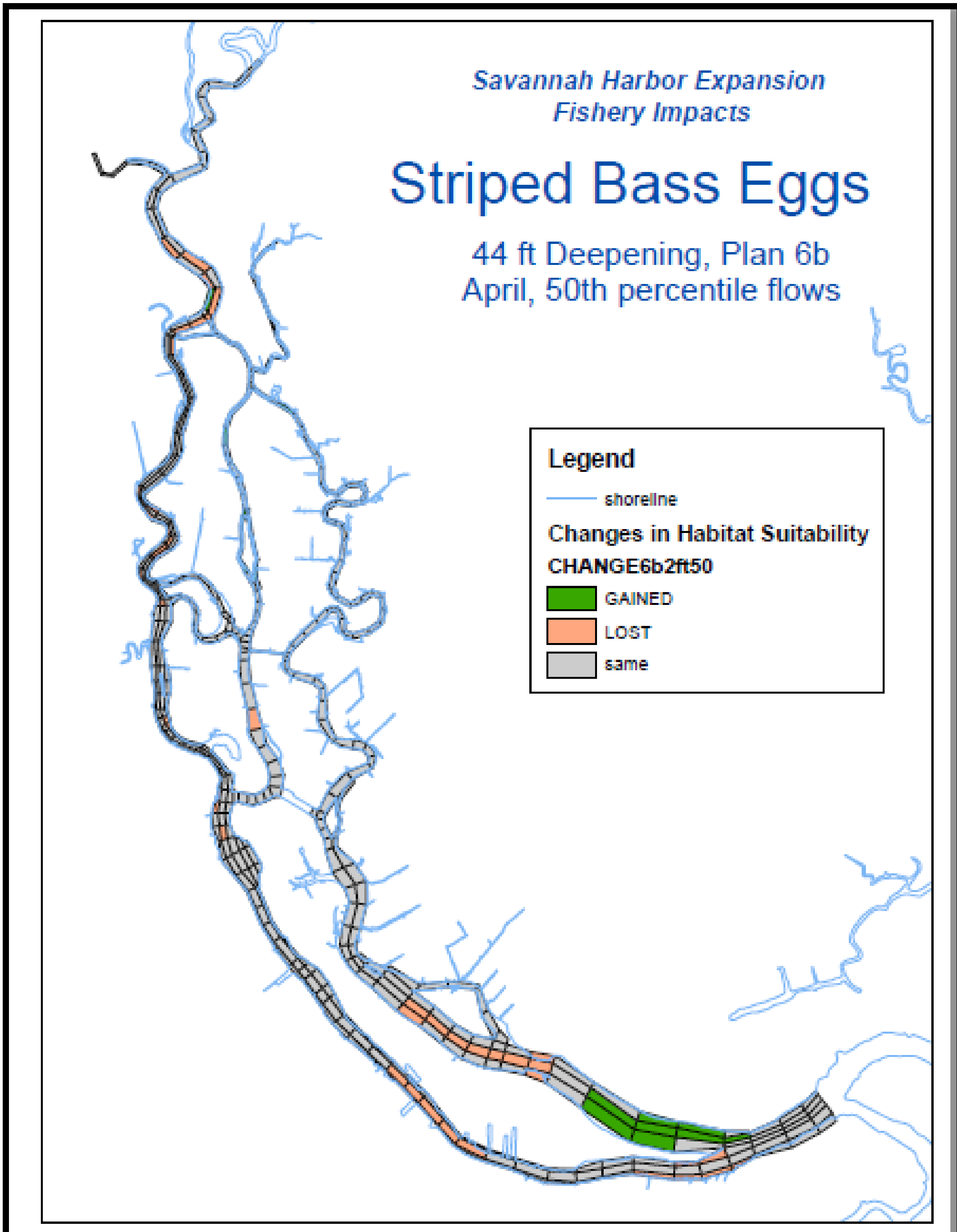

Figure 5-37. Striped bass egg habitat for the 44-foot depth alternative.

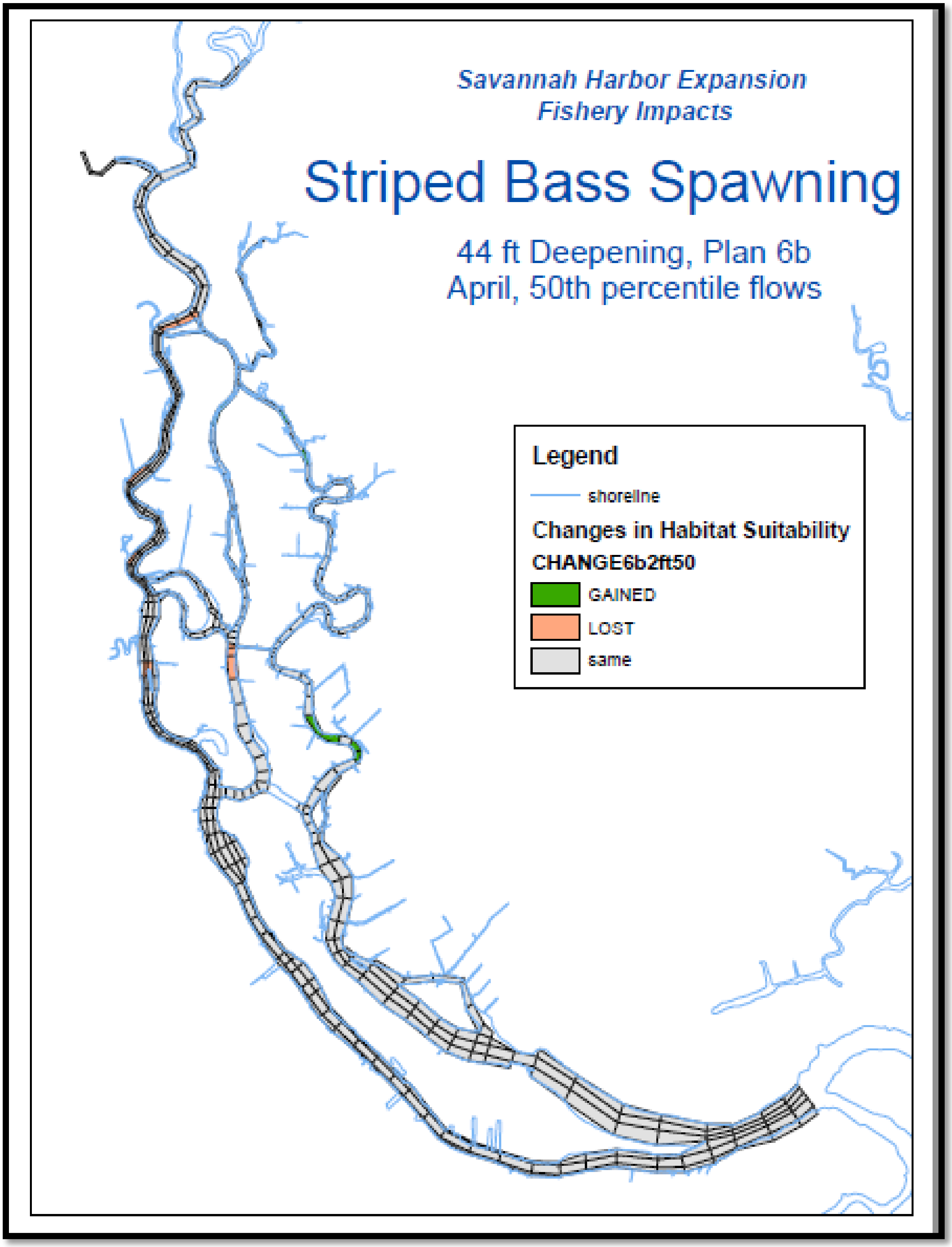

Figure 5-38. Striped bass spawning habitat for the 44-foot depth alternative.

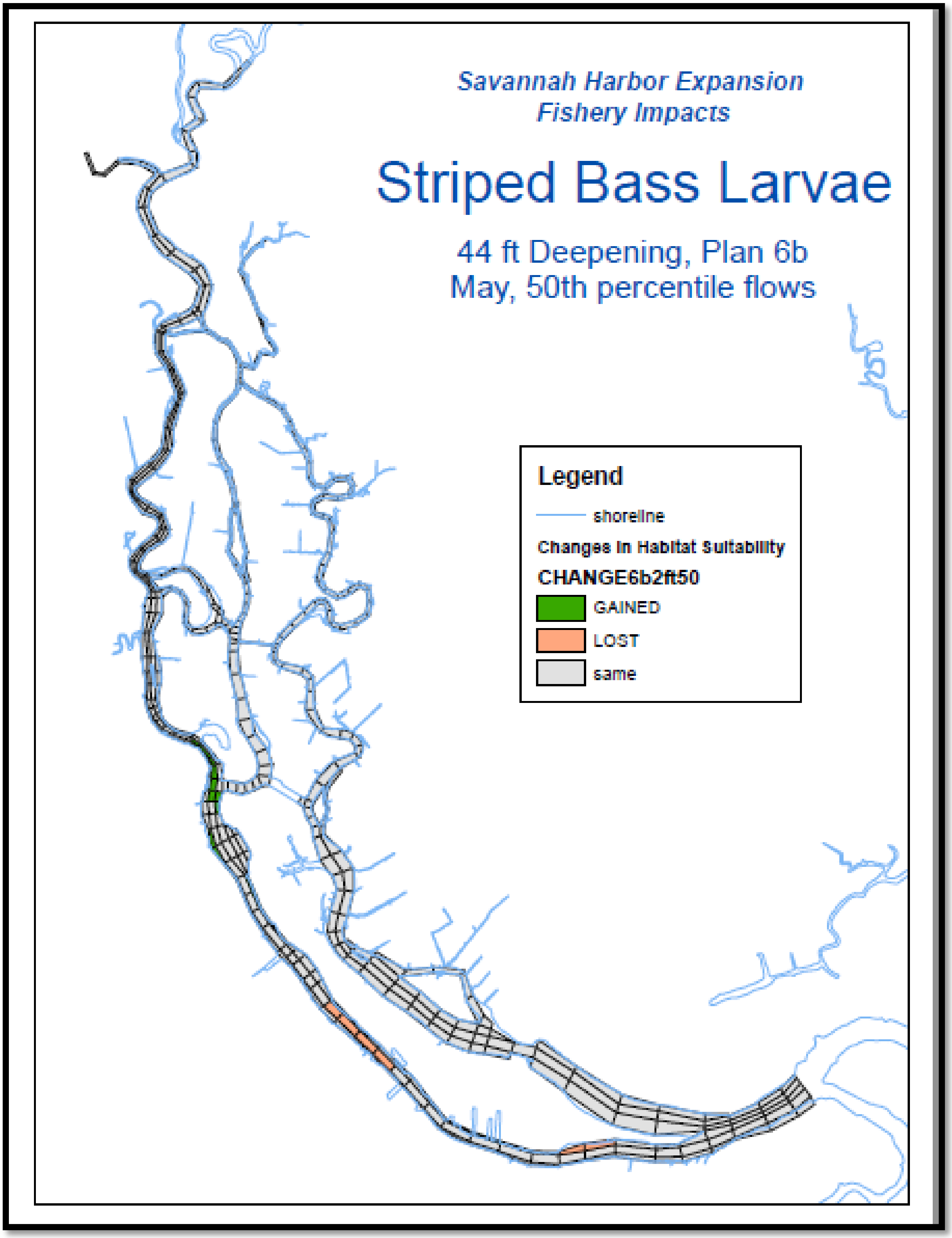

Figure 5-39. Striped bass larvae habitat for the 44-foot depth alternative.

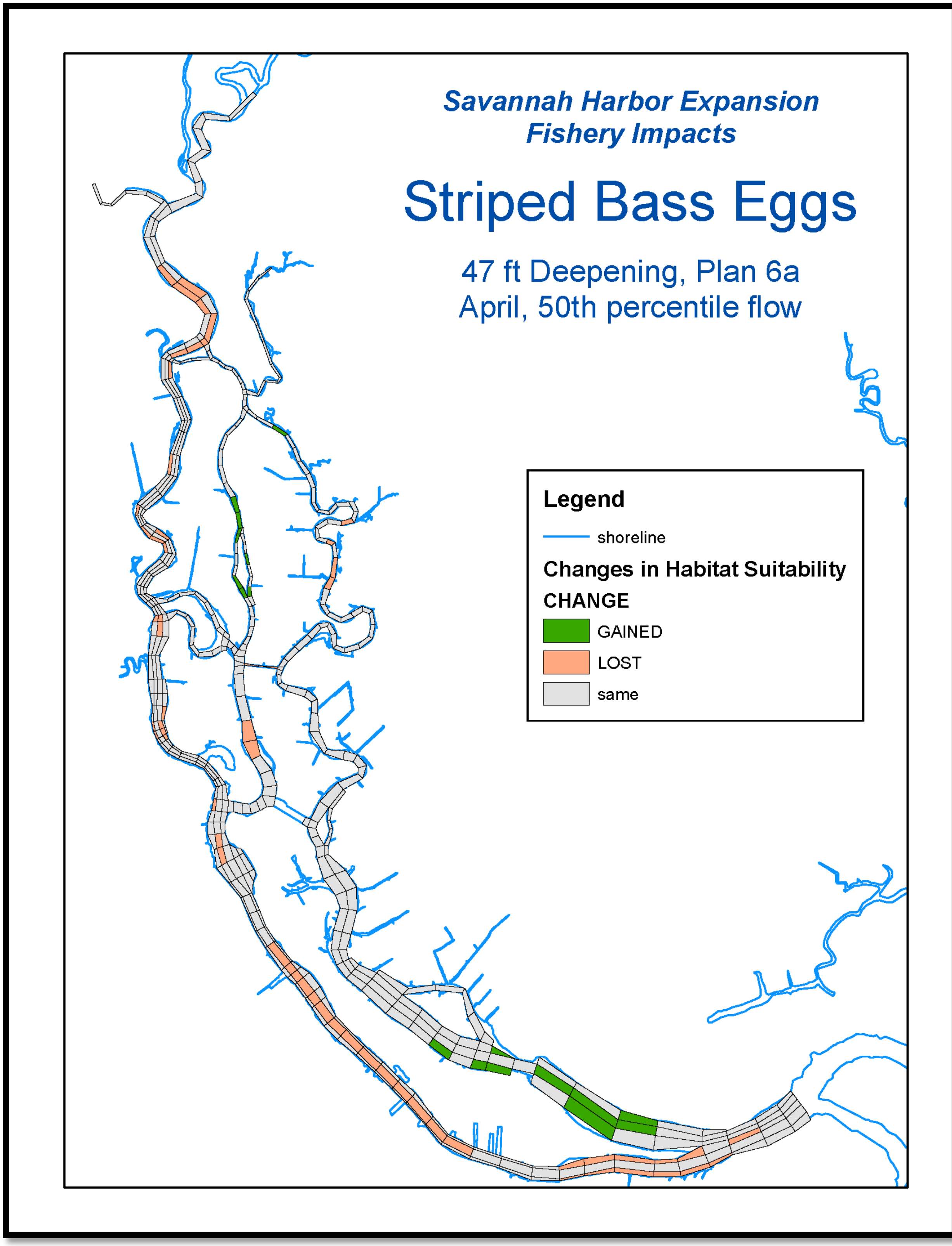

Figure 5-40. Striped bass egg habitat for the Selected Plan (47-foot depth alternative).

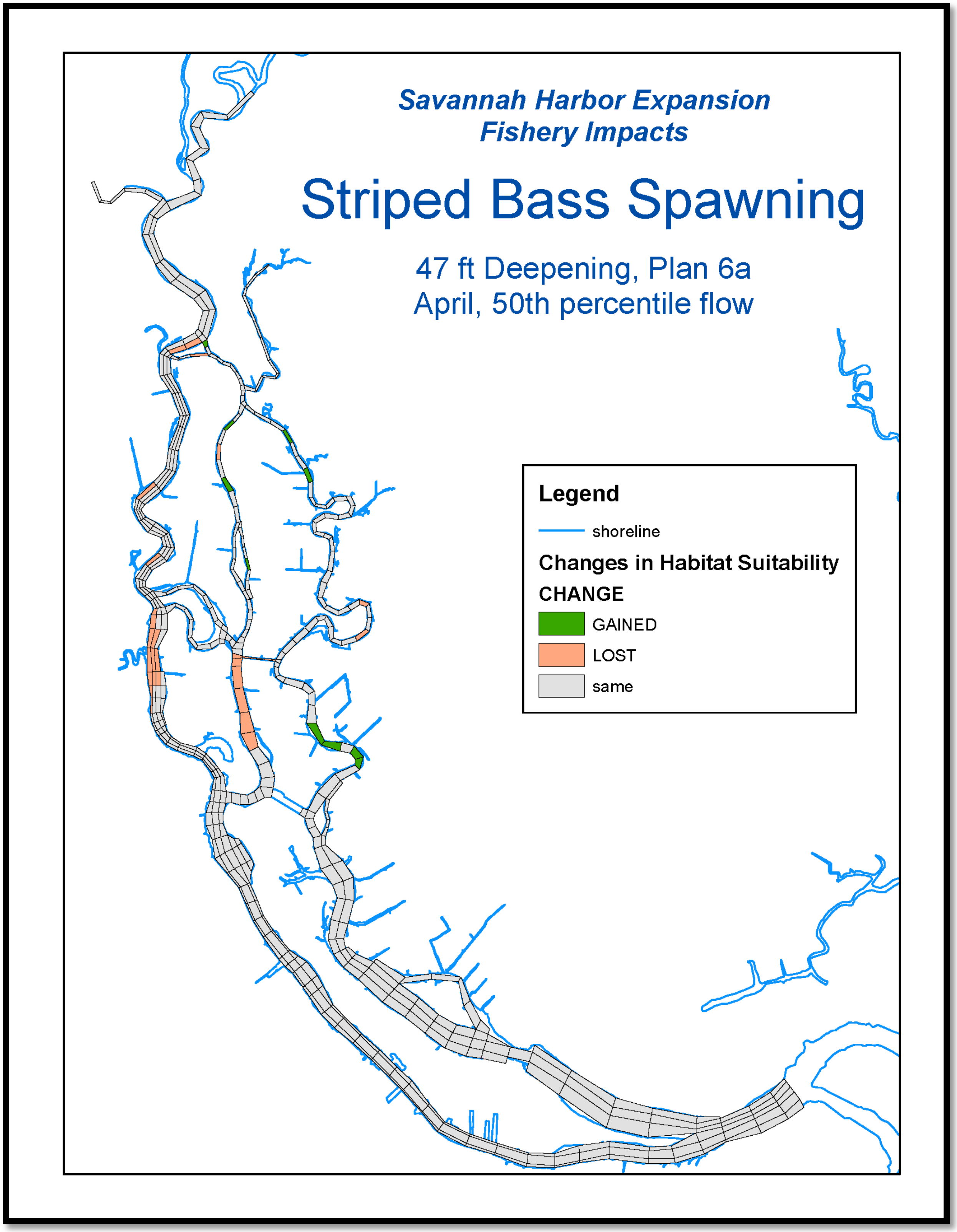

Figure 5-41. Striped bass spawning habitat for the Selected Plan (47-foot depth alternative).

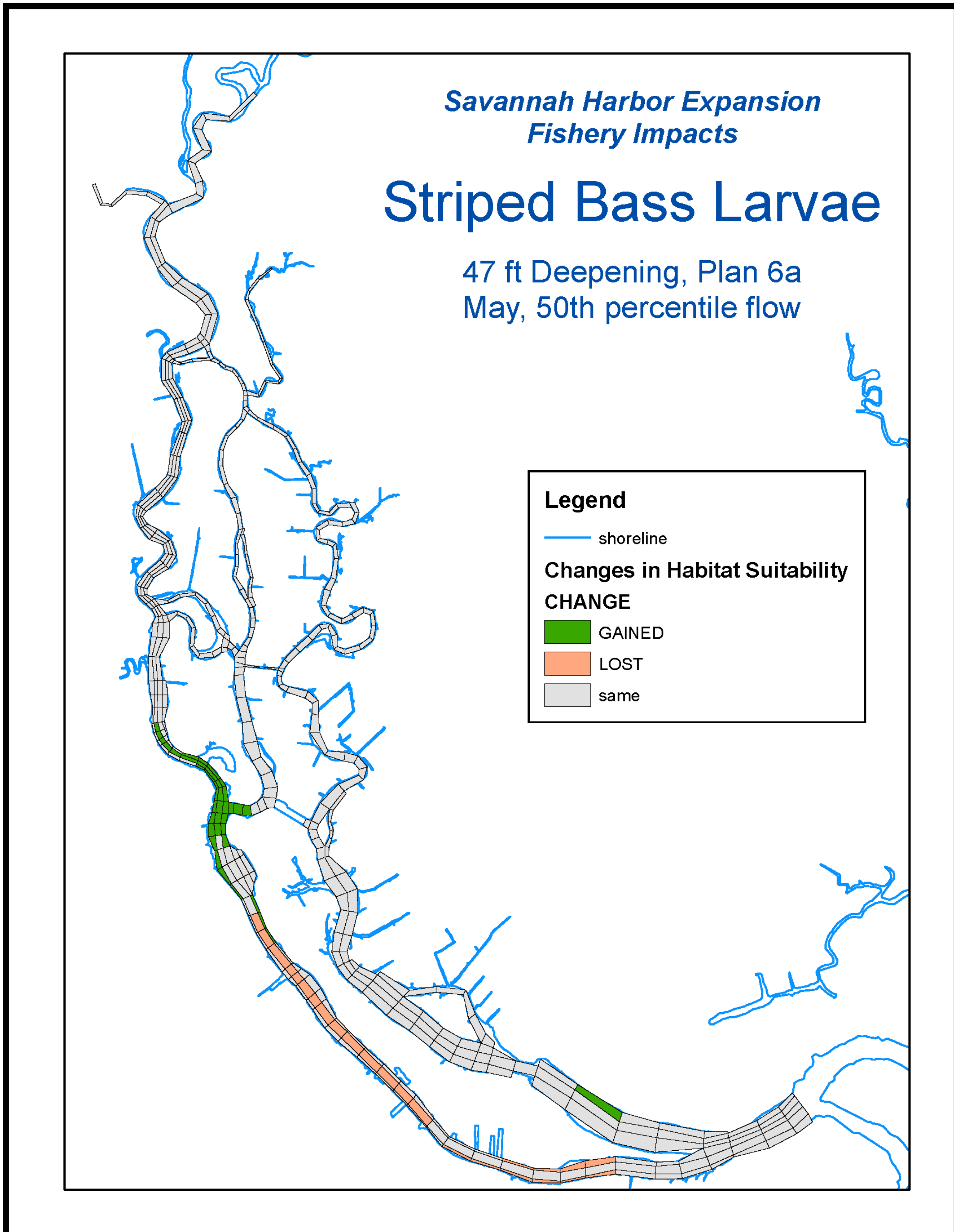

Figure 5-42. Striped bass larvae habitat for the Selected Plan (47-foot depth alternative).

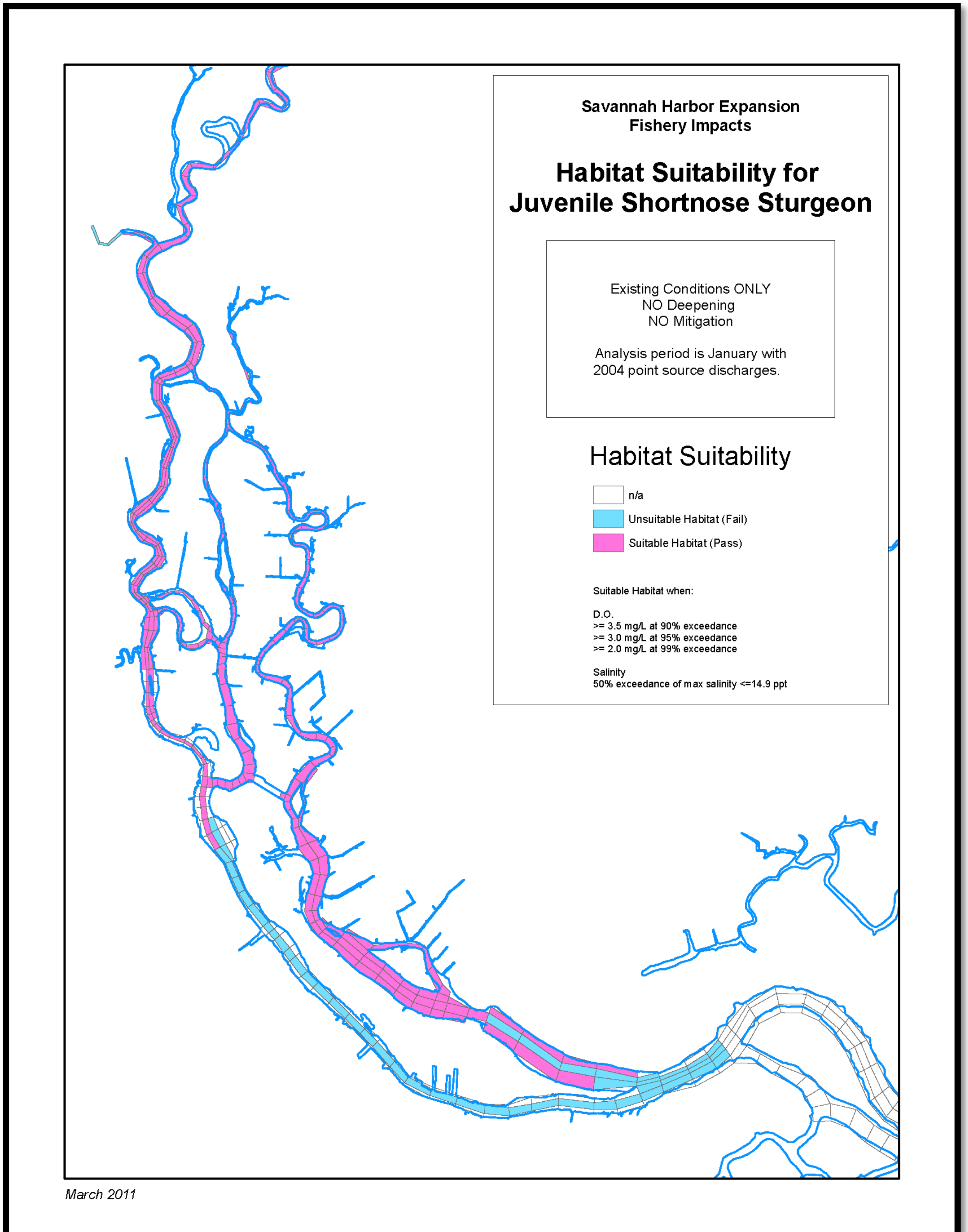

Figure 5-43. Shortnose sturgeon juvenile habitat for existing conditions (42-foot channel).

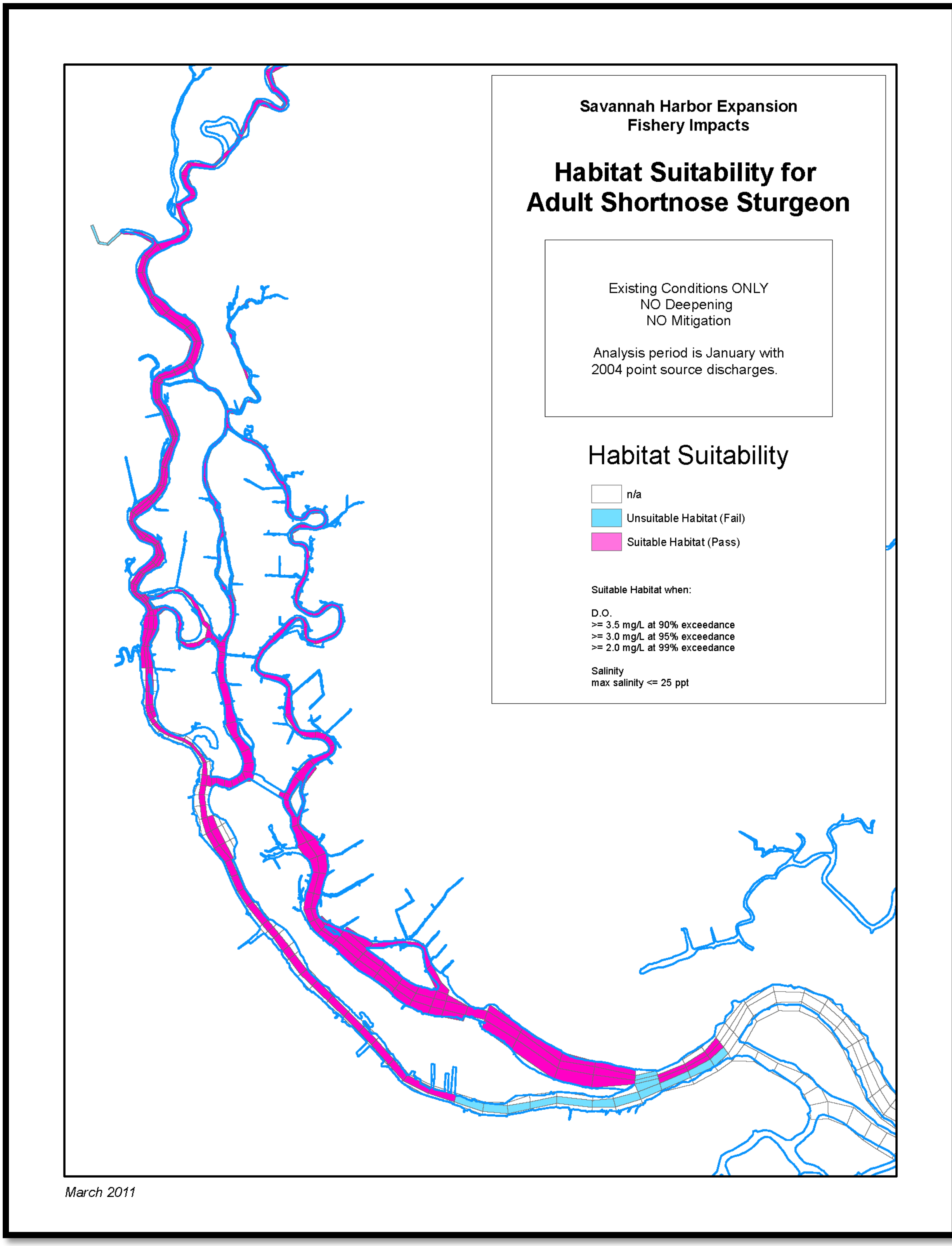

Figure 5-44. Shortnose sturgeon adult habitat for existing conditions (42-foot channel).

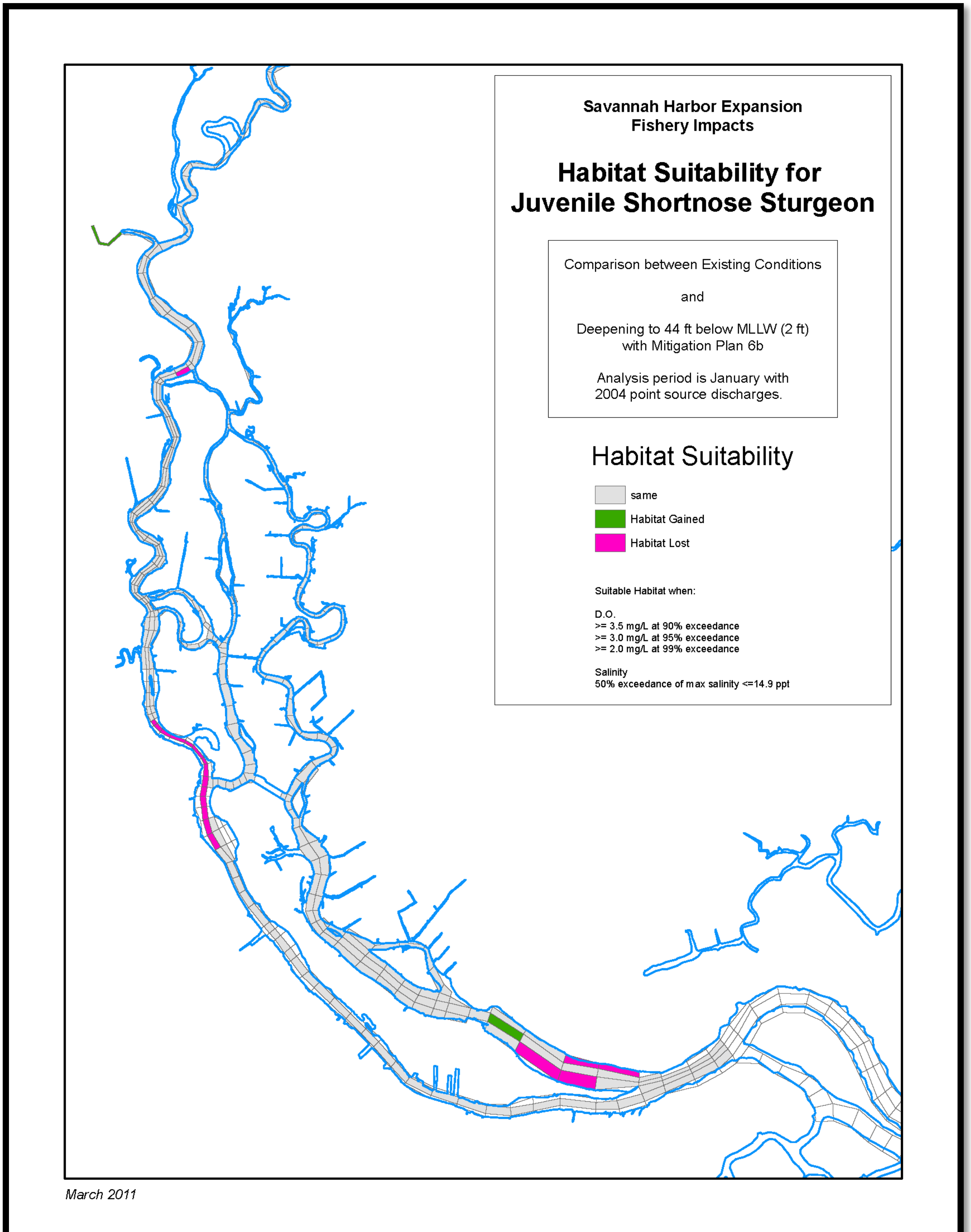

Figure 5-45. Shortnose sturgeon juvenile habitat for the 44-foot depth alternative.

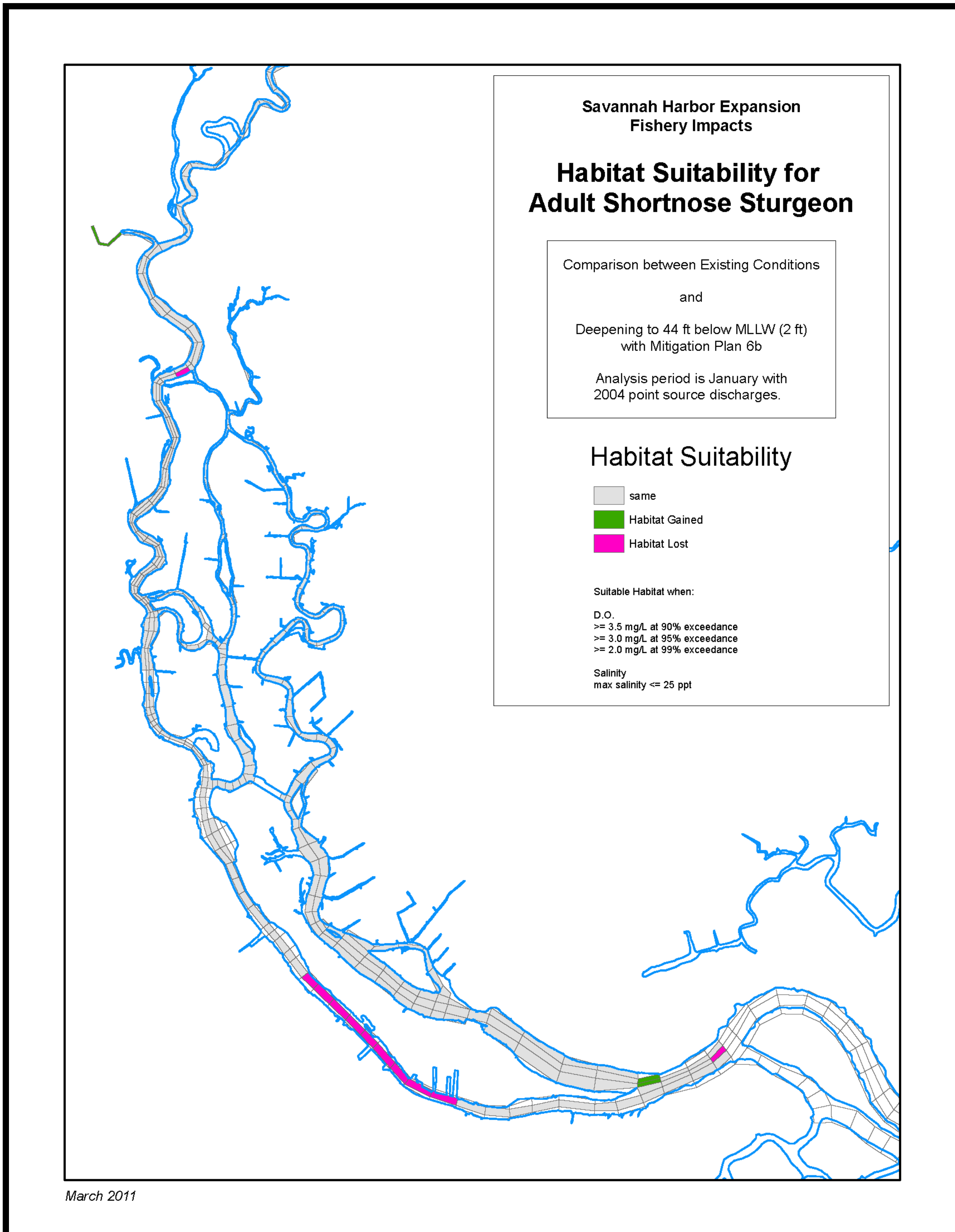

Figure 5-46. Shortnose sturgeon adult habitat for the 44-foot depth alternative.

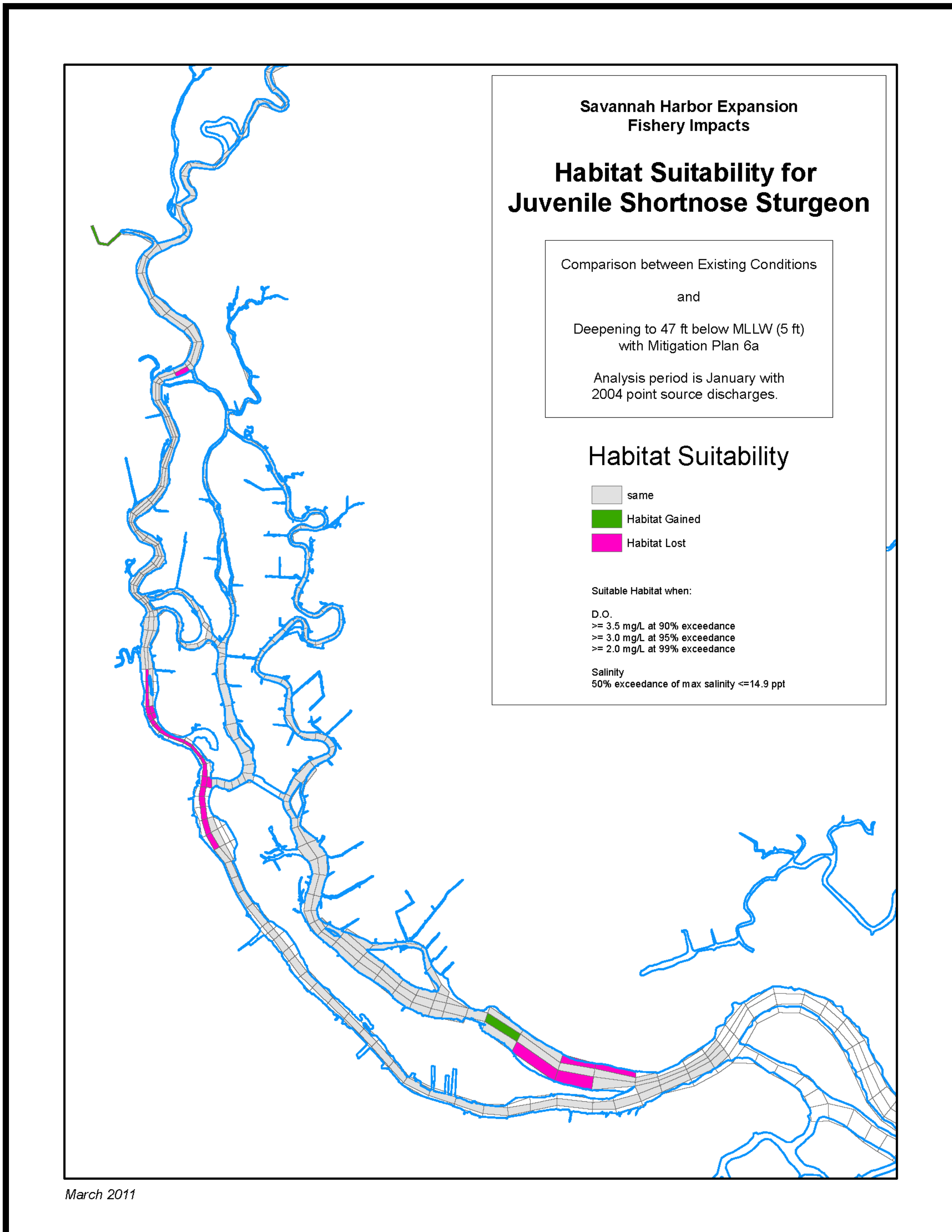

Figure 5-47. Shortnose sturgeon juvenile habitat for the Selected Plan (47-foot depth alternative).

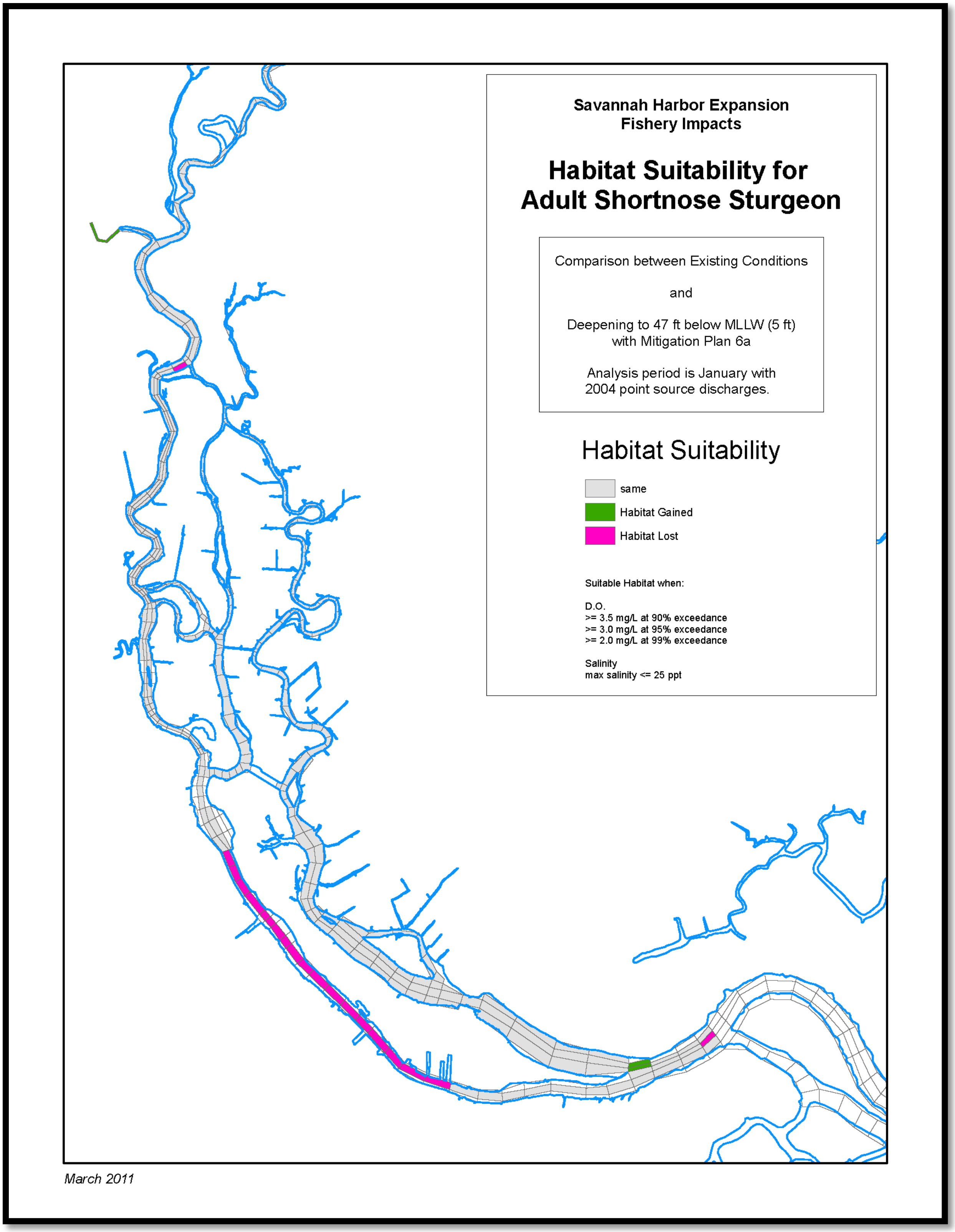

Figure 5-48. Shortnose sturgeon adult habitat for the Selected Plan (47-foot depth alternative).

5.03.2 Mitigation for Impacts to Fisheries

5.03.2.1 Shortnose Sturgeon. 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 Shortnose sturgeon habitat or enhance existing habitats.

Consequently, the Corps began to evaluate other means to improve Shortnose sturgeon habitat including upstream spawning habitat. The Corps acknowledged that removal of the lowest dam on the river, the New Savannah Bluff Lock and Dam (NSBL&D) at Augusta, Georgia, would be the biologically-preferred method to allow sturgeon and other anadromous fish to access upstream habitat. The Corps also acknowledged that removal of the lock and dam would benefit the ecosystem. The Corps had proposed such an action in 1999, but local governments opposed it, citing adverse impacts to recreational uses of the pool upstream of the dam. In response, the Corps proposed rehabilitating the structure and adding a fishway to allow fish to move pass the structure. In 2000, Congress authorized construction and operation of a fishway at NSBL&D as part of a lock and dam rehabilitation project. That project has not been funded. Coordination with local governments indicates they continue to oppose removal of the structure. Consequently, removal of the New Savannah Bluff Lock and Dam is not a feasible mitigation alternative for the following reasons:

A. The lock and dam is a Congressionally-authorized project; therefore, the Corps is obligated to maintain the project as Congress provides funding for such actions.
B. The current authorization language (WRDA 2000), amended in Omnibus Act 2001, calls for repair and rehabilitation of the lock and dam structure, construction of a fish passage, and conveyance of the Lock and Dam to the City of North Augusta.
C. Removal of the structure would adversely impact the freshwater supply of eight major users.

Since removal of the NSBL&D is not feasible, the Corps suggested that a fish passage structure at NSBL&D be considered as mitigation feature for the SHEP impacts to Shortnose sturgeon habitat. A fishway around the structure would allow migrating fish to move past the dam and allow Shortnose sturgeon to access upstream historic spawning areas at the Augusta Shoals. The structure would also open up the river to American shad and other anadromous fish species, thereby helping those populations. There is also evidence that some of the Savannah Harbor Striped bass population spawn in upstream areas near the fall line, which could also benefit from the fishway.

The previously-approved horseshoe rock ramp design was proposed as a means of allowing Shortnose sturgeon and other anadromous species of fish to move past the NSBL&D during spawning season. The fishway would be located around the South Carolina abutment of the dam. This is the wooded area on the bank opposite the lock in Figure 5-49 below. It would be designed to operate continuously and pass 600 cubic feet per second (CFS) during low flow conditions (95% exceedance). The 600 CFS minimum attraction flow is 5% of the mean river flow during upstream spawning migration period of February through June. Higher attraction flows are probably better, but Parasiewicz et al. 1998 indicated that 5% of the river flow should be an adequate attraction flow for most fish. The fishway would pass higher flows when the river flows are higher. Flows in the fishway are designed to be self-regulating over a two-foot headwater variation, including a range of river flows from 3,600 to 20,000 CFS. The horseshoe rock ramp would have roughly a 75-foot width across the base and use boulder weirs at approximately a 25-foot spacing. There would be roughly a 9-inch drop per weir along the length of the fishway. The water depth would range between 3.5 and 5.5 feet in the fishway. The horseshoe rock ramp bypass design would also allow fish to move downstream, thereby ensuring young fish spawned upriver could access other habitats needed in later life stages. Figures 5-50 and 5-51 show the rock ramp fishway design.

Figure 5-49. Aerial view of New Savannah Bluff Lock and Dam.

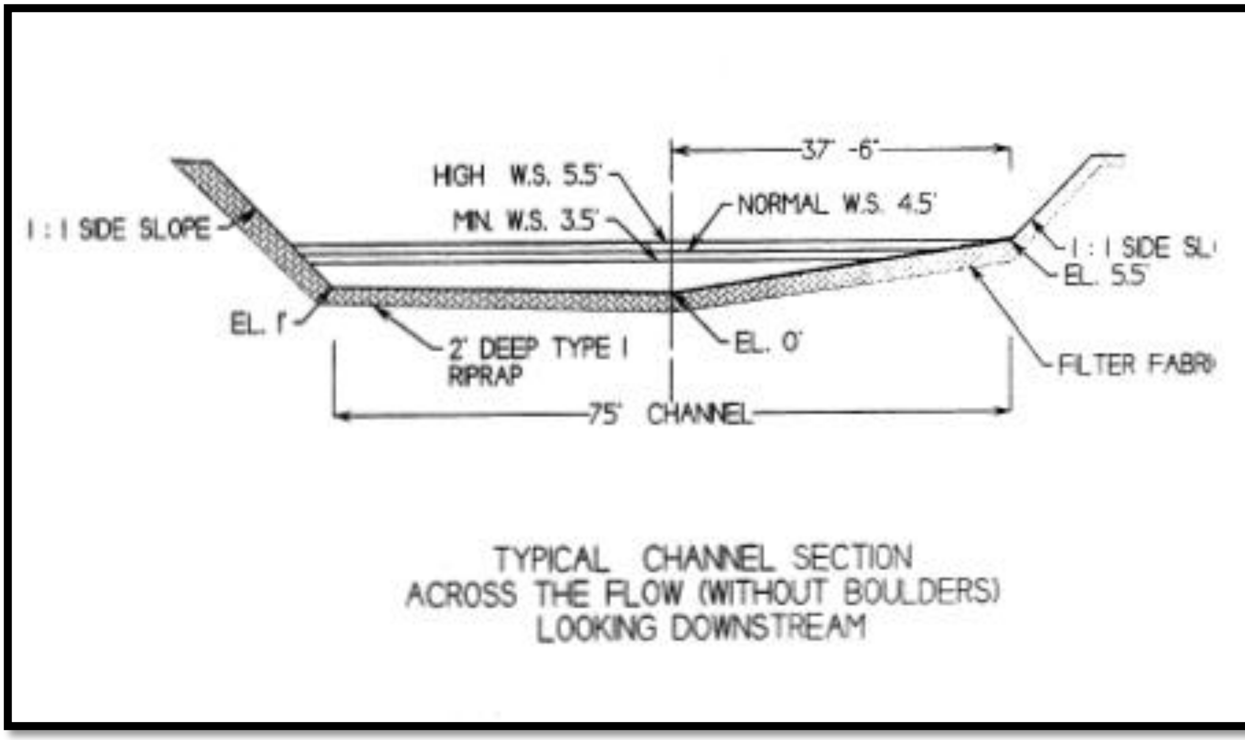

Figure 5-50. Typical cross-section of rock weir.

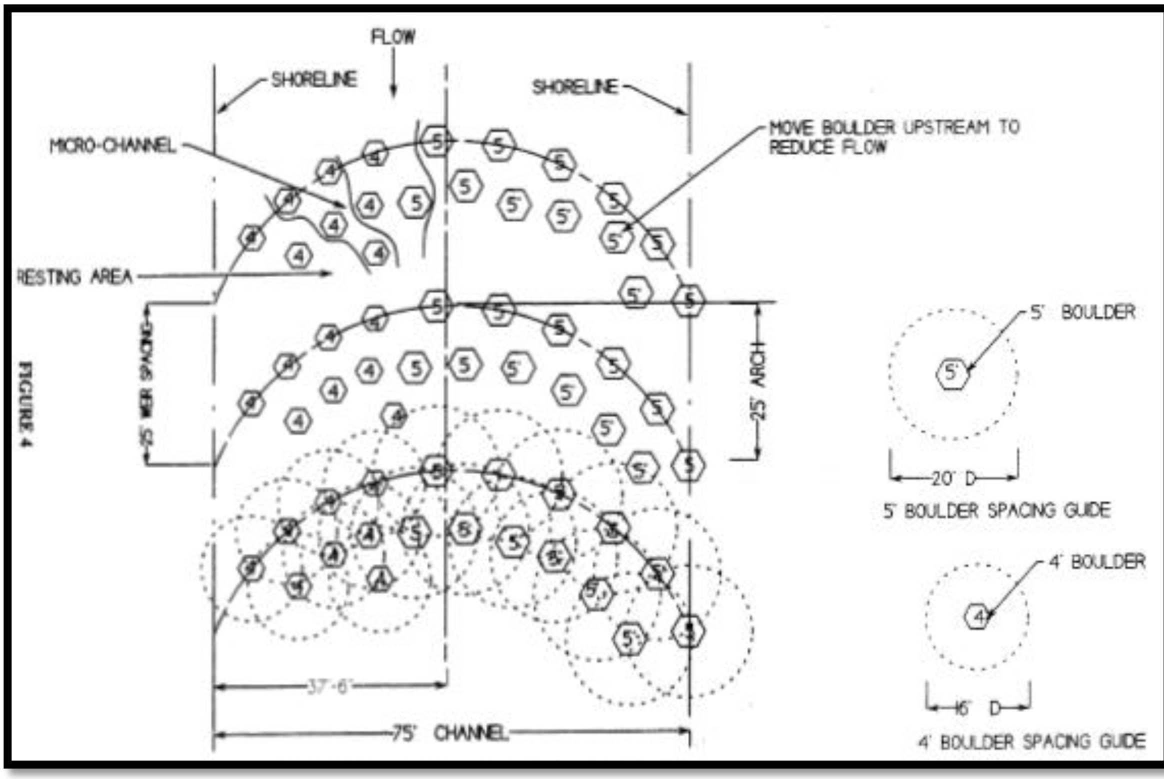

Figure 5-51. Plan view of boulder layout for rock weirs.

In June 2007, representatives of the resource agencies confirmed that the fishway appeared to be the only measure within the basin to effectively compensate for the predicted loss in Shortnose sturgeon habitats. The Corps conducted a preliminary review of the 2001 fishway design and confirmed that conditions had not changed that would reduce its effectiveness or ability to be implemented. In 2010, the Corps consulted the Federal and State regional natural resource agencies to determine if the state-of-the-art had advanced substantially since the design was completed for the fish passage structure at the NSBL&D. No fishery experts in the regional natural resource agencies identified any specific change to the proposed design that should be made as a result of recent documented fish passage research. The rock ramp design was provided to the cost estimators, who updated the cost for constructing the fishway. That fishway was added as a feature of the mitigation plan at an estimated ROM cost of $4.3 million.

The horseshoe rock ramp bypass design as described above was presented in the DEIS. In their comments on the DEIS, some agencies believed the horseshoe rock ramp bypass would need to carry more than 5% of the river flow to successfully pass Shortnose sturgeon. Consequently, the Corps convened an interagency workshop on April 25-27, 2011 to discuss and evaluate mitigation options available. Numerous options were evaluated for fish passage at the NSBL&D. Using the input from the agencies at the workshop, the Corps screened the potential fish passage options and prepared preliminary designs for three new fish passage alternatives: (1) Full River Rock Ramp, (2) Off-Channel Rock Ramp, and (3) a Hybrid Rock Ramp. Although not specifically considered at the interagency workshop, the Corps considers the Off-Channel Rock Ramp to be a variation of the Full River and Hybrid Rock Ramp designs since they would all transport roughly the same amount of water for Shortnose sturgeon to use while moving through that location of the river. These alternatives differ by their location across the channel's cross-section. Once upstream passage occurs, successful downstream passage is critical to ensure that the adult breeding population as well as juvenile fish can return to traditional foraging habitats in the estuary. For all three alternatives, a rock ramp would be constructed to allow Shortnose sturgeon to swim to the upstream pool. In each design, large boulders would be used to create pools with local areas of lower velocities. All three designs would also accommodate the larger Atlantic sturgeon and readily pass other anadromous species such as American shad and Striped bass.

Table 5-42 shows a comparison of the three designs. The Full River Rock Ramp would capture all of the river flow (up to 10,000 cfs) 73% of the time from February-June which is the Shortnose sturgeon spawning season. Flows over 10,000 cfs would flow through the flood bypass channel and the ramp. The Off-Channel Rock Ramp Design would capture all of the river flow (up to 8,000 cfs) 64% of the time from February-June while the Hybrid Rock Ramp Design would capture all of the river flow (up to 9,000 cfs) 70% of the time. Since all three designs would achieve the objective of Shortnose sturgeon passage at the NSBL&D, the Off-Channel Rock Ramp Design was selected as the preferred design because it is the most cost effective. Figure 5-52 shows the most recent design for the Off-Channel Rock Ramp. A complete discussion of the analysis of fish passage alternatives at NSBL&D can be found in Appendix C.

Table 5-42. Comparisons of Potential Fishway Designs at NSBL&D

Parameter	Full River Rock Ramp	Off-Channel Rock Ramp	Hybrid Rock Ramp
100% of flow through ramp up to X cfs	10,000 cfs	8,000 cfs	9,000 cfs
Crest elevation of Rock Ramp	109 ft	109 ft	109.5 ft
Number of gates operational	0	5	3
Modification to existing Lock & Dam structure	Major	Minor	Moderate
Modification to existing Lock & Dam project	Major	Minor	Moderate
Percent of time ramp captures all of river flow (February - June)	73%	64%	70%
Effectiveness in fish passage (Upstream)	90%	75%	80%
Effectiveness in fish passage (Downstream)	100%	85%	90%
Effectiveness in fish passage (Overall)	Acceptable	Acceptable	Acceptable
ROM cost	$100 mil	$32 mil	$41 mil
Cost Effectiveness (Cost /% SNS passage effectiveness)	$1,050,000	$325,000	$480,000

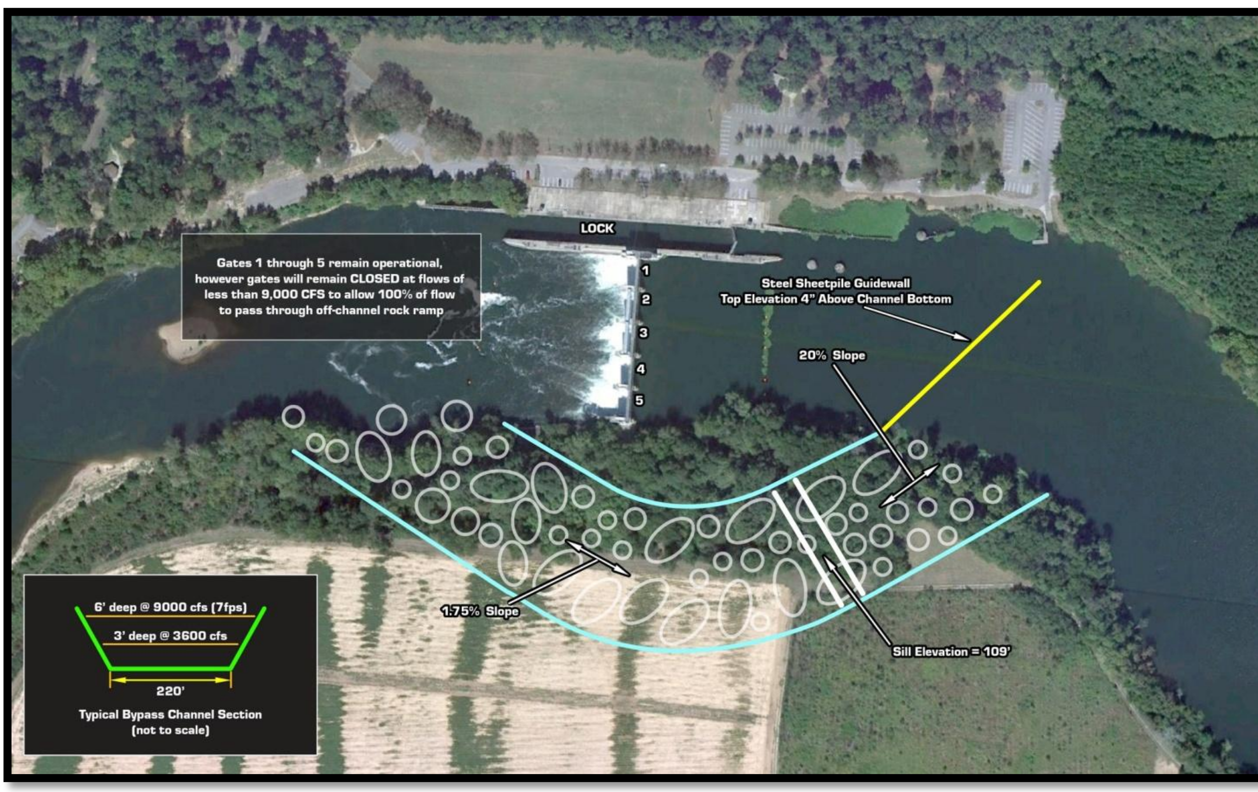

Figure 5-52. Conceptual design of off-channel rock ramp.

The project's Monitoring Plan includes studies to evaluate Shortnose sturgeon distribution at the NSBL&D as well as the success of the fish passage structure. During the pre-construction monitoring, the movement of fish at the NSBL&D would be monitored for one year. This monitoring would include capturing, tagging and tracking Shortnose sturgeon and possibly other representative species of fish indigenous to that area (Striped bass, Robust redhorse, and American shad). Fish would be collected and implanted with combined radio and acoustic transmitters. If possible, fish would be collected within one km of the dam. The fish would be monitored continuously in the vicinity of the dam using a fixed station radio receiver. In addition, the river would be searched weekly during migration season between NSBL&D and Jackson, SC Landing and between NSBL&D and the Augusta Diversion Dam. The Savannah River would also be searched from the Kings Island Turning Basin to the NSBL&D and above to the Augusta Diversion Dam on a monthly basis. When located, species, identification number and location would be recorded. Temperature would be recorded several times daily at locations above and below the dam. Dissolved oxygen, turbidity, and river stage at the dam would be recorded at least weekly and dam discharge recorded daily.

This study would be continued during the Post-Construction monitoring for the project during years 1-5 and 9 of the post-construction monitoring program. The original scope of the study would be supplemented with additional tasks that would concentrate on Shortnose sturgeon passage at NSBL&D. The results of this study would help the Corps determine if changes to the fish passage structure are warranted. If so, adaptive management funds would be available to make any required modifications as outlined in Appendix D.

It should be noted that construction of the off-channel rock ramp fish passage facility at NSBL&D would have a potential indirect, adverse impact on any future plans to generate hydropower at this facility should some entity desire to do that in the future. With the proposed bypass design, most of the flow would pass around the dam through the bypass, resulting in little flow being available to generate power by passing through the dam.

5.03.2.2 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. See Tables 3-7 and 3-8 in Section 3 for a summary of impacts and Appendix C of the EIS for more details on the impacts analysis. 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 1990s and continues to stock Striped bass on an annual basis. The Corps coordinated with GA DNR-WRD and confirmed that expanding their ongoing 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 acceptable spawning or early life stage habitat in the estuary. However, since the alternatives being considered are not predicted 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 5-43. Summary of Impacts to Striped Bass Habitat

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 as summarized below in Table 5-44.

Table 5-44. Annual Compensation Amounts for Striped Bass Mitigation

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 5-45. Lump Sum Compensation Amounts for Striped Bass Mitigation

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.

An evaluation of the impacts of the SHEP on Striped bass habitat would be conducted during years 2, 4, and 9 of the Post-Construction monitoring to ensure that impacts do not exceed what is expected. The field data collected during the monitoring would be used in conjunction with the hydrodynamic and water quality models to conduct this assessment. Adaptive management funds would be available to provide further mitigation for Striped bass habitat should the study show that is warranted.

5.04 Sediment Quality

5.04.1 Overview

The proposed deepening of the Federal navigation channel to -47 feet MLW would require excavation of approximately 23.6 million cubic yards of sediments. Estimated maintenance dredging of the new deeper Federal channel will require the yearly removal of about 7 million cubic yards of sediments from the river and entrance channels.

Sediments of the Savannah River and the nearshore ocean continental shelf are continually subject to movement by wind, tide and strong currents. Redistribution of sediments is, therefore, a natural and continuous phenomenon. New work sediments removed from the entrance channel would be deposited in the ODMDS or existing upland CDF. If a non-Federal source of funding is identified, suitable O&M sediments from the entrance channel could also be deposited in the nearshore sand sharing system or directly on the Tybee Island beach. Otherwise, the O&M sediments from the entrance channel would be deposited in the Savannah ODMDS or a CDF.

5.04.2 Sediment Quality Evaluation (Assessing Potential Contaminant Impacts)

Three rounds of new work sediment sampling and analysis were performed for the Savannah Harbor Expansion Project, with each round building upon the results of the previous work. The details of the entire evaluation are described in the Sediment Quality Evaluation contained in Appendix M. This section summarizes that information.

The initial round of sampling and analysis was performed during the Tier I studies. Sediment core samples were collected in 1997 and examined for sediment physical and chemical properties to identify whether any chemicals occur in the new work sediments at concentrations that present environmental concerns. The sampling area covered the entire area proposed for harbor deepening, extending from deep water in the ocean to the Kings Island Turning Basin (Station 103+000). Parameters investigated included metals, PCBs, PAHs, petroleum hydrocarbons, phenols, pesticides, dioxin congeners, cyanide, organotins, and nutrients.

The evaluation found that most of the sediments did not provide any concern for potential contaminant-related impacts associated with the proposed dredging and dredged sediment placement. However, three potential issues were identified.

One issue involved sediments near the old RACON Tower site located on the outer end of the entrance channel. Polycyclic aromatic hydrocarbons **(**PAHs) and cadmium were detected in a sample taken at about Station 75+000 near the old RACON Tower where a spill of fuel, batteries, and paint lacquer occurred in November 1996. Sampling conducted there in 2005 during the second round of analysis revealed that those sediments do not pose a potential for potential contaminant-related environmental impacts.

The second issue pertained mostly to whether the sediment chemistry data for pesticides, PAHs and phenols were adequate for comparison to screening criteria. This issue was addressed during the 2005 sampling. The confirmatory sampling within the channel revealed there are no potential sediment contaminant concerns related to pesticides, PAHs, phenols, or metals other than cadmium.

The final issue involved the concentration and distribution of cadmium within the new work sediments. Cadmium was found to occur naturally in unusually high levels within Miocene clays that would be excavated during the SHEP dredging. Again, sampling was conducted during the second round to address this issue.

Sediment samples from the harbor were examined for radionuclides. Both maintenance and new work sediments were examined. The examination found sediment samples with radioactivity ranging from 0.02 to 0.04 mRem/hr. These results are consistent with the background levels, with only a few samples exhibiting an increase of 0.01 mRem/hr over the background range. Such findings were anticipated, since these soils contain phosphatic and glauconite minerals, along with other clays, that exhibit naturally-occurring levels above background levels. These results are two orders of magnitude below acceptable action levels approved by OSHA and the US Environmental Protection Agency that range between 1 mRem/hr to 5 mRem/hr. Based on these results, the levels of gross radioactivity measured in the harbor sediments pose no reason for concern. Further information can be found in the GRR Engineering Appendix, Dredged Material Physical Analysis Report.

5.04.2.1 Cadmium-Laden Sediments. The second round of new work sampling was completed in 2006 and it concluded that the only sediment contaminant of concern for the proposed harbor deepening is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 to 94+000 (River Mile 8.5 to 17.8).

The answers to three questions influence the degree to which cadmium might move from channel bottom sediment to benthics to the aquatic food chain: (a) would clay sediment with elevated cadmium be exposed so that benthics growing in the clay could support an aquatic food chain, (b) can Miocene clays support benthic organisms, and (c) would cadmium in the bottom sediments be available to benthic organisms such that the organisms would accumulate cadmium and pass it through the food chain?

To help answer these questions, the Corps contracted with EA Engineering, Science, and Technology to perform additional detailed studies (third round of sampling). Those studies were performed in 2007 and included the following activities:

A. Sediment Profile Imaging to locate/verify exposed Miocene clays and assess the potential existence of benthic communities in the clay;
B. Side scan sonar survey to identify and map bottom characteristics in the channel;
C. Benthic community assessment;
D. Sediment sample collection (vibracoring 6 ft into Miocene clay at four locations in the navigation channel, reference sediment sampling, and upland reference soil sampling);
E. Collection of dredging water from one location in the Federal navigation channel and one receiving water location in Fields Cut;
F. Compositing and processing sediment cores to create “high cadmium” and “low cadmium” composite samples for further testing;
G. Analytical testing of bulk sediment, standard elutriates, effluent elutriates, dredging water, and receiving water samples;
H. Analytical testing of porewater and SLRP samples at the high cadmium locations only;
I. Aquatic bioaccumulation studies and plant uptake studies using high and low cadmium composites; and

J. Risk evaluation and report preparation.

EA's findings are summarized in the following paragraphs. Their full report is available from Savannah District for review.

One of the investigations that EA conducted was of the benthic community of the river bottom, both inside and outside the navigation channel. They found a substantial benthic community within the channel bottom. In addition, they found that the coarse sand/gravel/clay substrate was used by benthic organisms, although they were unable to determine to what extent benthic organisms burrow into the clay. They found that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. However, the limited availability of exposed high cadmium sediments within the navigation channel, as discussed above, precludes more than minimal potential for clay dwelling benthic input to the riverine ecosystem. EA found that the clay substrate does support benthic organisms, but that this substrate comprises less than 28 percent of the channel bottom between Stations +16+000 and +60+000. This finding indicates that benthic organisms residing in exposed Miocene clays should present a relatively small fraction of the benthic organisms within the channel ecosystem. Because of the predicted small fraction of available habitat, potential impacts through bioaccumulation of cadmium by benthic organisms within the Miocene clays appear to be minor, but not zero. To be conservative, the potential for bioaccumulation of cadmium by benthic organisms was evaluated. Section 4.2.5 of the Sediment Quality Evaluation (Appendix M) contains that assessment. The bioaccumulation studies show bioaccumulation in high cadmium sediments to be well below potential levels of effect. Therefore, potential environmental impacts through bioaccumulation of cadmium by benthic organisms are expected to be minimal.

Laboratory testing revealed that cadmium within the exposed high cadmium sediments would be relatively unavailable to biota. The essentially anoxic state of the channel sediments should preclude significant movement of cadmium to the environment. In addition, exposure of the riverine environment to high cadmium clays would be restricted, since the majority of the exposed clays are expected to be covered by O&M sediments.

Discharges of sediment to the water column during hydraulic dredging, seen as increased turbidity in the water column, are normally considered *de minimis*. However, in this case, the dredged sediment could contain elevated levels of cadmium. The presence of sediments with elevated levels of cadmium raises the potential for environmental impact. However, the Miocene clays thought to contain elevated levels of cadmium are expected to remain relatively intact during the dredging process and remain relatively intact and form clay balls that would be deposited in CDFs 14A and 14B. Relatively minor amounts of clay would be expected to be released to the water column. Furthermore, standard elutriate analyses on the sediment composites found the dissolved fraction of only three parameters to be above water quality criteria. Cadmium was not one of the parameters.

Other potential impacts or exposure pathways include:

A. The cadmium-laden sediments would also be pumped to an upland CDF.

B. Once in a CDF, the cadmium-laden sediments could contaminate ground water (under the CDF).
C. The dredge effluent from the CDF containing the cadmium could be discharged back into the Savannah River.
D. Birds and other terrestrial animals living in the CDF could take up cadmium while feeding.
E. Worker exposure during dredging of cadmium-laden sediment.

The Sediment Quality Evaluation (Appendix M) indicates the following about those issues:

1. Potential impacts associated with other pathways by which a contaminant might leave a CDF (leachate to groundwater, runoff, effluent, volatilization) were found to be minimal. A liner could be used to prevent cadmium movement to groundwater as leachate. Studies found cadmium to be tightly bound within wet sediments and clay porewater concentrations were found to be very low. Therefore, movement of cadmium through leachate (into the groundwater) is expected to be minor and of minimal environmental concern. Therefore, a liner to prevent cadmium movement to groundwater is not warranted.

2. A risk assessment was conducted for workers associated with dredging and sediment placement operations exposed to cadmium-laden enriched sediments. The conclusion was that exposure to the cadmium-laden dredged sediment does not pose a concern for adverse non-carcinogenic or carcinogenic health effects.

3. Birds and mammals feeding in the CDF would not be exposed to cadmium-laden sediments (from the Station +16+000 to +45+000 reach) if the sediments are isolated within a CDF and capped/covered with sediment from another reach. The high cadmium sediments would not be disturbed further and would not be allowed to be later excavated and placed in any exposed upland area.

5.04.2.2 Mitigating Exposure to Cadmium in Sediments. All cadmium-laden sediment from Stations 6+375 to 45+000, 51+000 to 57+000, and 80+125 to 90+000 would be placed in CDF 14A (if there is sufficient capacity) or CDFs 14A and 14B. The sediment would be deposited so that it remains covered with water until after placement of the cover is completed. This material would not be allowed to dewater and/or desiccate until after placement of the cover is completed and cadmium levels in the surface sediments of the CDF are less than 4 mg/kg. Samples would be taken of the inflow (head section of dredge discharge pipe) during placement and analyzed for cadmium. The Corps would perform monthly biological sampling (wildlife and avian use abundance surveys) in CDFs 14A and 14B. This monitoring would be performed during and after (for 3 years) sediment placement to provide a record of wildlife and bird use of these CDFs. The monitoring methodology that the Corps would perform is summarized below. Please see Appendix D for a more detailed description of the timing of each event. If conflict exists between the descriptions, then Appendix D takes precedent.

Following placement of cadmium-laden sediments within a CDF, grab samples would be collected to characterize the cadmium levels of the surficial sediments. This would occur prior to placement of the sediment cap. Eighty-six (86 grab) samples would be collected from a depth of 15 cm. Samples would be evenly spaced across the CDF, and analyzed for cadmium concentration on a dry weight basis.

A cap/cover of sediments obtained from areas of the channel where concentrations of cadmium are believed to be 4 mg/kg or less would be placed on the sediments in the CDFs. Following placement of the cover, eighty-six (86) grab samples would be taken from a depth of 30 cm and analyzed for cadmium. If the analysis of the sediment samples taken from the cover indicates that concentrations of cadmium are less than 4 mg/kg, monitoring of the cover would be complete.

If the analysis of the sediment samples taken from the cap indicates that concentrations of cadmium are equal to or exceed 4mg/kg in a cumulative area of 25 acres or more of the capping/covering layer, then three actions would be initiated. First, the CDF would be kept flooded to keep the sediments wet/moist. Second, the CDF would receive a cover of O&M material at the earliest possible time. Once the layer of O&M material has been placed in the CDF, the surface sediments (to depth of 30 cm) would be sampled (86 grab samples) and analyzed for cadmium. The process of placing O&M material into the CDF and testing for cadmium would be repeated until cadmium concentrations in the surface sediments are less than 4mg/kg.

Third, biological monitoring would be conducted (monthly) to determine which avian and wildlife species are frequenting the CDFs. If there is concern about the number of birds or animals or a particular species using the CDFs, then some type of hazing may be appropriate. Vegetation sampling would be conducted on a quarterly basis, if required (if the surface sediment sampling in the CDF indicates that cadmium levels are 4 mg/kg or higher). Vegetation sampling would be conducted in defined “hot spots” to determine the potential for cadmium uptake by plants. Samples collected from CDFs 14A and 14 B would be compared to control samples from other, cadmium-free environments found in adjacent CDFs. If vegetation samples have significantly elevated cadmium concentrations, then efforts would be initiated to eradicate vegetation and/or place an additional capping layer in the CDF.

Independent of the concentrations of cadmium on the cap/cover, the Corps would perform monthly biological monitoring of birds that use CDFs 14A and 14B during and after sediment placement. Cadmium levels in blood samples would be evaluated before, during and after sediment placement. Appendix M describes the plan for bird sampling protocols which take into account the hydrologic condition of the CDFs (wet or dry) and the season since these conditions greatly influence the avian species that use the CDFs. A reference CDF would also be sampled as background. Samples would be obtained prior to the placement of material into the CDFs which would serve as baseline data. This sampling would continue during all dredged material placement activities and for 3 years after placement is completed. If the concentration of cadmium in the samples taken during and after construction is significantly higher than that observed in the baseline samples, tissue (liver) sampling would be conducted.

The effluent from all CDFs would be monitored during dredging operations. The effluent from CDFs 14A and 14B would specifically be monitored for cadmium. Sampling (weekly) would be conducted to determine the cadmium concentrations in the effluent discharged from CDFs 14A and 14B. Monitoring of the effluent from CDFs 14A and 14B would continue as long as a discharge was present and until all sediments have been covered, dewatered, and stabilized. Following the installation of a clean cap, cadmium would be monitored in the effluent on a monthly basis for one year.

At the end of construction, sediment samples will be taken from the exposed channel bottom sediment surface and analyzed for grain size and metals (aluminum, iron, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc). Samples will be cores taken to a depth of 15 cm. Where both O&M and new work sediments appear in the core, each will be analyzed separately. Samples will be taken within the channel every 2,000 feet from Stations +100+000 to 0+000 (26 samples) randomly selecting either the center line of the green side or red side. Five stations will be randomly selected to have two adjacent samples collected, from both the red and green side (10 samples). These last samples would be used to define the variability in bottom sediment metal concentrations across the channel. In addition, 5 samples would be run in duplicate (lab duplicates). Analysis of the river bottom would provide an assessment of anticipated cadmium concentrations in sediment at the sediment water interface.

As requested by the GA DNR-EPD, sediment analysis would be required prior to maintenance dredging in channel reaches with cadmium-laden sediments. Samples would be taken and analyzed for cadmium from two locations for at least two maintenance dredging cycles and furnished to the GA DNR-EPD at least 45 days prior to dredging.

In light of the information summarized above, the dredging and the placement of cadmium-laden sediment in CDF 14A, CDF 14B is not anticipated to result in adverse impacts to the aquatic environment or biota found in the CDFs.

5.05 <u>Groundwater</u>

Since the 1880s, increasing withdrawals of water from the Upper Floridan aquifer has lowered the water levels in the aquifer under Savannah Harbor as much as 100 feet below MLW (USACE 2007). This lowering of the water level within the Upper Floridan aquifer has created a cone of depression centered beneath Savannah, extending 50 km or about 31 miles in all directions. The net effect of this lowering of the water level is the reversal of the movement of water within the aquifer to a downward flow of water through the confining layer toward the center of the area of greatest pumping from the aquifer (Savannah).

In recognition of concerns about potential impacts to the groundwater that were expressed during the NEPA scoping process and in other public forums (meetings of the Stakeholders Evaluation Group), the Corps conducted additional detailed evaluations of this issue.

Savannah District used input from various agencies including the USGS, GA DNR-EPD, SC DHEC, the Stakeholders Evaluation Group, and GPA to develop a scope of work for the supplemental studies. The activities included the tasks shown in the following table.

Table 5-46. Tasks Comprising Aquifer Effects Evaluation Supplemental Studies

Task	Subject	Description
1	Subbottom Seismic Survey	Conduct additional subbottom surveying with particular emphasis to better define paleochannel geometry and Miocene confining unit thickness. All seismic data will be acquired in digital format to facilitate analysis and storage in the GIS.
2	Marine Drilling	Conduct additional marine continuous core borings to further characterize in-filled sediments of paleochannels and Miocene confining unit below paleochannels.
3	Land Drilling	Conduct additional continuous core borings on land adjacent to navigation channel to top of Upper Floridan aquifer at three strategic locations where geologic or hydrogeologic data is sparse.
4	GIS	Combine existing geologic, hydrogeologic, seismic, and engineering data from previous studies into the harbor-wide GIS being constructed for Savannah Harbor. Add future supplemental data to the GIS to allow enhanced analysis and visualization.
5	3-D Numerical Hydraulic Model	Develop 3-D coupled flow and transport model of the hydrologic system focused on the navigation channel, and use model to compare before and after dredging results as related to projected chloride changes in the Upper Floridan aquifer.
6	Aquitard Test Feasibility	Conduct trial step-drawdown pumping test on two recently installed Upper Floridan wells located adjacent to river channel to determine feasibility of hydraulic testing of confining unit. If results indicate hydraulic testing of confining unit is feasible, estimate design parameters and assumptions for full aquitard testing.

The detailed study approach provided a greater understanding of the geologic and hydrogeologic framework underlying the navigation channel. Measured porewater data, hydraulic conductivity data, head data, seismic data, and confining layer thickness data were used to build upon a regional model built by USGS and refine it to address water quality issues specifically associated with dredging impacts. To ensure the groundwater model results were conservative, the dredging scenarios were run assuming an additional three feet of sediment would be removed below the proposed dredging depths. In addition, the model outputs used two values of hydraulic conductivity and provided two sets of results that bracketed true conditions, yielding a best-case and worst-case scenario for both dredging and no dredging conditions.

The overall study results are summarized as follows:

A. The ground water simulation model results indicated that the head gradients (water withdrawals from the Upper Floridan aquifer) are the dominant force contributing to the downward movement of salt water through the Miocene confining unit.

B. The groundwater modeling simulations were run 200 years into the future with a constant pumping rate in the Savannah area. This rate of pumping would cause breakthrough of seawater to occur at some downstream locations in approximately 100 to 300 years regardless of the proposed harbor deepening.

C. The negative head gradient induced by pumping water from the Floridan aquifer in Savannah has caused limited breakthrough of chlorides to occur in the downstream reaches of the Savannah River. The porewater profiles and model results from this study (USACE 2007) indicate that increased salinity in the Savannah River and the reduced thickness of the confining layer due to the proposed deepening in the Savannah River will not significantly affect the timing of the breakthrough of chlorides along the navigation channel in the Upper Floridan aquifer. The proposed deepening would contribute a maximum of only about 3 to 4 percent of increased total downward flow through the confining layer into the Upper Floridan aquifer. However, modeling results show that chloride concentrations decrease significantly upon entering the Upper Floridan aquifer due to considerable horizontal flow of fresh water within the aquifer mixing with and diluting the relative low volume of salt water migrating downward from the navigation channel. Therefore, the proposed deepening of the Savannah River navigation channel would have minimal impacts on water quality in production wells that tap the Upper Floridan aquifer in and around the City of Savannah.

The proposed harbor deepening would have minimal adverse impacts on groundwater. The full results of the field work, groundwater modeling, and GIS analyses are described in Section 5 of the Engineering Appendix of the GRR. They are described in further detail in a document titled "*Supplemental Studies to Determine Potential Groundwater Impacts to the Upper Floridan Aquifer, Savannah Harbor Expansion Project, Final Report , June 2007"* (USACE 2007).

5.05.1 Paleochannels

Another groundwater-related issue is the possibility that chlorides could enter the aquifer through the removal of harbor sediments from paleochannels. These are former Pleistocene-age stream channels that eroded into the aquifer's confining Miocene cap and later became filled with less-dense and more transmissive sediments.

Savannah District conducted sub-bottom profiler surveys of the existing entrance channel area. The purpose of the survey was to identify the depth and character of the aquifer's Miocene-age cap and locate paleochannels that cut into the cap. No Pleistocene streams were found in the ocean end of the entrance channel that would be lengthened.

The groundwater modeling results indicate that any additional contribution of chloride by the paleochannels is negligible when compared to the total contribution from other adjacent saltwater sources outside paleochannels along the Savannah River bottom. GIS analyses indicated that the minimum thickness of Miocene confining material occurs where paleochannels have incised into the top of the unit, and that deepening of the Federal navigation channel to -48 feet MLW would not further impact the Miocene confining layer in these areas.

5.05.2 Fractures within the Miocene Confining Unit

A groundwater-related issue identified at the end of the Tier I EIS and scoping meetings for the current EIS was the possible existence of fractures or joints within the Miocene confining unit underlying the navigation channel. Fractures within the Miocene aquitard could provide an avenue for saltwater to more rapidly move through the Miocene layer into the Upper Floridan aquifer. The potential effects of such fractures were a specific target of the District's expanded groundwater investigations.

The geophysical sampling did not identify any fractures or joints in the Miocene clay. Based on the following reasons, the Corps concluded that fractures or joints are not a factor in the hydraulics of the confining layer in the Savannah area:

1. The in-situ conditions under which the confining layer exists. At a depth of -42 feet MLW, the Miocene clay exists at a considerable overburden or lithostatic pressure. If fractures or joints existed in the past, the in-situ conditions would not allow them to exist as open pathways for enhanced downward flow. Instead, the overburden or lithostatic pressure and the plastic nature of the clay found in the Miocene aquitard would cause any open fractures to heal.

2. The nature of the confining material (i.e., there is considerable amount of clay within the Miocene aquitard), and

3. The lack of any physical evidence (i.e., no fractures observed in core samples, no springs in the project area).

The proposed harbor deepening would not cause increased salinity to enter any fractures of the Miocene aquitard and, thereby, increase salinity into the Upper Floridan aquifer.

Although construction of the SHEP is expected to have very little effect on the downward migration of saltwater into the Upper Floridan aquifer, the Georgia DNR-EPD has required as a condition of its water quality certification that a monitoring plan be developed to detect any potential chloride migration into the aquifer that could be caused from channel deepening. Consequently, monitoring of chloride levels in the Upper Floridan aquifer would be conducted along critical groundwater flow paths to ensure that the SHEP does not result in the significant migration of chlorides downward through the confining layer that could move towards production wells in the Savannah area. The monitoring would involve the establishment of sentry wells along critical groundwater flow paths which would be installed near the top of the aquifer to monitor downward migration of chlorides through the confining unit and deeper in the aquifer to monitor how horizontal flow of freshwater mixes with and dilutes the chloride. Monitoring wells would be established upgradient of critical groundwater flow paths to provide information on the background chloride concentrations associated with groundwater withdrawals in the Savannah area independent of SHEP dredging activities. Annual monitoring of these wells would be conducted for the life of the project, and differences in the long-term trends of chloride concentrations in the sentry and background wells would be used to evaluate impacts of the SHEP from impacts of groundwater withdrawal on chloride concentrations in the aquifer.

Groundwater monitoring also includes the establishment of benchmark chloride concentrations for each sentry well. The benchmark chloride concentrations would be established to protect the Savannah area production wells. If it is determined that the rate of downward migration of chloride into the Upper Floridan aquifer through the confining unit beneath the Savannah River is increasing due to the project and is affecting Savannah area production wells, the Corps would be required, as indicated in the water quality certification, to develop a remediation and implementation plan.

5.06 Air Quality

The air quality in the harbor area is generally good. The area is designated by USEPA as in attainment for all National Ambient Air Quality Standards (NAAQS) for criteria pollutants, which means the area is under no Federal or State restrictions for the purpose of improving air quality to meet any air quality standard. For example, USEPA has designated both Chatham County, Georgia and Jasper County, South Carolina as attainment areas for the 8-hour ozone standard, as well as other NAAQS.

Local industries have implemented process improvements over the last 5 to 10 years which have significantly reduced the quantity of substances emitted to the air. Concerns do exist among some in the community about the quality of the air, and a community group has actively pursued improving air quality. In general, maritime industries are not major air emitters. However, some industries located along the river that move raw materials or processed goods through the harbor also produce large amounts of air emissions. Harbor maintenance activities do not generate significant amounts of air contaminants.

To identify potential impacts to air quality from the proposed harbor deepening, the Corps conducted an air quality analysis in 2006. The investigation quantified emissions from deep-draft containerships that call at the port, as well as those that are expected to call in the future, and considered how those emissions would change as a result of the proposed harbor deepening. The Corps provided its report to the U.S. Environmental Protection Agency (EPA) Region 4 office for review and comment. As a result of their review, EPA requested the analysis be expanded to include (1) the emissions from landside equipment that service these vessels, (2) the air toxics emitted by both the vessels and the landside equipment, and (3) similar analyses associated with the privately-owned terminals in the harbor. EPA recognized that the emissions associated from vessels calling at the privately-owned terminals were not likely to be affected by the proposed harbor deepening, but they desired the comprehensive air quality assessment of the harbor to be able to more accurately place any expected increase in emissions resulting from the proposed harbor deepening in its proper context.

In response to EPA Region 4's request, the Corps prepared an Air Emission Inventory for the Port of Savannah. The objective of the inventory was to expand the Corps' 2006 air quality analysis to the entire harbor to more completely assess air quality impacts from the proposed harbor deepening. This more detailed assessment evaluates the air emissions from all cargo-carrying vessels and landside cargo handling equipment at both the GPA and privately-operated terminals at the port. It also compares these emissions for both the "With" and "Without

Project" (No Action) alternatives. In addition to the criteria pollutants that are traditionally evaluated when one discusses air emissions, estimates of air toxics and greenhouse gases emitted at the Port were also calculated. The assessment does not include a detailed dispersion modeling assessment of these emissions or a risk-based assessment of the health effects associated with the proposed project. The primary focus of the work is a comparative assessment of the air emissions associated with the operation of the port before and after project implementation, in conjunction with consideration of the current status of air quality in the Savannah area.

Upon their review of the DEIS, EPA submitted additional comments on January 28, 2011 concerning the Air Emission Inventory. As a result, the Corps further revised the analysis to address those additional comments.

The Air Emission Inventory for the Port of Savannah, dated January 2012 can be found in Appendix K of this EIS. Air emission impacts are thoroughly discussed in the analysis section (Chapter 5) of the inventory and the conclusions are summarized as follows:

> Five categories of activities in the Port of Savannah in 2008 were found to have relatively minor amounts of air emissions (Table 6-1 and Figures 6-1 and 6-2 in Appendix K). Those categories consist of (1) internal movement of vessels within the port (Shifts); (2) Maintenance dredging performed by the Corps; (3) Tourist boats (Chatham County's shuttle service and two large private tour boats); (4) hotelling of container vessels at Garden City Terminal, and (5) operations associated with Liquefied Natural Gas vessels. Those activities do not adversely affect the quality of air in Chatham County or at the Port. NOx is the pollutant that is emitted in the largest quantities in the port (see Table 6-3 and Figures 6-1 and 6-2 in Appendix K). This pollutant comprises roughly 58 percent of the amount of emissions among the seven pollutants analyzed (HC, VOC, CO, NOx, PM10, PM2.5 and SO2).
>
> Container vessels are the source of most air emissions among the various types of vessels that call at the port. That is to be expected, as the port services more container vessels than any other vessel type.
>
> Most of the air emissions at the Port result from the deep-draft vessels which call there. The tugs which guide those vessels and the land-based operations that handle their cargoes were found to contribute much less pollution than the vessels or their land-based support operations.
>
> The Corps predicts a larger number of vessels would call on the Port of Savannah in years 2016, 2020, 2025, 2030, and 2066 with the existing channel depth of -42 feet (Without Project Condition) than with the proposed depth of -47 feet (see Table 4-3 I Appendix K). In 2030, for the -42 and -47 foot depths, the number of vessels predicted to call at Savannah would decrease from 4,092 to 3,601 respectively. In 2030, the Fleet Forecast estimates 14% more vessels would call in Savannah with the existing depth of - 42 feet than with the proposed depth of -47 feet. More vessels calling on the Port with the existing -42 foot depth during

this projected time (i.e., 2016 to 2066) would result in a greater amount of criteria pollutants, air toxics and greenhouse gases being emitted in Chatham County. Those emissions would be reduced by a deeper harbor that would allow a fleet of larger vessels that each carries more cargo. With a deeper harbor, the same cargo quantities could be moved through the port with fewer container ships. Tables which provide a summary of all emissions (Appendix K) show this trend.

For the land-based operations at GPA's Garden City Terminal, toplifts were found to produce the most air emissions, followed by rubber-tired gantry cranes, jockey trucks, and aerial cranes. The trucks which bring containers to the port and take them to their US destination were found to be relatively small contributors to the total air emissions. Although trucks emitted more NOx than other pollutants, they contributed a larger percentage of CO (8.8 percent) to the emissions from the terminal. Truck emissions comprise less than 5 percent of all air emissions produced by the port.

While containerships are docked and being serviced (referred to as hotelling) at Garden City Terminal, they contribute less than 12% of the total emissions of the total port emissions. The emissions while hotelling represent less than 12% of the emissions from the Garden City Terminal (vessels, tugs, and landside CHE). With the proposed future EPA reductions in both NOx and sulfur emissions for containerships, this percentage would be further reduced. Therefore, hotelling is not a major contributor to the port's emissions.

New work dredging to deepen the harbor would be a substantial contributor (>29 percent) of the port's emissions of CO and NOx during the four-year construction period. However, a large portion of those emissions would occur offshore while deepening the entrance channel and are not likely to contribute to air pollution in the City or County.

The Port of Savannah is a substantial contributor of NOx (18.3 percent) emissions in Chatham County, when compared to the EPA 2002 NEI data. It only contributes minor amounts to emissions of SO2 (5.4 percent), PM10 (3.4 percent), PM2.5 (9.5 percent), HC (1.9 percent), VOC (1.9 percent), and CO (1.3 percent). When these same 2008 port emissions are compared to the Chatham County EPA 2005 NEI Data, NOx is reduced to 13.5%, SO2 is 5.1%, PM10 is 3.1%, PM2.5 is 7.2%, HC is 2.0%, VOC is 2.0%, and CO is 1.6%. Lastly, when the 2008 Port of Savannah emissions are compared to combined Chatham County, Georgia and Jasper County, South Carolina, (EPA 2005 NEI data), NOx is further reduced to 11.5%, SO2 is 4.8%, PM10 is 2.1%, PM2.5 is 4.9%, HC is 1.6%, VOC is 1.6%, and CO is 1.24%.

Emissions of NOx, SO2, and PM2.5 are likely to continue to decrease as the terminal operators replace their equipment with newer engines that do not emit as much pollution and use the lower sulfur fuels mandated by EPA. The port's contributions to SO2 emissions are expected to decrease as a result of EPA's requirements for use of cleaner fuels. These new standards should substantially reduce SO2 emissions, as the SO2 content in the fuels used by non-road diesel, locomotives, and marine diesel engines transitioned from 500 ppm sulfur in 2007 to ultra low sulfur diesel (ULSD) -- which is 15 ppm -- in 2010.

For ocean-going vessels (OGV), EPA issued new emission standards in late 2009 for Category 3 marine diesel engines which will require an 80 percent reduction in NOx emissions beginning in 2016. EPA also adopted standards for engines covered by MARPOL Annex VI that require OGV within 200 miles of the US to use fuel with a maximum of 1% sulfur (10,000 ppm) beginning in 2012 and 0.10% (1,000 ppm) beginning in 2015. Again, the port's contributions of NOx and SO2 emissions in the County should substantially decrease as a result of these new requirements for cleaner fuels.

Comparing the calculated port air toxic emissions in 2008 to EPA's 2002 and 2005 county-wide air toxic emissions, the Port is not a significant contributor of any air toxics emitted in Chatham County. The Port contributes minor amounts (less than 4%) of the County's totals for the 28 air toxics that were calculated.

For the 50-year project life, the Port does not appear to be a significant source of greenhouse gases (primarily CO2). Port operations contribute less than the one facility that is included in EPA's public database for Chatham County - the existing coal fired Kraft Steam Electric Plant in Port Wentworth, Georgia, which has emitted on average over 1.3 million tons per year of CO_2 into the atmosphere since 2002.

Moreover, EPA's Emissions data for the Kraft Steam Electric Plant in Port Wentworth show that it discharged about 7,705 tons of SO2 in 2007. The Total Port Emissions (2008 values) show that the SO2 emissions for all 22 terminals in the port was about 1,177 tons. This means that the Kraft Steam Electric Plant, which is adjacent to the Garden City Terminal, discharges more than 6 times (7,705 tons SO2/1,177 tons SO2) the amount of SO2 than all 22 terminals in the harbor.

Future growth in cargo movements and accompanying air emissions are expected at Savannah. Those increases would be the result of increasing demand for the goods which move through the port and not a result of a harbor deepening. Those higher total emission levels in the future would be lessened if larger container vessels were enabled by deepening to regularly call at the port. The expected future growth in total emission levels will be substantially lessened by the recently-mandated use of cleaner fuels.

Any of the proposed harbor deepening alternatives would reduce air emission levels in the Port of Savannah from what they would be with the present 42-foot navigation channel. The beneficial effect increases with the amount of deepening.

Construction of a deeper channel would result in temporary increases in air emissions during new work dredging. However, those temporary increases would be distributed along the length of the channel -- roughly a third of which is in the ocean (the entrance channel). Future maintenance dredging emissions would likewise be temporary and very similar in type and quantity to emissions that occur now during maintenance dredging for the existing project.

Even though future ships calling at Savannah Harbor will be larger, there will be fewer numbers of them and their engines/fuels will be cleaner, so overall total emissions from ships, the main contributors to port emissions, would be reduced as explained in Appendix K. As a result, there would be a positive overall air emissions impact from a harbor deepening project that would not require mitigation.

5.06.1 Air Quality Standards

Chatham County is considered by EPA to be in an attainment area since it meets the National Ambient Air Quality Standards, which are shown below:

Table 5-47. Air Quality Standards

Pollutant	Primary Standard	Secondary Standard
PM_{10}	150 ug/m3 (daily)	Same
$PM_{2.5}$	15 ug/m3 (annual) 35 ug/m3 (daily)	Same
NO_x	53 ppb (annual) 100 ppb (1-hour)	53 ppb (annual)
SO_2	75 ppb (1-hour)	0.5 ppm (3-hour)
CO	9 ppm (8-hour) 35 ppm (1-hour)	None
Lead	1.5 ug/m3 (3-month average)	Same
Ozone	0.075 ppm (8-hour)	Same

EPA published information in January 2008 about air quality in Chatham County in its “Latest Findings on National Air Quality, Status and Trends Through 2006”. In that document, EPA stated that Savannah’s 2006 Ozone level ranged from 0.065 to 0.084 ppm (4th highest daily maximum 8-hour concentration), below the standard of 0.08 ppm. Ground level ozone is formed when NOx and VOC react in the presence of sunlight. That document also reported that ozone levels had improved in Savannah from 2000 to 2006. The summer daily maximum 8-hour ozone concentrations between 2000-2001 (average) and 2005-2006 (average) decreased by 0.002 ppm (from Figure 12 in EPA’s document). For a number of years, EPA has indicated that they may promulgate a new ozone standard, but the Corps does not know if or when that may occur.

EPA also reported a small increase in PM 2.5 concentration from 2000-2006. Figure 14 of that document showed that PM 2.5 had decreased by -1 to 4 ug/m3 over that period. The average annual PM 2.5 concentrations were in the range of 12.1 to 15 ug/m3, with 66 out of 895 measurements exceeding 15.1 ug/m3. The daily range of PM 2.5 was in the range of 16 to 35 ug/m3, with 126 out of 895 measurements (14%) exceeding 35 ug/m3 (Figure 15 of EPA's document).

EPA reported that PM 10 levels for Savannah ranged from 0 to 54 ug/m3 (Figure 21 in EPA's document), with 425 out of 904 measurements exceeding 54 ug/m3.

These values indicate that the air quality in the Savannah Harbor area is within the standards for ozone and PM2.5 and well within the standard for PM10.

The State Implementation Plan (SIP) identifies how the State will attain and maintain the primary and secondary NAAQS. Each State is required to have a SIP which contains control measures and strategies which demonstrate how each state will attain and maintain the NAAQS. Georgia and South Carolina each have a State Implementation Plan approved or promulgated under Section 110 of the CAA. Part D of title I of the Act specifies additional requirements applicable to nonattainment areas, Section 110 and part D describe the elements of a SIP and include, among other things, emission inventories, a monitoring network, an air quality analysis, modeling, attainment demonstrations, enforcement mechanisms, and regulations which have been adopted by the State to attain or maintain NAAQS. EPA has adopted regulatory requirements which spell out the procedures for preparing, adopting and submitting SIPs and SIP revisions that are codified in 40 CFR Part 51.

Under CAA Section 176(c), certain Federal actions must be analyzed to determine whether they conform with the applicable SIP(s). However, a Conformity Determination is not required for the SHEP under Section 176(c) because 40 CFR Section 93.153 (b) provides: "For Federal actions not covered by paragraph (a) of this section, a conformity determination is required for each pollutant where the total of direct and indirect emissions in a non-attainment or maintenance area (emphasis added by the writer) caused by a Federal action would equal or exceed any of the rates in paragraphs (b)(1) or (2) of this section." Since both Chatham and Jasper Counties have been designated by the States as attainment areas, a Conformity Determination is not required.

Table 5-78 in Appendix K, Summary of all Pollutants (Tons/Year) for all Vessels and all Land Based Emissions for the 22 Terminals, clearly shows that the air emissions (including greenhouse gases, primarily CO2) at the existing (No Action Alternative) or baseline depth of -42 foot depth would be greater than the total air emissions for the -47/48 foot depth in all years from 2016 to 2066. The data also indicate that for the future project condition, air emissions for the No Action Alternative would be greater than the deepened harbor. Since air toxics are ratios of either VOC or PM10, that the amount of air toxics discharged by the 22 terminals would be greater for the No Action Alternative than a deepened harbor. There would be less emissions with a deepened harbor (comparing With and Without Project conditions) because fewer larger vessels (more heavily loaded) would be needed to transport the same number of containers than with the existing depth (No Action Alternative) of -42 foot. This does not mean that these larger vessels emit less air pollutants than smaller vessels; they do not. Fewer but larger vessels (more heavily loaded) would be needed to transport the 6.5 million TEUs in a deepened harbor than in the No Action Alternative. This is also reflected in the Commodity and Fleet Forecasts found in the GRR Economic Appendix.

Since the proposed harbor deepening is not expected to increase the number of vessels or total cargo moving through the port, no changes to air quality would occur as a result of the project. Increases in air emissions at the port are expected over time as a result of growth in demand for goods that move through the port. Those increases would occur independent of a harbor deepening project.

Therefore, over the life of the project (from 2016 to 2066) the proposed deepening of the harbor will not interfere with the area remaining in attainment of the NAAQS under Section 110 of the Clean Air Act.

Since, (1) the calculated air emissions for the Future Without Project Condition (i.e., baseline or existing depth of -42 feet) would be greater than with the Proposed Action (i.e., 47-foot depth), and (2) both Chatham County, Georgia and Jasper County, South Carolina are designated as attainment areas, air quality modeling is not warranted to evaluate the effects of the Proposed Action (i.e., 47-foot depth).

5.07 Marine and Estuarine Resources

5.07.1 Dredging Impacts

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

5.07.1.1 Entrainment. Pipeline dredging consists of mechanical action of a rotating cutterhead to loosen bottom material and hydraulic action by a pump to transport it to the placement site. The transported sediment consists of a slurry of approximately 15-20 percent solids and 80 percent water, depending on the characteristics of the bottom sediment. The suction-velocity field or entrainment field will extend over only a small area in the vicinity of the cutterhead at the river bottom.

The biological effect of hydraulic entrainment has been a subject of concern for more than a decade, and a number of studies have been conducted nationwide to assess its impact on early life stages of marine resources, including larval oysters (Carrier et al., 1986), post-larval brown shrimp (Van Dolah et al., 1994), striped bass eggs and larvae (Burton et al., 1992), juvenile salmonid fishes (Buell, 1992), and Dungeness crabs (Armstrong et al., 1982). These studies indicate that the primary organisms subject to entrainment by hydraulic dredges are bottom-oriented fishes and shellfishes. The significance of this impact depends upon the species present; the number of organisms entrained; the relationship of the number entrained to local, regional, and total population numbers; and the natural mortality rate for the various life stages of a species.

A hydraulic dredge with a discharge pipe no larger than 30-inch diameter would be capable of transporting about 40,000 cubic yards of sediment per day, pumped as a slurry containing about

15 percent sediment by volume. The volume of water discharged would, thus, be about 226,700 cubic yards per day, or about 70 cubic feet per second (cfs). In contrast, the average daily freshwater flow in the Savannah River at Clyo is about 11,290 cfs. Therefore, the amount of water intercepted by the operating dredge (70 cfs divided by 11,290 cfs) is estimated to be less than 6/10ths of one percent of the daily freshwater flow in the Savannah River. That small amount does not present a concern.

Assessment of the significance of entrainment is difficult, but it is believed that the impact is minimal. The reasons for the expected low levels of impact include: (1) the very small volumes of water pumped by dredges relative to the total amount of water in the vicinity, thereby impacting only a small proportion of organisms, and (2) the extremely large numbers of larvae produced by most estuarine-dependent species. Since natural larval mortalities may approach 99 percent (Dew and Hecht, 1994; Cushing, 1988), entrainment by hydraulic dredges operating in the harbor should not pose a significant additional risk in most circumstances. Neither direct quantification studies nor modeling efforts have demonstrated population-level impacts due to larval entrainment by hydraulic dredges (Memorandum dated 8 August 1995 from Douglas Clarke, Ph.D., Coastal Ecology Branch, Waterways Experiment Station, Corps of Engineers, DOTS Request for Assistance). It should be noted that hydraulic dredging in Savannah Harbor would not be conducted above Station 63 during the spawning season for the Striped bass (April 1-May 15). This restriction would also apply to the channel improvements proposed at McCoys Cut, Little Back River and Middle River.

Phytoplankton and zooplankton could be impacted through entrainment into a dredge. Phytoplankton concentrate near the surface of the water. Dredges typically remove water from the bottom of the channel, so no adverse impacts to phytoplankton are expected from entrainment. Depending on the species, zooplankton are generally scattered throughout the water column. Since they are widely dispersed and not concentrated on the bottom of the river, no adverse impacts are expected to zooplankton from entrainment.

In light of these factors, the proposed harbor deepening is not expected to substantially adversely affect impact fish or shellfish through direct entrainment or impacts to their feeding areas.

5.07.1.2 Dredge Plume Turbidity. Studies performed by Dr. D.F. Hayes in 1986 on a hydraulic cutterhead dredge operating in Savannah Harbor indicated that average suspended sediment concentrations within 1,600 feet of the dredge were generally raised less than 200 mg/l in the lower water column and less than 100 mg/l and 50 mg/l in the middle and upper water column, respectively. More recent data indicate that present-day dredging operations are conducted in ways that do not increase suspended sediment concentrations to such an extent. (USACE 2006, USACE 2009, and USACE 2011). The Corps' 2006 EIS for the Long Term Management Strategy included information from new work dredging obtained from the 1989-1991 Savannah Harbor Widening Project and the 1993/1994 Savannah Harbor Deepening Project. TSS was measured at mid-channel and near the surface (3 feet below). In only 5 percent of the time did a mid-depth reading exceed 100 mg/L, while none of the near surface readings exceeded 100 mg/L. The Corps' 2011 report discussed the effects of O&M dredging on turbidity and dissolved oxygen. One analysis focused upon data collected in 2007 –2009 when turbidity data were consistently collected both up-current and down-current of the operating dredge. The vast majority of data collected over those three years indentified little net effect of the dredging on suspended sediments in the river. The Savannah River has a naturally high suspended sediment load which during storm events increases well beyond the 200 mg/l increase created by a hydraulic dredge. In addition, during storm events, the higher suspended sediment loads would likely be more uniform throughout the water column due to mixing as the plume proceeds downstream.

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

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

Fish and shellfish species inhabiting the Savannah Harbor vicinity are adapted to, and highly tolerant of, naturally-elevated suspended sediment concentrations. In reviews of laboratory tests, Hirsch et al. (1978) and Stern and Stickle (1978) found marine and estuarine organisms to be very tolerant of the effects of sediment suspensions. Lethal or sub-lethal effects on larval or adult fish or shellfish occur after longer exposures to higher concentrations of suspended sediment than typically occur in the water column during dredging and sediment placement operations (Peddicord and McFarland 1978; Preist 1981).

The potential for interruption of the movement of estuarine fish and shellfish, particularly anadromous fishes, to and from nursery and spawning areas in the Savannah estuary by the physical presence of dredging equipment or by the physical-chemical water quality alterations associated with dredging is an issue of concern. However, river currents or flows upon which larval organisms depend for transport will not be interrupted or reduced. Dredge-induced water quality conditions will only be short-term and impact a small cross-sectional area of the Savannah River. Therefore, the potential for blockage of migration routes would be minimal.

The frequency of maintenance dredging should not be significantly different than what occurs now in the harbor.

In addition to entrainment, phytoplankton and zooplankton can be impacted by increases in suspended sediment concentrations and turbidity. Because of tidal currents, turbidity and suspended sediment caused by dredging will essentially be confined to the navigation channel down current of the dredge and will dissipate generally within 1,600 feet of the dredge (Payonk et al. 1988, Palermo et al. 1988, and McLellan 1989).

The existing navigation channel side slopes would not change with the proposed deepening and, therefore, any adjacent shellfish areas to the channel will not be impacted.

According to GA DNR-CRD, there are three shellfish harvesting areas near the project area – the Chatham County Recreational Shellfish Harvest Area and two commercial leases (Halfmoon and Wilmington). All three shellfish harvesting areas are located a sufficient distance from the dredging in the Savannah River channel that sedimentation and high turbidity would not adversely impact these resources. The closest area is located over 3,000 feet from the navigation channel. As such, turbidity caused during the new work dredging would not adversely impact shellfish areas.

In light of these factors, the proposed harbor deepening is not expected to result in more than minimal adverse impacts as a result of the dredge plume.

5.07.1.3 Dissolved Oxygen Concentrations During Dredging and Disposal Process. In addition to the factors outlined above, dissolved oxygen levels in Savannah Harbor are also of concern during the dredging and disposal process. The dissolved oxygen regime in Savannah Harbor is characterized by low levels of dissolved oxygen during the summer months, with much of the estuary typically dropping below state standards. The Corps is required to monitor dissolved oxygen levels in the effluent from its sediment disposal areas, as well as in the vicinity of its dredging operations. When dissolved oxygen levels fall to 3.0 mg/liter or less, the Corps is required to cease dredging operations unless a waiver is obtained. If the SHEP is approved and constructed, the terms of the new Section 401 Water Quality Certifications would be in effect. For both Georgia and South Carolina Georgia waters, that would include compliance with the 2009 dissolved oxygen standard. It may also require the Corps to cease dredging operations when dissolved oxygen levels in the river drop below a daily average of 5.0 mg/liter and an instantaneous average of 4.0 mg/l throughout the water column when natural conditions result in dissolved oxygen above those values. If it is determined that the natural condition in the waterbody is less than these values, the criteria will revert to the “natural condition” and the water quality standard allows for a 0.1 mg/l deficit from the “natural” dissolved oxygen value. Up to a 10% deficit is allowed if it can be demonstrated that resident aquatic species would not be adversely affected. Since the available dissolved oxygen deficit has already been allocated, the Corps would be only be able to conduct maintenance dredging when the dissolved oxygen, one meter from the bottom, is 3.0 mg/l or greater and the maintenance dredging does not affect the dissolved oxygen levels in the Savannah Harbor. Variances for maintenance dredging when dissolved oxygen levels are less than 3.0 mg/l may be granted under some circumstances, including if the Corps injects additional dissolved oxygen into the Savannah River.

5.07.1.4 Loss of Benthic Resources During Dredging. Removal of the bottom substrate within the dredging areas would eliminate all benthic resources in those locations. Those sites would be available for recolonization and use by benthic organisms once the dredging event ceases, so no irreversible loss of resources would occur. The populations that reestablish should be similar to those eliminated, since the species are substrate dependent and the sediments that create shoals in the channel and adjacent areas now will continue to do so after the proposed dredging. Maintenance will not limit the density and diversity of the benthic community that becomes reestablished any more so than existing maintenance activities. However, benthic populations in the navigation channel are in a state of flux due to the continual sedimentation and shoaling that creates the need for maintenance dredging. EA (2008) conducted a benthic community assessment of the river bottom both inside and outside the navigation channel. They found a substantial benthic community within the channel bottom. They observed that the coarse sand/gravel/clay substrate was used by benthic organisms, but they were unable to determine to what extent benthic organisms burrow into the exposed clay. They stated that the substantial presence of benthic organisms within the channel maintenance sediments indicates that the impact of maintenance dredging is temporary. The bottom substrate consists of exposed clay in roughly 28 percent of the channel bottom between Stations +16+000 and +60+000. EA found that the clay substrate supports a limited benthic community.

Although a temporary loss of benthic communities would result from the proposed excavation, the long-term effect on this resource would be minimal.

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

The noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. Once the barge is full, it would be towed by a tug offshore and emptied into the Savannah ODMDS or other approved placement sites. According to discussions with Doug Clarke and Charles Dickerson, US Army Engineer Research and Development Center the maximum noise spike with mechanical dredges is when the bucket hits the bottom. All other noises from this operation (i.e., winch motor, spuds, etc.) are insignificant. The sediment within Savannah Harbor is predominantly sand/silt/mud mixture. No rock, gravel, or cobbles are located within the portion of the navigation channel to be deepened. According to the Clarke et al (2002), the peak amplitude for the bucket hitting the rocky, gravel, cobble bottom at Cook Inlet, Alaska was about 120 dB. Both Doug Clarke and Charles Dickerson, US Army ERDC stated that this peak amplitude of the bucket hitting the existing sand/silt/mud substrate of Savannah Harbor would be significantly less than 120dB.

In light of these factors, the proposed harbor deepening is not expected to result in more than minimal adverse impacts as a result of noise.

5.07.1.6 Lighting During Construction. Dredge plants and associated tugs and barges are required to meet Corps, US Coast Guard, and OSHA lighting standards for safety. During the dredging process, if the dredge is within the vicinity of the nearshore area off Tybee Island, lighting from the dredge or other associated vessels may impact sensitive beach organisms (i.e. sea turtles). This impact would be of most concern during the nesting season for sea turtles.

The Biological Opinion for the project prepared by the NMFS contains reasonable and prudent measures to minimize potential effects of lights on sea turtles during the nesting season. All lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nm of sea turtle nesting beaches shall be limited to the minimal lighting necessary to comply with the US Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

5.07.2 Sediment Placement Impacts

5.07.2.1 Nearshore Placement Areas. In the DEIS, the Corps proposed placement of new work and maintenance dredged material into nearshore sites off Tybee as a means of putting this material into the sand budget for the island. There is a potential for impacts to fish and other mobile aquatic life from placement of dredged sediments in the nearshore areas off Tybee Island. Impacts from placement operations could result from physical impacts from the dredge plume, as well as high suspended solids and increased turbidity.

The sediments that would have been deposited in the nearshore area consist primarily of sands; however, they are not considered “beach quality” material. The sand content of the sediments generally exceeds 70 percent and in most reaches exceeds 80 percent. The high sand content reduces the amount of fines that would be suspended in the water column and produce turbidity.

Since adult fish are mobile and the placement impacts are very localized (at the end of the dredge discharge pipeline), the potential for adult fish being harmed due to physical impacts from the dredge plume and attendant vessels traffic is quite low.

Eggs and larval fish are not as mobile as adults, so there is a higher potential for those early life stages to be physically damaged by sediment or materials in the dredge plume. However, the nearshore areas off Tybee Island have a very high sediment load since the Savannah River discharges at the north end of the island. Also the wind and wave climate in the nearshore area tends to have a naturally high sediment content and high turbidity. The placement activities would be very localized and therefore not impact a large area.

The benthic communities residing in the nearshore placement areas could be physically buried by the deposited sediment. After the sediment placement is complete, the site would be available for recolonization. The extent to which recolonization would occur would depend on the frequency and amount of maintenance sediment being placed in these nearshore areas. Literature dating back to the 1970’s along the southeastern coast of North Carolina indicate that opportunistic infauna species (ex. *Emerita* and polychaetes) found in beach nourished areas are subject to direct mortality from burial. Recovery occurs in 1 to 3 years depending on the sediment compatibility and the relationship of the beach nourishment placement to recruitment timeframes (Hayden and Dolan, 1974; Saloman, 1984; Nelson, 1989; Van Dolah et al., 1992; Van Dolah et al., 1993; Hackney et al., 1996; P.C. Jutte et al., 1999)

Deposition in the nearshore placement sites would result in elevated turbidity and suspended solids. The Corps proposed to place sediments within the nearshore area that are a minimum of 70 percent or greater sand (averaging about 30 percent or less silt and clay). Due to the fairly low percentage of silt and clay content of the sediments that were proposed to be placed in the nearshore areas, the impact was not expected to be greater than the natural increase in turbidity and suspended material during storm events. Because of the quality of the sediment to be deposited (70 percent or greater sand), the sediment plumes generated from these activities in the marine environment were not expected to extend further than the general vicinity of the harbor entrance.

The GA DNR-CRD has designated and leased three locations for recreational and commercial shellfish harvesting. Those leased areas are located about 7 miles from the closest nearshore placement site (i.e., MLW 500) near Tybee Island. The Corps believes that the sediment plume (increased turbidity and suspended solids) generated from the proposed placement operations within the nearshore area off Tybee Island would not impact these shellfish harvesting areas.

The Corps believes that the placement of sediment in the nearshore areas off Tybee Island would not result in any long-term adverse impacts to the benthic communities or the recreational and commercial shellfish harvesting leases in the area.

However, based on concerns expressed by the GA DNR-CRD and the City of Tybee Island on the DEIS, the use of the nearshore placement areas for new work material from the SHEP has been removed from the project. All material removed from deepening and extending the entrance channel would be placed in the ODMDS or a CDF.

The nearshore placement sites at Tybee Island approved as part of the LTMS could be used for suitable future maintenance material from the entrance channel provided a non-Federal sponsor provided the additional funds to use that site.

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

5.07.2.2 Effluent Turbidity. The turbidity in effluent from diked sediment placement is controlled by adjustable spillways. The South Carolina standard for turbidity is that discharges are not to exceed 25 NTUs provided the existing uses of the water body are maintained. Savannah District imposes a 500 mg/l limit on suspended solids in the CDF discharges. This limit is believed to be sufficient to reduce turbidity impacts in the receiving waters to acceptable levels.

Based on this factor, no significant adverse impacts from turbidity during sediment placement operations are expected from implementation of the harbor deepening alternatives.

5.07.2.3 Hardbottoms. Of special concern in the offshore area are hardbottoms, which are localized areas, not covered by unconsolidated sediments where the ocean floor is hard rock. Hardbottoms are also called “live bottoms” because they support a rich diversity of invertebrates such as corals, anemones and sponges, and are refuges for fish and other marine life. They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. Hardbottoms are not abundant along the Georgia coast.

In June 2001 (Barry A. Vittor & Associates 2001), the Corps funded benthic sampling and analysis of about 2,500 acres south of the Savannah Harbor ocean bar channel. This benthic survey did not identify any hardbottom areas within or near the nearshore placement areas off Tybee Island or the ocean bar channel. That survey did not include all the nearshore areas that were proposed for sediment placement. Based on surveys of adjacent sites and the similarity of the bottom contours and substrate, no unique benthic communities are expected in those areas.

The Corps is not aware of any previous surveys that have been performed for hardbottoms on some of the nearshore placement sites that were proposed to be used for the SHEP. Based on surveys of adjacent sites and the similarity of the bottom contours and substrate, no hardbottoms are expected in those areas. No additional nearshore surveys are planned since the use of new nearshore placement sites at Tybee island has been removed from the project.

The proposed harbor deepening would occur within the existing channels of Savannah Harbor. There are no hardbottoms within these areas. Additional surveys will be conducted offshore in the area of the new bar channel extension . Although not expected, should the surveys indicate possible presence of hardbottoms, the Corps will coordinate with NMFS at that time.

Based on these factors, no significant adverse impacts to hardbottom communities are expected from implementation of the harbor deepening alternatives.

5.07.2.4 Artificial Fishing Reefs. The Georgia DNR, Coastal Resources Division lists one artificial reef in the project vicinity. Artificial Reef SAV is located about 6 nautical miles southeast of Tybee Island in an average water depth of 30 to 40 feet mean low water (Figure 5-53). No excavated sediments would be placed near Artificial Reef SAV. Therefore, the proposed action would not adversely impact Artificial Reef SAV.

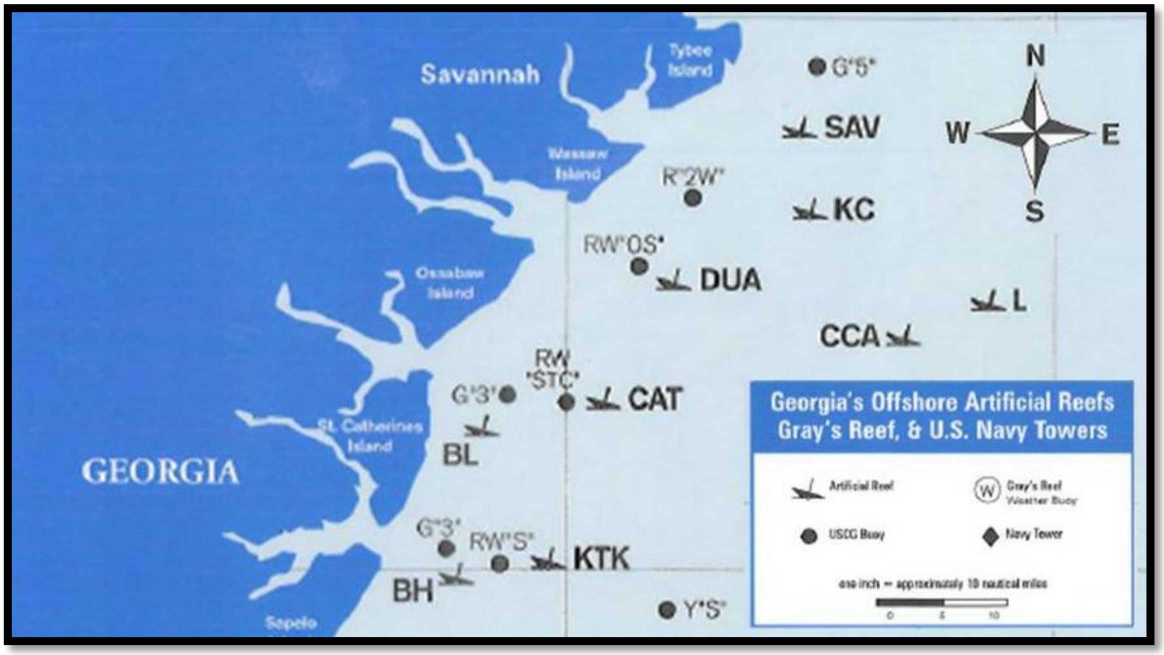

Figure 5-53. Georgia's artificial reefs.

5.08 Terrestrial Resources

Several environmental resources exist in the harbor which deserve special recognition and are special resources of concern as described in Section 4.07. Actions which could impact those areas may affect multiple resources, such as water quality, wetlands, aquatic species, benthic communities and wildlife. To ensure these areas receive the recognition and concern which they warrant, they are described and evaluated separately. The resources which warrant special concern include the Savannah National Wildlife Refuge, the Tybee National Wildlife Refuge, and the Turtle Island Wildlife Management Area.

5.08.1 Savannah National Wildlife Refuge

The proposed deepening of the existing Federal navigation channel to 47-feet depth would adversely impact tidal freshwater wetlands. Most of these types of estuarine emergent wetlands are located within the SNWR. Both marsh and uplands would be excavated to enlarge the Kings Island Turning Basin. The Corps will mitigate these adverse impacts (see Section 5.01 and Appendix C).

5.08.2 Tybee National Wildlife Refuge

The Tybee National Wildlife Refuge consists of 400-acres of wetlands and low diked islands. Some of the Jones/Oysterbed Island CDF is located within this Refuge. New work and/or O&M

sediments would be deposited within the CDF. The Jones/Oysterbed Island CDF is routinely used for the deposition of sediments dredged from Savannah Harbor. No adverse impacts are anticipated.

5.08.3 Turtle Island Wildlife Management Area

No impacts are anticipated because no work will take place within this site or adjacent to the site.

5.08.4 Confined Disposal Facilities (CDFs)

The proposed action would not adversely impact the useful life of the CDFs. Deposition of sediments within the CDFs would not adversely impact terrestrial habitats within the CDFs beyond what has received prior approval. Within the CDFs, expected impacts to flora and fauna are as follows:

5.08.4.1 Flora

As a result of dredged sediment deposition, the CDFs can be expected to continue to support mixed early-successional stage plant communities within diked areas. These communities will probably be dominated by the following species, which are common in the diked placement areas in the region today:

A. *Baccharis halimifolia* (Grounsel-tree)
B. Tamarisk (salt cedar)
C. *Phragmites australis* (common reed)
D. *Aster subulatus*
E. *Xanthium sturmarium* (cocklebur)
F. *Heterotheca subaxillaris* (golden aster)

The impacts of dredge pipeline across marsh or other vegetation to reach the placement areas should be short-term and minor. The vegetation should quickly recover following pipeline removal.

When dikes are constructed or rebuilt, heavy equipment such as bulldozers, backhoes and draglines are used. The CDFs have upland access; therefore, temporary earth loading and unloading ramps from barges would not be needed to get the heavy equipment to the sites.

The Corps will use Best Management Practices as defined by the SC Department of Health and Environmental Control to control stormwater and erosion when dikes are raised.

Therefore, no long term adverse impacts to the flora on the CDFs are expected.

5.08.4.2 Fauna

The impacts associated with the proposed action on the fauna which inhabit the CDFs would be minimized to the maximum extent feasible. These CDFs are used in the regular maintenance of the harbor. Work on these CDFs take place on a recurring basis. The fauna should quickly recover following any dike work or dredging activity. No adverse long-term impacts are anticipated.

Dredged sediment placement sites that receive a high percentage of fine materials (silts and clays), have the potential to become mosquito breeding habitat. As the sediment dries and compacts, it forms a network of cracks, extending from the surface down to a depth of nearly one foot. The sides of these cracks are used as attachment sites for mosquito eggs. In the past, there have been several instances of nuisance mosquito outbreaks from the CDF placement areas located along the northern bank of the Savannah River.

Management recommendations for mosquito surveillance and control on the CDFs was prepared by Chatham County Georgia and Jasper County, South Carolina, the Georgia Department of Transportation, and the Corps of Engineers (USACE 1996). The recommendations include surveillance, surface water management, and chemical and biological control measures. The Corps has funded mosquito control activities at the CDFs, and that funding is expected to continue in the future.

5.08.4.3 Migratory Birds

Many species of migratory birds use the harbor's confined upland placement sites. A variety of species of birds are regularly observed in the scrub/brush habitat that surrounds the CDFs. That habitat is present to some degree on other uplands throughout Chatham and Jasper Counties. However, the existing CDFs provide unique habitat in the Project area for certain species of migratory birds. These sites provide nesting habitat for a limited number of migratory bird species, but those species include some of special concern such as Least tern, Black-necked stilt, and Wilson's plover. Many other species of birds use the CDFs outside the breeding season, some in high numbers.

These birds using the CDFs for feeding, loafing, and nesting areas will continue to use them during the new work sediment placement for the harbor deepening. During construction activities, not all of the CDFs would be used at the same time. The work on these CDFs will be sequential (one or two at a time, out of the six) depending on the order of work. With the management approach that Savannah District has adopted, the CDFs are managed to provide bird habitat during sediment placement operations. Water is ponded in the CDFs to provide feeding and loafing areas. The ponded CDFs are used by shorebirds, waterfowl, herons, egrets, ibis, wood stork, gulls, and terns. The ponded water also isolates the bird nesting islands constructed within the CDFs. Once a CDF has temporarily ceased being used for sediment placement, it would be dried and the site would then provide terrestrial habitats for birds.

The Corps would continue to implement its protective measures to ensure its use of the CDFs do not adversely impact migratory birds. Based on these factors, no adverse impacts are anticipated to this resource.

5.08.4.4 Proposed Jasper County Marine Terminal

The proposed deepening of the Savannah Harbor navigation channel would occur prior to construction of a container terminal in Jasper County if the SHEP is constructed. The consulting firm that is presently managing studies that may lead to construction of a terminal have stated that a successful container terminal in Jasper County would require a navigation channel to the site with a depth greater than 42 feet MLW. Consequently, construction of the SHEP would provide a deepened entrance channel and inner harbor channel to the site of a proposed Jasper County Marine Terminal if the project is constructed.

New work sediments would be deposited on the property (currently CDFs 14A and 14B) last identified as the location for this proposed terminal. Deposition of those sediments would raise the elevation of the property, resulting in less fill being required in the future to raise the site to an elevation suitable for terminal operations.

The new work sediments identified for deposition on the site are primarily those that have been found to possess elevated levels of naturally-occurring cadmium. The presence of the cadmium should not substantially affect subsequent development of the site into a marine terminal, because a terminal would pave the surface of the site to allow ready movement of trucks and containers. Pilings could be driven through the new work sediments as needed for any future development of the site.

5.09 <u>Existing Shorelines Adjacent to the Federal Navigation Channel</u>

The proposed deepening of the Federal navigation channel could increase shoreline and/or beach erosion along the channel shoreline, from Savannah to Tybee Island. In light of that possibility, Savannah District conducted several investigations to identify and evaluate potential shore erosion impacts, including the following: Ship Wake Analysis, Bank Erosion Analysis, and Coastal Erosion Study at Tybee Island. Many areas are presently experiencing erosion and the vessel fleet continues to change, so determining the incremental effect of deepening the harbor is a technically difficult analysis.

The Ship Wake Analysis was conducted by the US Army Corps of Engineers, Engineer Research and Development Center (ERDC), Coastal and Hydraulics Lab. The report documenting that study was titled "*Ship Forces on the Shoreline of the Savannah Harbor Project"* and was completed in August 2006. This ERDC study and the GEC forecast of ship traffic were used by the Savannah District to complete the "*Savannah Harbor Expansion Bank Erosion Study"* dated November 2006. The 2006 *Bank Erosion Study* (updated in 2011) used aerial photographs taken between 1957 and 2006, site inspections made in 2003 and 2006, history of the Savannah River documents from 1850 through 2006, and previous erosion studies conducted for the Savannah River and Tybee Island. A revised fleet forecast resulted in the updated Bank Erosion Study.

The following were taken into account during the Bank Erosion Study:

A. All shoreline areas of the river between Tybee and Station 103+500 at the Garden City Terminal were reviewed for potential project impacts.

B. River Front erosion was not considered a factor during the study because the shoreline is already protected by bank protection and structures.

C. Fort Jackson erosion was not considered a factor during the study because the shoreline was stabilized in 2003 (see Figures 5-54 and 5-55).

D. Bight Area (from about Stations 40+000 to 50+000) erosion was not considered a factor since it is in the process of being stabilized.

E. The North Tybee Island and Ft. Pulaski shorelines were considered within the study area.

The following conclusions were taken from the Bank Erosion Study and updates, copies of which can be found in the GRR Engineering Appendix.

A. The North Tybee shoreline studied indicates some degree of erosion from various causes (i.e., tide, Northeaster's, ship wake, etc.). However, the distance from the North Tybee Island shoreline to the shipping channel is roughly one mile and the site is separated from the shipping channel by the Cockspur Island Training Wall. Correlations to ship traffic and the proposed deepening work do not appear to be supported. All indications (including the ERDC study dated August 2006) suggest that deepening the shipping channel will reduce energies from ship wakes by approximately 2.3 to 5.9 percent. Therefore, the proposed harbor deepening will not have any measurable effect on the North Tybee shoreline.

B. The distance from the Fort Pulaski shoreline to the southernmost edge of the shipping channel varies from about 470 to 1,060 feet. The portion of Fort Pulaski that was evaluated is an unprotected area. It has three major drainage features and one ongoing scour depression on the upstream side immediately adjacent to the end of the rock slope protection. Aerial photographs from 1955 through 2006 were used to estimate the average yearly bank erosion along about 4,100 feet of shoreline. Photos indicate that a minimum of about 1.8 feet each year is lost toward the ends of the rock protection. The maximum erosion occurs in a bend area of this site with measurements indicating about 3 feet of shoreline per year lost to erosion in both the with and without project condition. Construction of the project would not cause substantial additional erosion to occur. Calculations indicate that in the worst case, up to 3.1 feet of shoreline erosion due to all causes could occur along Fort Pulaski's unprotected shoreline in any given year, of which only 0.1 foot (1.2 inches) of erosion is due to present-day ship traffic. The majority of the ongoing and expected future erosion at the site is due to tide, flows, river mechanics, shape and other causes unrelated to ship traffic through the channel. Given the current traffic predictions and forecasts, the bank erosion expected to result from harbor deepening at this site would be less than 1/2 inch at the end of the 50-year project life, an amount that would not be measureable in the field in light of the erosion caused by other factors.

The Savannah District recently constructed shore protection measures at CDFs 13A, 13B, 14A and 14B. Consequently, they are protected from long-term shoreline erosion. The District is constructing bank protection on Jones/Oysterbed Island, so it can be assumed to be protected in the without project condition. The revetment at Jones/Oysterbed Island is currently underway. The first of three phases was completed in December 2012, and the two remaining phases are scheduled to be completed by 2015, prior to completion of the proposed inner harbor dredging. With a deepened harbor, fewer ships are expected to call (when compared to without project condition). As a result, the proposed deepening is not expected to impact the shoreline of the confined disposal areas to any measurable degree.

In 2006, ERDC completed the "*Coastal Erosion Report*", which examined "*the impact of the Savannah Harbor navigation project on the regional morphology and to quantify the influence of the navigation project on increased shoreline recession rates along Tybee Island.*" Those evaluations included a combination of quantitative shoreline change analysis, volume change calculations, and hydro/sediment modeling. Sediment volume change analysis and modeling results were integrated to assess the impact of the Savannah Harbor navigation channel on sediment transport pathways. The results of the circulation and wave modeling indicate very small changes associated with the proposed deepening on the beaches of Tybee Island. This report is included in GRR Engineering Appendix.

Based on these factors, the Corps believes that the proposed harbor deepening alternatives would not result in major or significant adverse impacts to ocean or river shorelines.

5.10 Floodplains

In 2005, Applied Technology and Management, Inc. (ATM) developed an EFDC model using data based on measured water surface elevations collected at the USGS Customs House gage located in Charleston, SC during Hurricane Hugo which made landfall on September 21, 1989 as a Category 4 storm. Hurricane Hugo was chosen because it was the largest hurricane in recent record with closest proximity to the Savannah River estuary. Moreover, the data sets recorded during this event were used to model a similar event in the Savannah River estuary because they are relevant and available.

The results from the ATM hurricane surge modeling indicate that the change in storm surge water surface elevation due to the proposed harbor deepening would not be significant. The existing depth is compared to the 48 foot deepening alternative (deepening an additional 6 feet) for all of the 6 storm events scenarios simulated. The maximum increase for the maximum 48-foot depth alternative in predicted surge height is 0.90 foot, which occurs during the 15 foot surge at the I-95 Bridge. The hurricane surge modeling shows no significant adverse impacts due to harbor deepening from a propagated storm surge as it travels upstream through the river system and navigation channel.

In December 2007, TetraTech also evaluated hurricane surge (see Savannah Harbor Expansion Project, Evaluation of Hurricane Surge Impacts with Proposed Mitigation Plan, December 2007). They analyzed surge heights within the estuary for each depth alternative with their mitigation plans. The results of the both the ATM and TetraTech evaluations are shown in the tables below.

Table 5-48. Increase in Water Surface Elevation due to Hurricane Surge for the 48-Foot Depth Alternative

Storm Surge Height	Increase in Water Surface Elevations	
	Ft. Jackson	I-95 Bridge
5 Foot		
Peak on peak	0.3 foot	0.7 foot
Offset peaks	0.3 foot	0.7 foot
10 Foot		
Peak on peak	0.3 foot	0.8 foot
Offset peaks	0.3 foot	0.8 foot
15 Foot		
Peak on peak	0.3 foot	0.9 foot
Offset peaks	0.3 foot	0.8 foot
Maximum Difference	0.3 foot	0.9 foot

Table 5-49. Increase in Water Surface Elevation for 15-Foot Hurricane Surge (Peak on Peak Condition)

Project Depth Alternatives	Increases in Water Surface Elevation	
	Ft. Jackson	I-95 Bridge
44 feet MLLW	0.1 foot	0.3 foot
45 feet MLLW	0.2 foot	0.5 foot
46 feet MLLW	0.2 foot	0.6 foot
47 feet MLLW	0.3 foot	0.8 foot
48 feet MLLW	0.3 foot	0.9 foot

In the most extreme case (i.e., with the peak 15-foot storm surge and at the 48-foot channel depth), both the ATM and Tetra Tech hurricane storm surge analyses predict less than a 0.9 foot increase at the I-95 bridge. The Corps consulted officials at the Chatham County Emergency Management Agency about these results. The County indicated that since the impact amount is less than the 1-foot contour interval available for the high ground areas, they would not be able to identify any locations that would be adversely impacted by the small increase in surge height. They also noted that the maximum predicted increase was in addition to a substantial surge height (15 feet), which would cause noticeable adverse impacts on its own.

No new dredged material placement areas are being planned for the proposed harbor deepening. All dredged material would be placed either in the existing upland CDFs or within the offshore EPA-approved ODMDS. The exception is the use of excavated sediments to construct the submerged broad berm at the lower end of Back River.

The proposed project would not adversely impact floodplains in the project area since the Corps is not planning to develop any area within the 100-year floodplain. The height of hurricane storm surges on the floodplains would also not be measurably affected.

Therefore, the Corps believes that proposed deepening alternatives would not significantly increase hurricane storm surges in the project area, including Tybee Island, Fort Jackson, or the City of Savannah and floodplains in the project area will not be adversely impacted.

5.11 Threatened and Endangered Species

A biological assessment (BATES) evaluating the potential impacts of the proposed action on endangered and threatened species was prepared. The biological assessment resulted in a determination that the project, as currently proposed, "may affect, but is not likely to adversely affect" Piping plover, Wood stork, West Indian manatee, Right whale and Humpback whales, sea turtles, and Shortnose sturgeon, and Atlantic sturgeon. The biological assessment appears in Appendix B, and discusses the relationship of the proposed action to these species. Project plans have been refined to minimize potential effects to the extent feasible.

5.11.1 US Fish and Wildlife Service Findings

The BATES was coordinated with the USFWS (jurisdiction over the West Indian manatee, Piping plover, Wood stork and nesting sea turtles) and NMFS (jurisdiction over whales, sea turtles, Atlantic sturgeon and Shortnose sturgeon) pursuant to Section 7 of the Endangered Species Act. The BATES includes a discussion of the impacts of the SHEP on the Atlantic sturgeon, even though the species was listed as endangered just prior to release of the Final EIS.

Based on their review of the project, the DEIS and the GRR, the USFWS submitted their views on the BATES by letter on April 28, 2011. The USFWS concurred with the findings in the BATES that the SHEP may affect but is not likely to adversely affect the Piping plover, Wood stork, West Indian manatee, and nesting sea turtles. Their report on the BATES is included in Appendix Z.

5.11.2 National Marine Fisheries Service Findings

The NMFS submitted their Biological Opinion (BO) for the SHEP by letter dated November 4, 2011. The BO concurred with the findings of the BATES that the SHEP may affect but would not likely adversely affect Leatherback sea turtles, Green sea turtles, Hawksbill sea turtles, North Atlantic Right whales, and Humpback whales. However, the BO determined that construction of the SHEP would likely adversely affect Kemp's ridley sea turtles, Loggerhead sea turtles, Shortnose sturgeon and Atlantic sturgeon. The NMFS BO is included in Appendix Z.

5.11.2.1 Sea Turtles. The "likely to adversely affect" determination for Loggerhead sea turtles and Kemp's ridley sea turtles is primarily based on the incidental take of these species that would be expected to occur during hopper dredging operations over the 3-4 year construction period for the SHEP. To minimize impacts, hopper dredging would be conducted during the months of December through March, when sea turtles are least abundant. Despite the limited dredging window during winter months, use of deflector dragheads and relocation trawling (removing sea turtles from the entrance channel prior to dredging), the NMFS estimates that approximately 16 Loggerhead sea turtles and 11 Kemp's ridley sea turtles would be taken during the entrance channel dredging required for the SHEP. Once the NMFS reaches a determination that a project will likely adversely affect a listed species, they must conduct a Jeopardy Analysis to determine whether the proposed action would likely jeopardize the recovery of that species. Based on information developed in the BO, the NMFS concluded that construction of the SHEP would not interfere with the recovery objectives for either the Northwest Atlantic DPS (distinct population segment) of the Loggerhead sea turtle or Kemp's ridley sea turtle, or result in an appreciable reduction in the likelihood of their recovery in the wild. This determination is based on their knowledge of existing populations of these species and their anticipated future reproduction trends.

The determination by the NMFS that the SHEP is not likely to jeopardize the continued existence of the Northwest Atlantic DPS of the Loggerhead sea turtle or Kemp's ridley sea turtle is also based on implementation of Reasonable and Prudent Measures (RPMs) outlined in the BO, and the Terms and Conditions which implement those measures. Section 9 of the Endangered Species Act prohibits the take of endangered or threatened species. NMFS believes that for the SHEP to comply with the provisions of Section 9, the Corps must adhere to the Reasonable and Prudent Measures and the Terms and Conditions that implement those measures provided in the BO. The BO includes three Reasonable and Prudent Measures to protect the Northwest Atlantic DPS of the Loggerhead sea turtle and Kemp's ridley sea turtle. These three Reasonable and Prudent Measures and the Terms and Conditions to implement them are as follows:

A. Take Reporting
   1. NMFS approved protected species observers must be on-board hopper dredges;
   2. 100 percent inflow screening of dredged material is required and 100 percent overflow screening;
   3. The hopper's inflow screens should have 4-inch by 4-inch screening;
   4. Flexible, graduated screens should be used; and
   5. The dredging pump shall be disengaged by the operator when the draghead is not firmly on the bottom to prevent impingement or entrainment of sea turtles.

B. Deflector Dragheads
   1. A state-of-the art rigid deflector draghead must be used on all hopper dredges at all times;
   2. Observer reports of incidental take by hopper dredges must be reported by onboard NMFS approved protected species observers, the dredging company, or the COE within 24 hours of any sea turtle or other listed species take observed. A final report summarizing the results of the hopper dredging and any documented sea turtle or other

listed species take must be submitted to the NMFS within 30 working days of completion of the dredging project;

3. The Corps' representative shall notify the Sea Turtle Stranding and Salvage Network of the start-up and completion of hopper dredging operations and ask to be notified of any sea turtle strandings in the project area that bear signs of potential draghead impingement or entrainment, or interaction with a bed-leveling type dredge; information of such stranding shall be reported in writing within 30 days of project end to the NMFS' Southeast Regional Office; and

4. The COE shall provide NMFS' Southeast Regional Office with a report detailing instances, with photographs when available, of stranded sea turtles that bear indications of draghead impingement or entrainment and/or bed leveler interactions.

C. Relocation Trawling

1. Relocation trawling (RPM 3) (if applicable). Prior to turtle relocation trawling, the COE shall develop and submit to the NMFS detailed specifications on the final selected turtle relocation trawling gear sufficiently ahead of dredging activities for NMFS to review and comment on the plans. The use of relocation trawling will be required during all proposed hopper dredging during December 1 through March 31;

2. The COE shall provide the NMFS' Southeast Regional Office with an end-of-project report within 30 days of completion of relocation trawling; and

3. In the event that trawling does result in the capture of a sea turtle, the COE may employ a separate chase boat to relocate the turtle at a distance of no less than 3 miles from the centerline of the navigation channel at the capture site. The Corps shall be subject to the conditions outlined in the BO concerning handling, captured sea turtle holding conditions, scientific measurements and data collection, injuries, flipper tagging, PIT-Tag scanning, etc.

In addition to the requirements discussed above, the Corps shall follow the Terms and Conditions of the BO with respect to:

A. The BO provides the permitting authority for any NMFS-approved protected species observer to tissue-sample live or dead captured sea turtles. All live or dead sea turtles captured by relocation trawling and hopper dredging shall be tissue sampled prior to release in accordance with NMFS' procedures.

B. The COE must ensure that all contracted personnel involved in operating hopper dredges receive thorough training on measures of dredge operation that will minimize take of sea turtles.

C. All lighting aboard hopper dredges and hopper dredge pumpout barges operating within 3 nautical miles of sea turtle nesting beaches shall be limited to the minimal light necessary to comply with the U.S. Coast Guard and/or OSHA requirements. All non-essential lighting on the dredge and pumpout barge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the water to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches.

D. The COE will be required to conduct activities in compliance with NMFS' March 23, 2006, *Sea Turtle and Smalltooth Sawfish Construction Conditions*.

5.11.2.2 Shortnose and Atlantic Sturgeon. The "likely to adversely affect" determination for Shortnose sturgeon is primarily based on adverse effects (increase in salinity) to important estuarine winter foraging habitats for both juvenile and adult fish. While the NMFS expects these effects to be sub-lethal for individual sturgeon, these effects could reduce the Savannah River's overall carrying capacity and ability to provide optimal habitat for the Shortnose sturgeon to forage. The NMFS believes that both adults and juveniles will move to suitable habitats further upriver once the SHEP is constructed. However, the NMFS also points out that there may be a transitional period as the habitat adjusts to the new, higher salinity. They expect sturgeon to use these areas for foraging once their prey have colonized and stabilized to the new environmental conditions. The NMFS also determined that construction of the SHEP would not likely cause a long-term reduction in reproduction. NMFS expects that construction of the fish passage facility at the NSBL&D will result in access to historic spawning habitat upstream of the dam that increases spawning activity over the long-term. Based on these determinations, the NMFS concluded that construction of the SHEP is not likely to jeopardize the continued existence of Shortnose sturgeon. With implementation of the Reasonable and Prudent Measures NMFS identified to protect this species, NMFS concluded that the overall effect on the species would be acceptable.

The "likely to adversely affect" determination for Atlantic sturgeon is primarily based on NOAA's estimated incidental take of four Atlantic sturgeon during hopper dredging operations necessary to construct the SHEP and adverse effects (increase in salinity) to important estuarine foraging habitat for juveniles and adults. The estimated incidental take of four Atlantic sturgeon during entrance channel construction would not decrease the overall population of this species in the South Atlantic DPS (Distinct Population Segment) as there are significant numbers of fish found in the rivers comprising the South Atlantic DPS range of Atlantic sturgeon. The effects of SHEP on foraging habitat and spawning success of Atlantic sturgeon are similar to those for the Shortnose sturgeon. Based on these determinations, the NMFS was able to conclude that construction of the SHEP would not likely jeopardize the continued existence of the South Atlantic DPS of Atlantic sturgeon, and the project's overall effect on the species would be acceptable.

For sturgeon, the BO includes five Reasonable and Prudent Measures that must be implemented for the Corps to be exempt from the provisions of Section 9 of the ESA. These five Reasonable and Prudent Measures and the terms and conditions to implement those measures are as follows:

A. Implement Safe and Effective Fish Passage in a Timely Manner.

1. Develop a plan for safe and effective fish passage. Using the proposed off-channel rock ramp design as its basis, the COE will coordinate with the NMFS, USFWS, SCDNR, and GADNR to develop the final design details. The COE shall conduct a comparison analysis of the performance of existing rock ramps located in other parts of the country with similar characteristics to the proposed New Savannah Bluff Lock and Dam fish passage conditions to review information on the spatial variation of velocities

across the width of rock ramp designs. The COE will coordinate the results of that effort with the natural resource agencies within 6 months of receiving all of the environmental approvals to implement the project. NMFS has requested a minimum of 2 months to provide a review of the final fish passage design. The proposed final design shall require NMFS' final review to validate that the design meets the requirements specified in the BO. The goal of the fish passage alternative is to achieve at least 75 percent upstream passage effectiveness for both Shortnose and Atlantic sturgeon, at least 85 percent downstream passage effectiveness, and cause no serious injury to sturgeon that come into contact with the passage or dam structures. The fish passage would maintain velocities comparable to those found in the upstream habitat that the sturgeon are expected to access upon completion of the fish passage facility.

2. Fish passage construction shall commence prior to or concurrently with inner harbor dredging and be complete within two years.

3. The COE shall purchase any additional land necessary for the fish passage and for an access road to the site. The land acquisition process must be initiated prior to, or concurrent with, commencement of entrance channel dredging.

4. To protect spawning sturgeon and their offspring, no in-water fish passage construction downstream of the New Savannah Bluff Lock and Dam shall occur during the late winter/spring period and early summer larval period between February 1 and May 31 of any year.

5. The COE shall adhere to protective measures during construction of the fish passage including appropriate erosion and turbidity controls. Additionally, the Corps will ensure passage throughout the habitat. Adequate pathways must be provided at all times so that fish can migrate between foraging habitat and spawning habitat; no blocking of the channel is allowed. Normal water flows must be maintained throughout the construction areas. The COE shall not reduce flows during the spring/early summer to aid in the construction of the fish passage.

6. The COE shall develop a Monitoring and Adaptive Management Plan specifically for the fish passage that will, to the maximum extent practicable, ensure the performance criteria will be achieved. The plan will also identify triggers for passage modification. Post-construction monitoring shall be designed and conducted to assess the effectiveness of the fish passage in safely passing sturgeon upstream and downstream. The COE shall consult with the NMFS and the other natural resource agencies to complete the plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. If it is determined that sturgeon are not safely and effectively passing upstream and downstream through the fish passage, measures shall be taken to rectify the problem.

B. Protective Measures for Sturgeon during Construction in the SHEP Project Area.

1. The construction of the diversion structure associated with the flow re-routing modifications shall be conducted between May 15 and November 1 while most sturgeon are congregated upstream of the construction area.

2. During construction of the various flow diversion measures, the COE will adhere to appropriate erosion and turbidity controls. No blocking of the channel is allowed, except where included as part of the flow re-routing modifications.

C. Ensure Appropriate Monitoring and Adaptive Management Within the Lower Savannah River Project Area. A comprehensive monitoring and adaptive management plan shall be developed for assessing project impacts associated with the deepening, the flow-re-routing modifications, the injection of oxygen, the fish passage and for implementing corrective actions. The plan shall identify success criteria and triggers. The COE shall consult with the NMFS and the other natural resource agencies to complete the plan within 6 months of receiving all environmental approvals to implement the project. NMFS shall have final review of such plan. The plan shall be completed within 6 months of receiving all environmental approvals to implement the project. The Plan shall include monitoring to determine whether the predicted amount of habitat loss is being exceeded. If the monitoring indicates habitat loss to any species within NMFS' ESA authority is being exceeded, this will trigger re-initiation of consultation with the NMFS.

D. Ensure Appropriate Dissolved Oxygen Levels. Monitoring and adaptive management for dissolved oxygen levels shall ensure that the dissolved oxygen systems perform as expected to offset harbor deepening impacts and ensure the amount of suitable habitat as predicted in the modeling of the three-level summer habitat suitability criteria for sturgeon are not reduced. If dissolved oxygen excursions below minimum levels in the modeled river cells are longer in duration than specified in the criteria, corrective action (increasing or adjusting the operation of the Speece cones, cessation of dredging in the area of concern, etc.) will be taken immediately. If short-term response is not practicable, solutions shall be implemented as soon as possible, and not later than July 1, following identification of the poor oxygen levels.

E. Tissue Sampling, Tags and Reporting Take. A tissue sample shall be taken of any sturgeon handled or stranded. All sturgeon encountered shall be scanned for a PIT tag. If a lethal take occurs, the COE shall arrange for containment analysis of the carcass. Sonic tags, or some other state-of-the-art tracing device shall be placed on sturgeon captured during relocation trawling, or alive by the hopper dredge by NMFS-approved personnel only. Observer reports of incidental take by hopper dredges and relocation trawls will be reported to the NMFS' Southeast Regional Office.

5.11.2.3 Corps Proposed Actions. The Corps will follow the Reasonable and Prudent Measures and the Terms and Conditions in the NMFS November 4, 2011 BO for construction of SHEP. If the NMFS updates the Regional Biological Opinion (RBO) for operation of hopper dredges, the Corps will follow that newer document for long term operation and maintenance of the SHEP. If the NMFS does not update the RBO for operation of hopper dredges, the Corps will follow the 1997 RBO for long term operation and maintenance of the SHEP.

5.12 <u>Cultural Resources</u>

Analysis of potential impacts to cultural resources considers both direct and indirect impacts. Direct impacts may be the result of physically altering, damaging, or destroying all or part of a resource, altering characteristics of the surrounding environment by introducing elements that are out of character for the period the resource represents, or neglecting the resource to the extent that it deteriorates or is destroyed. Indirect impacts are those that may occur as a result of a change in the wave action in the vicinity of the resource during dredging and other construction activities.

The APE has been defined as those areas listed in Section 4.10.1 where ground disturbing activities and placement of dredged material will occur. Previous cultural resource investigations as described in Section 4.10. 2 have located several resources within and in the vicinity of the APE. These resources are displayed in Table 4-16. Table 5-50 lists the potential impact to those resources from the action and proposed mitigation, if required. Areas within the APE that require additional cultural resources investigation are discussed in Section 5.12.3.

Table 5-50. Known Cultural Resources within the APE Requiring Additional Investigation

Resource Name/Site Number	NRHP Status	Potential Impact	Proposed Mitigation
Fort Pulaski National Monument (GA)	Listed as National Monument	Negligible increase in erosion	None Required
Savannah National Historic Landmark District (GA)	Listed as National Historic Landmark	None	None Required
Fort James Jackson National Historic Landmark (GA)	Listed as National Historic Landmark	None	None Required
CSS *Georgia* (SC & GA waters)	Listed	Dredging Impacts	To be determined in consultation with GA, SC SHPO and US Navy
The Savannah and Ogeechee Canal (GA)	Listed	None	None Required
Pennyworth Island (GA)	Nomination Pending Approval	Increased shoreline erosion or accretion	To be determined in consultation with GA SHPO
Fig Island Channel Site (GA)	Determined Eligible	None	None Required
Mansfield/Shaftsbury Plantation—09CH685	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the GA SHPO
Poplar Grove Plantation—38JA203	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the SC SHPO
Shubra Plantation – 38JA204	Recommended Eligible	Increased shoreline erosion or accretion	To be determined in consultation with the SC SHPO

5.12.1 Alternatives Considered During Project Design in Order to Reduce the Area of Potential Effect

The initial concept design for this project was to deepen the channel by up to 10 feet the full channel bottom width for the entire length of the navigation channel. This design would have resulted in side slope sloughing that would have impacted an area up to 50 to 80 feet wide on either side of the navigation channel. The design was subsequently modified to deepen the channel by no more than 6 feet and to dredge to a width that would not affect existing side slopes. The decision to maintain the existing side slopes and narrow the bottom width of the navigation channel greatly reduced potential impacts to cultural resources.

The initial project design also included a series of 16 bend wideners varying from 76 to 156 feet in width and with a total length of over 56,000 linear feet. The results of a ship simulation study resulted in a new design with three bend wideners with widths from 76 to 156 feet and a total length of less than 15,250 linear feet and nine areas to be dredged to the full existing channel width with a total length of less than 49,000 feet.

5.12.2 Cultural Resources Investigations for Specific Sites

As stated in Section 4.10 not all previously undisturbed areas within the APE have been investigated, nor have all resources that were previously identified been evaluated for the NRHP. The section below discusses previous cultural resources investigations, resources identified and any investigations and/or evaluation of resources that will be required.

5.12.2.1 Bar Channel Extension (Outside State Waters) –Stations –60+000 to –97,680--Bottom and Side Slopes. The project, as originally proposed, included a 25,000-foot long channel extension, Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and cesium magnetometer surveys of the proposed channel extension area. The survey area was 700 feet wide, sufficient to include the 600-foot proposed channel width and side slopes. In 2005, Savannah District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of potentially significant anomalies and/or targets. The contractor has completed the analyses and has investigated one magnetic anomaly/sonar target. The anomaly/target was identified as modern debris.

As part of studies to identify potential impacts to the Floridan Aquifer, Savannah District conducted sub-bottom profiler surveys of the existing bar channel area, as well as areas on the bar considered for bend wideners and channel extension. The purpose of the survey was to identify the depth and character of the aquifer's Miocene-age cap and to locate former Pleistocene stream channels that cut into the cap. Since stream banks have a higher potential for containing prehistoric archaeological sites, the results of these surveys were also examined by District archaeologists. No Pleistocene streams were found in the extension area.

Due to changes in shoals, in 2009, the bar channel extension was redesigned to be a 38,600- foot-long by 600-foot-wide channel located on a different alignment. Savannah District is contracting for a side scan sonar, magnetometer, and sub-bottom profiler, and diver investigation of the new location. In order to ensure that avoidance of impacts to potentially significant cultural resources is a viable alternative, the area being surveyed is 1100 feet wide. The survey is designed to locate shipwrecks and landforms likely to contain prehistoric sites.

5.12.2.2 Bend Wideners and Full-width Dredging Areas. The project includes dredging along the entire length of the existing navigation channel up to Garden City Terminal (Station 103+000) and construction of three bend wideners at critical turns. A summary of the cultural resources investigation conducted in these areas are summarized below.

Bend Widener (SC waters)—Stations –21+000 to –14+000, 76-foot bottom width plus side slope of 20 feet. Savannah District archaeologists and hydrographic surveyors conducted side scan sonar and magnetometer surveys of this area. The survey area was 300 feet wide. In 2005, the District contracted with Panamerican Consultants, Inc., to analyze the data, identify anomalies and/or targets for further evaluation, and conduct diver investigations of the anomalies. The contractor completed the analyses and recommended no anomalies and/or targets for evaluation.

Sub-bottom profiler surveys conducted as part of the aquifer impact studies identified a Pleistocene stream channel that bisected this area. Savannah District geologists and a contract geoarchaeologist with Brockington and Associates selected four areas from which to take core samples—three located along the banks of the stream and one located on a terrace that formed within the stream channel as sea level rose. Analysis of the cores revealed that the sediments within and adjacent to the stream channel date to the mid-Pleistocene Era and are not associated with human activity.

Full-channel-width Dredging Area (SC waters)—Stations +9+000 to +12+750—side slope impact area of ca. 20 feet. The easterly 1000 feet has been previously impacted by construction of a 36-foot-deep turning basin. The remaining area was surveyed in 2003 by Savannah District contractor Panamerican Consultants for a then-planned 76-foot-wide bend widener plus side slopes. Eight anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 200 feet from the revised area of potential effect. No further investigations are recommended.

Full-channel-width Dredging Area (GA waters)—Stations +9+500 to +11+500—side slope impact area of ca. 20 feet. This area was surveyed for a previous deepening project. No magnetic anomalies and/or targets were located. No further investigations are recommended.

Full-channel width Dredging Area (SC waters)—Stations +27+250 to +31+750—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Ten magnetic anomalies and/or targets were recommended as potentially significant. Due to project redesign, all are located over 100 feet from the revised area of potential effect.

Full-channel-width Dredging Area (SC waters)—Stations +41+500 to +49+500—side slope impact area of ca. 20 feet. This area was surveyed as part of a previous deepening project. The survey identified four anomalies and/or targets for further evaluation. Two of the targets, SH-R15 and SH-R19N-1 were located within that project's area of potential of effect and were investigated. Both targets were found to be generated by modern debris. The remaining two anomalies/targets, SH-R16-2 and SH-R17N-1, have not been investigated. These targets will be relocated and assessed.

Full-channel-width Dredging Area (GA waters)—Stations +31+000 to +49+500—side slope impact area of ca. 20 feet. In 2003, an area 300 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Seven individual or clusters of anomalies and/or targets recommended as potentially significant are located within or near to the side slope impact area. Two anomalies and/or targets clusters (cluster 7C-1, 7C-9, 7C-10 and cluster 7E-6, 7E-14, 7E-18, 7E-34, 7E-53, 7E-55) were investigated by Panamerican Consultants, Inc., in 2005 and were found to be generated by modern debris. The remaining three potentially significant individual anomalies and one cluster are recommended for evaluation. Anomaly 7B-4 and anomaly cluster 7C-5, 7C-14 appear to extend into the area of potential effect and will be investigated.

Bend Widener (GA waters)—Stations +49+500 to +53+000—156-foot bottom width plus side slope of less than 75 feet. In 2003, an area 450 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. In 2005, Panamerican Consultants considered diving on anomalies 7A-1 and 7A-8, but, further analysis of the fathometer data and additional remote sensing data gathered as part of that investigation found that the anomalies were located in the dredged channel bottom and were generated by modern debris. Anomaly 7A-9 would be located within the side slope of the proposed bend widener and, based on limited dated, anomalies 7A-26, 7A-28, 7A-31, and 7A-32 are located sufficiently near to the area of potential effect to warrant further investigation.

Bend Widener (SC waters)—Stations +52+250 to +55+000—76-foot bottom width plus side slope of less than 100 feet. In 2003, an area 350 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with this widener. No anomalies and/or targets were recommended for further investigation. No further investigations are proposed for this bend widener.

Full-channel-width Dredging (GA waters)—Stations +63+250 to +69+000—side slope impact area of ca. 20 feet. The westernmost 1,750 feet of this area overlaps the Fig Island Turning Basin that has been previously dredged to 38 feet. The eastern portion of this area was surveyed as part of a previous deepening project. Five anomalies and/or targets were identified, none of which were recommended for additional investigation. No further investigations are recommended for this area.

Full-channel-width Dredging (GA waters)—Stations +69+000 to +71+000—side slope impact area of ca. 20 feet. In 2003, an area 500 feet wide was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. Four anomalies located within the existing channel side slope (4-22, 4-24, 4-26, and 4-27) are recommended for further investigation.

Full-channel-width Dredging (GA waters)—Stations +76+000 to +77+500—side slope impact area of ca. 20 feet. In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. One anomaly (3-1) was recommended for additional investigation based on the characteristics of its magnetic signature, however, this anomaly is located at the toe of the side slope of the existing navigation channel in an area that has been dredged to 36 feet for commercial wharves. Based on the history of bottom disturbance in this area, no further investigations are recommended for this anomaly.

Full-channel-width Dredging (GA waters)—Stations +87+750 to +89+500—side slope impact area of ca. 20 feet. In 2003, an area 400 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with a then-planned 76-foot-wide channel widener plus side slopes. No anomalies and/or targets located within the side slope impact area were recommended for further investigation. No further investigations are proposed for this area.

Bend Widener (GA waters)—Stations +101+000 to +103+000—128.6 feet plus side slope of less than 100 feet. This area was investigated by a Georgia Ports Authority archaeological contractor as part of studies conducted for proposed channel modifications associated with the construction of Container Berth 8. Section 106 compliance was completed as required by a Department of the Army Permit issued under the authority of Section 404 of the Clean Water Act of 1972. It has since been dredged. No further investigations are recommended for this area.

5.12.2.3 Kings Island Turning Basin Side Slopes (GA waters)—Stations 98+500 to 100+500—side slope impact area of ca. 20 feet. In 2003, an area 150 feet wide (to the shoreline) was surveyed by Savannah District contractor Panamerican Consultants, Inc., in order to identify potential impacts associated with side slope changes. No anomalies and/or targets were recommended for additional investigation. Two shoreline sites that had been identified by a previous survey and determined not to be eligible for inclusion in the National Register of Historic Places were relocated. No further investigations are recommended for this area.

5.12.2.4 Meeting Areas. The project includes construction of two meeting areas in the inner harbor. A summary of the cultural resources investigations conducted in these areas are summarized below.

GA and SC waters—Stations +55+000 to +68+500—100 feet wide plus side slope of less than 100 feet. In 2005, Savannah District contractor Panamerican Consultants, Inc., surveyed an area 400 feet wide to identify potential impacts associated with this passing lane. One previously identified resource, CSS *Georgia*, is located within this area and is discussed in the following section. The survey also identified a number of magnetic anomalies and sonar targets, six of which were selected for diver investigation. Three were found to be generated by modern harbor debris, one (GA waters) was generated by the remains of a steel-hulled sailing vessel dating to the late nineteenth or early twentieth century, and two (SC waters) were generated by the remains of Confederate crib obstructions.

The sailing vessel has been tentatively identified as the pilot boat *Eclipse*, which burned in this general area in 1918. The vessel is potentially eligible for inclusion in the National Register of Historic Places. It is located behind (north of) the submerged remains of the original Fig Island jetty where historical documentation indicates that the bark *Undine* was also abandoned in 1893. *Undine* was built in 1867 as a clipper ship by William Pyle of Sunderland, England. Attempts were made to redesign the passing lane to avoid impacts to these resources, however, it was found that a shorter lane would not meet the needs of the larger vessels transiting the channel.

The Confederate crib obstructions, although severely degraded, are sufficiently intact for the site to be recommended as eligible for inclusion in the National Register of Historic Places at the local level for their archaeological research potential and association with significant events.

GA waters—Stations +16+000 to +20+000—100 feet wide plus side slopes of less than 100 feet. An area 100 feet wide was surveyed in 1994 for the previous channel deepening project. No potentially significant sonar targets or magnetic anomalies were located in this area. The remaining 100-foot-wide impact area associated with the construction of the proposed passing lane will be surveyed. Archival research has shown that this area of the harbor has the lowest potential for containing shipwreck remains.

5.12.2.5 Mitigation Features (GA and SC). The project includes construction of a number of mitigation features to compensate for predicted adverse environmental impacts. Construction of these features will affect wetlands, submerged river bottoms, and high ground. A summary of the cultural resource investigations in the areas proposed for construction of the various mitigation features is summarized below.

Flow Rerouting Plan 6A. This plan includes the following features, McCoy Cut diversion structure, channel deepening on McCoy Cut to -4m NGVD and Upper Middle and Little Back Rivers to -3m NGVD, allowing sediment basin to fill to -3.85M NGVD by constructing a submerged sill, close Rifle Cut, remove tide gate abutments and piers, close lower (western) arm of McCoy Cut. Because the proposed features are designed to change the hydraulics of the Middle, Little Back, and Back Rivers, the area of effect includes the construction areas as well as any areas that will be subjected to increased erosion or deposition. In order to determine the effect of the proposed plan upon historic properties, the construction areas, as well as the entire lengths of Middle, Little Back, and Back River channels and shorelines will need to be archaeologically surveyed. These surveys will include archival research, shoreline low water survey and testing, remote sensing (magnetometer and side scan sonar) surveys of submerged areas, and diver investigation of anomalies and/or targets.

One portion of Back River has been surveyed previously. In 1992, Tidewater Atlantic Research, Inc. conducted remote sensing and low water surveys of the Back River area as part of the studies required under the terms of the 1992 Programmatic Agreement (PA) for the closing of New Cut and the removal of the tide gate from operation. The survey area included the Back

River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to lower end of Hog Island in Little Back River. The survey identified 31 archaeological sites. Sixteen were wrecked or abandoned vessels. One was a prehistoric archaeological site. The remaining sites were related to historic rice plantations (e.g. wharves, dikes, dams, bulkheads, canals, trunks, mills, etc.). The 1992 survey also identified 26 magnetic anomalies and/or sonar targets.

In 1993 and 1994 Savannah District archaeologists conducted archival research, archaeological survey, site monitoring, and diver investigations of sites, magnetic anomalies, and/or sonar targets in the portion of the 1992 survey area located above the tide gate. The purpose of the work was to determine the historical significance of the previously recorded resources and to assess the effect of the New Cut Closure Project upon these resources. A number of sites were determined eligible for inclusion in the National Register of Historic Places. The research concluded that the project had caused some erosion, the areas had stabilized and the extensive documentation conducted during the survey was sufficient to document the portions of the resources that were impacted. The potential impact of Plan 6a upon these resources will be evaluated.

Seven of the magnetic anomalies and/or sonar targets were located in the sediment basin area below the tide gate. More detailed evaluations of these anomalies/targets are needed to determine if they are located within the area of potential effect and their potential significance.

The remaining portions of the area of effect for Plan 6a are located within the Savannah National Wildlife Refuge. None of these areas have been previously surveyed for cultural resources.

Oxygen Injection Systems. Two areas have been proposed for construction of oxygen injection systems which would serve three oxygen injection locations. The area of effect for these systems includes the construction areas, as well as the submerged areas near the outlet pipes that would be subjected to larger increases in oxygen levels. Increases in oxygen result in increased degradation of submerged resources (e.g. wrecks, wharves, artifacts, etc.),

One system would be located on the Hutchinson Island. It would serve oxygen injection locations on both the west and east sides of Hutchinson Island. The terrestrial and submerged areas have been severely disturbed from construction of pipelines, infrastructure for existing aeration ponds, and disposal of dredged material. The second system would be above the harbor located near Georgia Power Company's Plant McIntosh. The terrestrial and submerged portions of the area of effect will be surveyed for historic properties.

Other Environmental Mitigation Features. Other proposed environmental features include: constructing a boat ramp on Hutchinson Island, constructing a fish passage at New Savannah Bluff Lock and Dam, stocking of striped bass, and restoring brackish marsh in existing Disposal Area 1S. Fish stocking will have no effect upon historic properties. The Hutchinson Island boat ramp would be located in Georgia within the area that was heavily disturbed during Tide Gate Construction and that has previously been determined to not contain historic properties. The fish passage structure would be located in South Carolina in an area believed to have been disturbed during original lock and dam construction. Savannah District will conduct archival research and an archaeological survey during the design process to verify that the entire area has been disturbed. Disposal Area 1S (Georgia) was not surveyed prior to its use as a Savannah Harbor disposal area. While it is unlikely that any historic properties buried beneath the disposal sediments would retain sufficient integrity to be determined eligible for inclusion in the National Register of Historic Places, Savannah District will conduct archival research and coring investigations to investigate this possibility.

5.12.2.6 Fort James Jackson National Historic Landmark (Georgia)--Station 58+000 and 59+000. During the Tier I process, the public made extensive comments about potential impacts to the fort. In 2003, the fort was stabilized with sheet piling along the outside perimeter of the fort wall and along the adjacent shoreline with rock rip rap (see photographs on the following two pages). The proposed harbor deepening would have no effect upon this historic property.

5.12.2.7 CSS *Georgia* (South Carolina & Georgia waters)--Station 58+500 to 59+000. The wreck of the CSS *Georgia* is included in the National Register of Historic Places at the national level of significance for architecture, association with significant events, association with significant people, and archaeological research potential. The National Register boundary includes the channel side slope, the top of slope, and an area extending 50 feet into the authorized navigation channel. The boundary between South Carolina and Georgia runs through the wreck site. Since 1984, Savannah District has had an agreement with both states to avoid the site area during dredging by 50 horizontal feet for a distance of 1000 feet along the channel. No dredging has been conducted of any portion of the existing navigation channel located between stations +58+000 and +59+000 since 1992.

A 1992 Programmatic Agreement required Savannah District to determine past, present, and future effects of the existing Savannah Harbor Navigation Project upon this resource and to identify and evaluate alternatives to mitigate these effects. This evaluation study was conducted in 2003 in conjunction with studies to determine the incremental effect of the proposed expansion project. The studies demonstrated that past, present, and future operation and maintenance activities have, and will continue to have, an adverse effect upon the wreck site. In addition, the proposed meeting area that would be constructed as part of the expansion project would adversely affect the site. Impacts to the site would not differ with the various harbor deepening alternatives. The report of these investigations has been coordinated with the Georgia and South Carolina State Historic Preservation Offices.

The navigation channel could not be substantially deepened without crossing a major portion of the wreck site. As a result, evaluation of the deepening alternatives included an *in-situ* archeological assessment of the present condition of the CSS *Georgia.* An extensive analysis of the wreck site was performed.

Using the new information, Savannah District reviewed the status of CSS *Georgia* in 2006 and concluded that past operation and maintenance dredging had severely impacted the wreck site. The wreck had become exposed and largely destroyed by a combination of factors including different river flow patterns, new work (primarily construction of the 4-foot advance maintenance section in 1983), maintenance dredging practices, and marine organisms. The data indicated that action should be taken to ensure the remaining archaeological information possessed by the remains of the wreck is obtained before the site degrades further.

The 2007 report documenting the *in-situ* archeological evaluation included recommendations for future actions. The evaluation recommended a systematic archeological salvage operation, which would include partial and full excavation conducted by divers working from a fixed platform. In light of the condition of the wreck at that time, the best plan consists of removing the remaining wreck and conducting archeological data recovery, which includes excavating, conserving, and curating. As a result of the likely impacts of the deepening alternatives on the site, the project includes performance of an archeological salvage operation as mitigation.

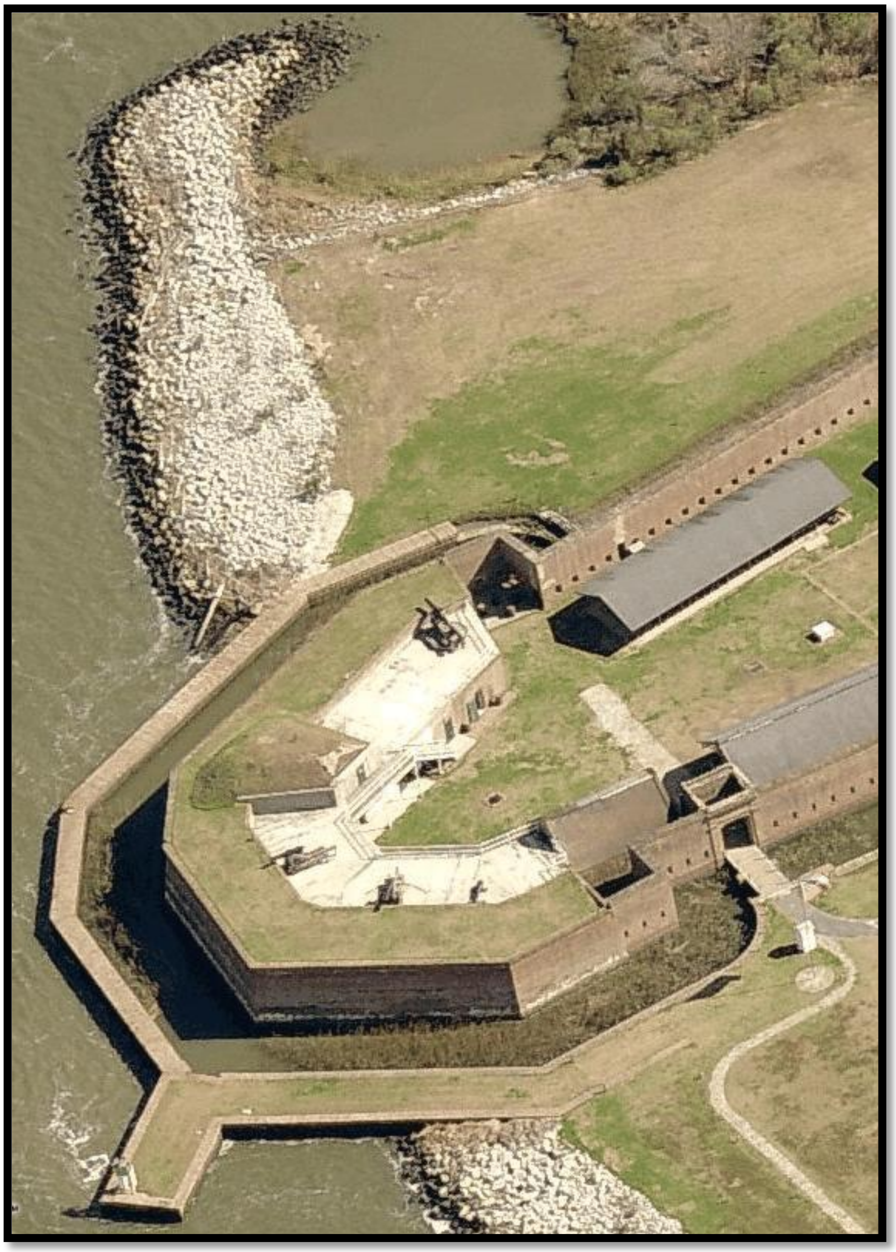

Figure 5-54. Aerial view of Old Fort Jackson.

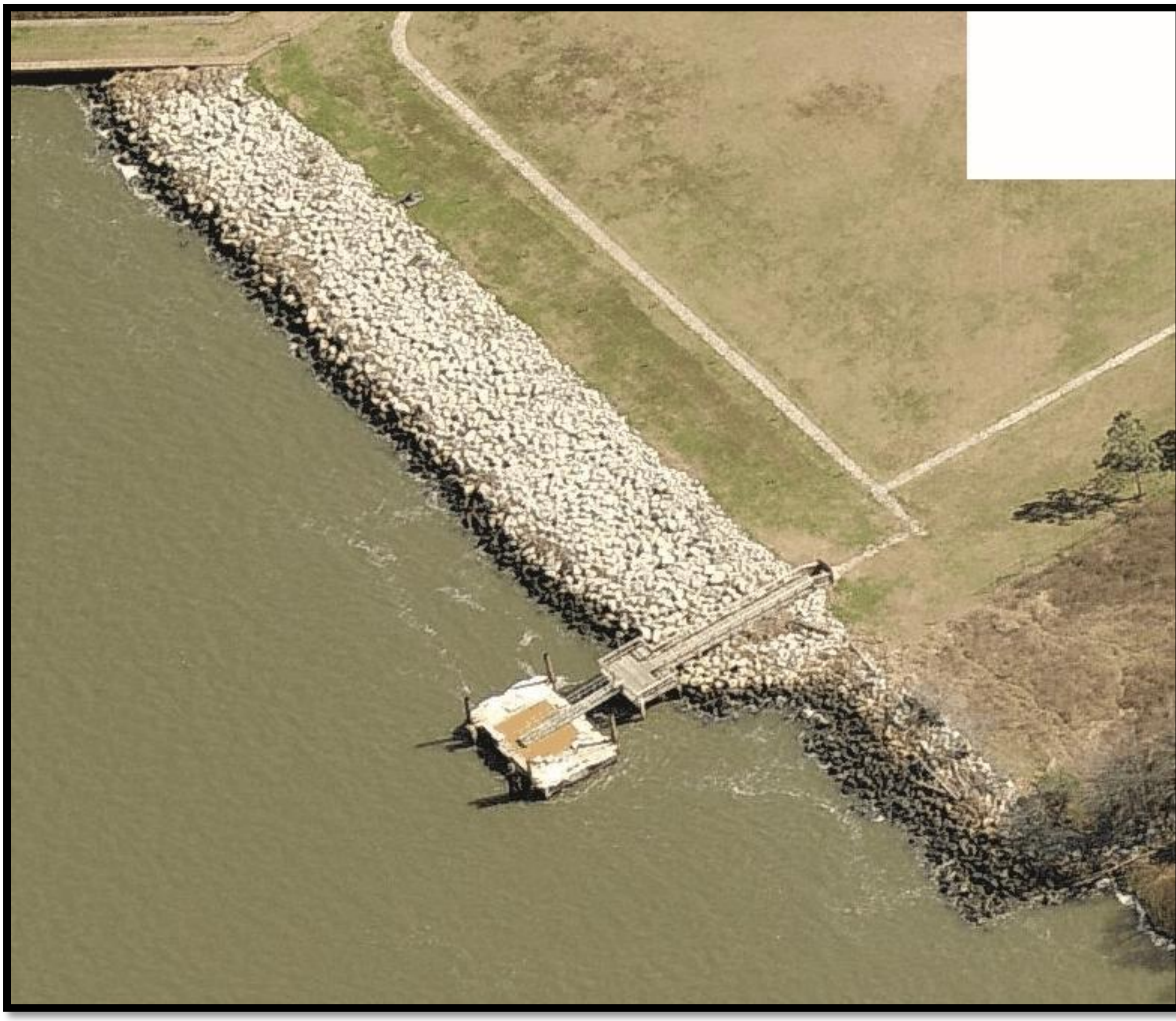

Figure 5-55. Upstream bank protection at Old Fort Jackson.

As a result of those findings, Savannah District will conduct archaeological data recovery of the CSS *Georgia* prior to or at the same time of the deepening of the navigation channel. The harbor deepening project would be responsible for final clearance of explosive ordnance prior to deepening the channel and constructing the meeting area.

Savannah District prepared a Programmatic Agreement in accordance with 36 CFR 800.14b(1)(ii) for the proposed Savannah Harbor Expansion Project, including activities at the CSS *Georgia*. Consulting parties include the Georgia and South Carolina State Historic Preservation Officers, Savannah District, and the Naval History and Heritage Command of the US Navy, the owner of the CSS *Georgia*. The Advisory Council on Historic Preservation decided it did not need to be a signatory party to the Agreement. The Catawba Nation is a concurring party. The Agreement has been signed by all parties and is included as Appendix G.

An Antiquities Permit would be required from the US Navy Naval History and Heritage Command.

5.12.3 Surveys to be Performed

The following surveys would be conducted prior to construction in compliance with all applicable cultural resources laws and regulations. The District will coordinate its findings with the SC or GA SHPO, whichever is applicable for that location in accordance with the stipulations of the PA, which is found in Appendix G.

5.12.3.1 Survey of Bar Channel Extension (Stations -75+000B to -97+680B) and Diver Investigation of Selected Anomalies/Targets in Bar Channel Extension Area and Inner Harbor. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of area 1100 feet wide and 39,000 feet long. Sonar lane spacing of 150 feet and scale of 75 meters would be required. Likewise, magnetometer lane spacing of 50 feet would also be needed. Two sub-bottom lines on full channel length plus short cross lines as needed. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged sites would occur for sites identified as eligible for inclusion in the National Register.

5.12.3.2 Mitigation Features and Associated Lands (GA and SC). In compliance with requirements of the Clean Water Act, Savannah District is working with the US Fish and Wildlife Service, US Environmental Protection Agency, the Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, and the South Carolina Department of Health and Environmental Control to mitigate for impacts to estuarine wetlands. The agencies identified properties to be used, and actions to be taken at those sites. Lands being considered include wetlands, submerged river bottoms, and high ground. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of Back River, Little Back River, and Middle River project areas. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be used as needed to define buried anomalies. Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

The mitigation plan includes the following features, McCoy Cut diversion structure, channel deepening on McCoy Cut to -4 m NGVD and Upper Middle and Little Back Rivers to -3m NGVD, constructing a submerged sill to -3.85 m NGVD at the Sediment Basin, close Rifle Cut, remove Tidegate abutments and piers, close lower (western) arm of McCoy Cut, constructing a boat ramp, and grading down a portion of Disposal Area 1S. Because the proposed features are designed to change the hydraulics of the Middle, Little Back, and Back Rivers, the area of effect includes the construction areas as well as any areas that will be subjected to increased erosion or deposition. To determine the effect of the proposed plan upon historic properties, the construction areas, as well as the entire lengths of Middle, Little Back, and Back River channels and shorelines will need to be archaeologically surveyed. These surveys will include archival research, shoreline low water survey and testing, remote sensing (magnetometer and side scan sonar) surveys of submerged areas, and diver investigation of anomalies and/or targets.

One portion of Back River has been surveyed previously. In 1992, Tidewater Atlantic Research, Inc. conducted remote sensing and low water surveys of the Back River area as part of the studies required under the terms of the 1992 Programmatic Agreement for the closing of New Cut and the removal of the Tidegate from operation. The survey area included the Back River, from shore to shore, from the mouth of the sediment basin at its juncture with the Savannah Harbor navigation channel to lower end of Hog Island in Little Back River. The survey identified 31 archaeological sites. Sixteen were wrecked or abandoned vessels. One was a prehistoric archaeological site. The remaining sites were related to historic rice plantations (e.g. wharves, dikes, dams, bulkheads, canals, trunks, mills, etc.). The 1992 survey also identified 26 magnetic anomalies and/or sonar targets.

In 1993 and 1994, Savannah District archaeologists conducted archival research, archaeological survey, site monitoring, and diver investigations of sites, magnetic anomalies, and/or sonar targets in the portion of the 1992 survey area located above the Tidegate. The purpose of the work was to determine the historical significance of the previously recorded resources and to assess the effect of the New Cut Closure Project upon these resources. A number of sites were determined eligible for inclusion in the National Register of Historic Places, including the Pennyworth Plantation Site which is being nominated to the National Register of Historic Places. The research concluded that the project had caused some erosion, the areas had stabilized and the extensive documentation conducted during the survey was sufficient to document the portions of the resources that were impacted. The potential impact of Plan 6A upon these resources will be evaluated.

Seven of the magnetic anomalies and/or sonar targets were located in the Sediment Basin area below the Tidegate. More detailed evaluations of these anomalies/targets are needed to determine if they are located within the area of potential effect and their potential significance. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be used as needed to define buried anomalies. Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

Three injection locations (near Georgia Power's Plant McIntosh, Hutchinson Island – west, Hutchinson Island –east) have been proposed for construction of oxygenation systems. The area of effect for these systems includes the construction areas, as well as the submerged areas near the outlet pipes that would be subjected to larger increases in oxygen levels. Increases in oxygen result in increased degradation of submerged resources (e.g. wrecks, wharves, artifacts, etc.). The terrestrial and submerged portions of the area of effect will be surveyed for historic properties. Proposed surveys include dual frequency side scan sonar, cesium magnetometer, and sub-bottom profiler survey of Back River, Little Back River, and Middle River project areas. Sonar lane spacing of 100 feet and scale of 50 meters would be required. Likewise, magnetometer lane spacing of 30 feet would also be required. A sub-bottom profiler would be used as needed to define buried anomalies.   Diving would also occur on selected anomalies/targets. If needed, Phase II testing of submerged and terrestrial sites would occur in areas that cannot be avoided. Mitigation and/or protection of submerged and/or terrestrial sites would occur for sites identified as eligible for inclusion in the National Register.

5.12.3.3 Other Environmental Mitigation Features. A number of other environmental mitigation feature alternatives are being formulated. Archaeological investigations will be conducted of the selected alternatives. If any historical sites are found as a result of these additional cultural resource investigations, the Corps will avoid and/or comply with any restrictions proposed by the Georgia and South Carolina State Historic Preservation Offices.

5.12.4 Consultation with Native American Tribes

The notice of availability for the 1998 draft Environmental Impact Statement for the expansion project was provided to a number of Native American Tribes. In March 2006 and November 2010, coordination letters were sent to the nineteen Federally recognized Native American Tribes who have an interest in the proposed project area informing them of the status of the project and inviting their comments. Several Tribes responded and requested that they be notified should sites with Native American components be encountered. Only the Catawba Nation requested to be added as a concurring party to the Programmatic Agreement.

5.12.5 Consultation with the Georgia and South Carolina Historic Preservation Offices

The draft Programmatic Agreement and preliminary project description were coordinated with the Georgia and South Carolina Historic Preservation Offices in March 2006. Shortly after both offices reviewed and approved the agreement, it was determined that project planning would proceed for an extended period and it was likely that large, new features would be added. It was decided to hold the document until more of the new features and their potential effect on historic properties could be identified. While the agreement document itself has not been changed, the attached supporting documentation report (this document) has been updated to reflect the final proposed project. The PA has been signed by both parties.

5.12.6 Consultation with the Advisory Council on Historic Preservation

The Advisory Council on Historic Preservation was contacted in May 2006 and asked if they wished to participate in the Programmatic Agreement. They indicated that they would not participate at that time.

5.12.7 Other Consulting Parties

In accordance with 36 CFR 800.2(c)(5), individuals or organizations with a demonstrated interest may participate as a consulting party due to the nature of their legal relation to the undertaking or affected properties.   The US Navy is the owner of the CSS *Georgia,* a resource that will be adversely affected by the proposed project. The US Navy Naval History and Heritage Command reviewed the draft Programmatic Agreement and draft EIS in December 2010 and requested they be included as a consulting party to the Agreement. Their involvement is limited to advice and comment pertaining to the mitigation of the CSS *Georgia* only. A copy of the signed agreement is found in Appendix G.

5.12.8 Public Involvement

A number of public involvement meetings have been held as part of the National Environmental Policy Act compliance activities. Two of these events included manned cultural resources information booths which informed the public about the cultural resources studies and potential impacts to these resources.

Savannah District conducted a media day and created brochures during studies of the CSS *Georgia*. A local television station ran a series of stories on the progress of the investigations, and one former reporter is creating a documentary about the vessel. District archaeologists made presentations to a large number of groups. Among them were the Society for Georgia Archaeology, local chapters of the Sons of Confederate Veterans and the United Daughters of the Confederacy, the Coastal Georgia Archaeological Society, an honors sorority, and other groups.

The 1998 draft environmental impact statement elicited 1,588 responses from individuals supporting archaeological recovery of the CSS *Georgia* and stabilization of Fort James Jackson (since completed).

5.12.9 Summary

With implementation of the Programmatic Agreement and the surveys and investigations described in the previous paragraphs, the Savannah Harbor Expansion Project would be in compliance with Section 106 of the National Historic Preservation Act, and no unacceptable adverse impacts to historic properties would occur.

5.13 Coastal Zone Management Consistency

The Corps performed an analysis of the proposed project with respect to resources under the purview of Georgia and South Carolina's programs concerning Coastal Zone Management Consistency. The analysis of Coastal Zone Management Consistency for Georgia and South Carolina can be found in Appendix I and Appendix J of the EIS, respectively. These Federal Consistency Determinations found that construction of the SHEP in conjunction with implementation of the various mitigation features was fully consistent with the Coastal Zone Management Programs of both states. The Federal Consistency Determinations were provided to each State for review during the comment period on the DEIS.

The Coastal Resources Division of the Georgia Department of Natural Resources submitted the results of their review of the Georgia Coastal Zone Management Consistency Determination by letter of January 25, 2011. The CRD of the GADNR found that in general, the proposal to deepen the Savannah Harbor is consistent with the enforceable policies of the Georgia Coastal

Zone Management Program. The CRD of the GADNR did express the following concerns/requests concerning the SHEP:

A. The CRD of the Georgia DNR supported the City of Tybee Island's concern that the new work material to be placed in the nearshore dredged material placement sites was not of beach quality and therefore unsuitable for placement in State waters. The Corps responded to this concern by eliminating the placement of new work dredged material into the nearshore sites off Tybee Island from the proposed project.

B. The CRD of the Georgia DNR expressed concern over the proposal to place dredged material into Sites 11 and 12 because of potential long-term impacts to marine habitat and commercial and recreational offshore fishing. The Corps responded to this concern by removing dredged material placement sites 11 and 12 from project plans.

C. The Georgia DNR-CRD also requested that material from the area of the entrance channel (Station -57+000B to Station -98+600B be considered for nearshore placement or beach nourishment. While this material would be suitable for beach nourishment, such placement would require cost sharing. The Corps must use the least cost environmentally acceptable method of disposal. In this case, placement of the sediments from the entrance channel extension into the Savannah Harbor ODMDS is the least costly environmentally acceptable alternative. Placement of that sediment into nearshore areas or directly onto Tybee Beach would require a local sponsor to incur the extra costs of placing the material into those areas.

D. The Georgia DNR-CRD also requested that future maintenance dredging material from Stations -30+000B to -40+000B and Stations 28+000 to 0+000 be used for beach nourishment. These sediments would be placed in the ODMDS and the existing CDFs respectively using the least cost, environmentally acceptable method of disposal. Consequently, use of these maintenance sediments for beach nourishment would require a local sponsor who would be willing to pay the extra costs required to place the material on the beach.

The SC DHEC-OCRM provided the results of their initial review of the South Carolina Coastal Zone Management Consistency Determination by letter of January 25, 2011. The SC DHEC-OCRM did not concur that the SHEP was consistent with the South Carolina Coastal Management Plan (SCCMP). A summary of their concerns is as follows:

A. The project as proposed will not restore or enhance resources of the state but will result in a degradation of coastal resources.

B. The project as proposed will reduce dissolved oxygen, and depends on mechanical means in attempt to maintain current levels. This causes a net loss of degraded fisheries habitat.

C. The proposed dredging to deepen the Savannah Harbor as set forth in the National Economic Development (NED) Plan, 47-foot Depth Alternative, and the Locally Preferred (LP) Plan, 48-foot Depth Alternative, will reduce the dissolved oxygen levels in the Savannah River from the existing state in an area utilized for spawning of important fishery species including Striped bass and Shortnose sturgeon (SNS). Stocking of fingerlings does not eliminate impacts to spawning and nursery areas for the Striped Bass, and the construction of a fishway does not assure the Shortnose Sturgeon will be able to use it. In the event low DO (Dissolved Oxygen) levels fall below current concentrations, as predicted in the EIS, the lower part of the river may not be passable by adult or juvenile sturgeon.

D. Models described in the EIS indicate impacts to large areas of freshwater marshlands including important habitat for fish, wading birds, and waterfowl. Mitigation for this impact is to preserve additional wetlands adjacent to the Savannah National Wildlife Refuge. Preservation does not replace the lost values and functions of the impaired freshwater marsh.

E. The project will result in a very large volume of spoils that will use significant areas within the existing spoils disposal sites, located mostly in Jasper County, resulting in a shorter life of the CDF. This may result in the need for additional wetland impacts for expansion of the CDF in Jasper County. The proposed disposal of spoils in the CDFs 14A/B will potentially eliminate the possibility of a new port in Jasper County.

F. The extent and significance of negative impacts on Geographic Areas of Concern (GAPCs). The proposed project will impact habitat for the federally endangered Shortnose sturgeon. Endangered species habitat is considered GAPC in the SCCMP. There is no certainty the sturgeon will use the proposed fishway at the New Savannah Bluff Lock and Dam or that it will have any effect on spawning or survival of this species.

G. Mitigation for impacts to Striped bass and Shortnose sturgeon is dependent on mechanical means (oxygen injection and release of fingerlings) that has not been adequately demonstrated to reduce or eliminate the impacts to water quality and fish survival.

H. The measures proposed to mitigate for the predicted increase in salinity are to close Rifle Cut and Little Back River. These alterations would result in a loss of navigable waters by the public in these two water bodies.

I. SC DHEC-OCRM policies require a demonstration of no feasible alternatives. The Federal Consistency Determination does not sufficiently demonstrate that there are no feasible alternatives.

The Corps met with SC DHEC staff and provided additional information to address their concerns. As a result of these meetings and the additional information the Corps provided, SC DHEC determined that the SHEP will comply with South Carolina water quality standards and is fully consistent with enforceable provisions of the SC CMP. The SC DHEC-OCRM removed their objection to the Corps' finding of Consistency for the SHEP. The approvals for both the South Carolina Water Quality Certification and Coastal Zone Consistency Determination are included in Appendix Z. These approvals include the following conditions:

A. The Record of Decision (ROD) will expressly recognize a binding commitment to install, operate, and maintain the DO system in accordance with the project mitigation plan, subject to Congressional appropriation of funds for the project. The Corps will make the DO system a top priority for annual operation and maintenance (O&M) funds appropriated and received for the project, above normal maintenance requirements.

B. The Corps shall comply with all terms and conditions in the National Marine Fisheries Service Final Biological Opinion.

C. To ensure protection of cultural resources, the SC DHEC must receive an executed Programmatic Agreement for Cultural Resources signed by the COE and the South Carolina Historic Preservation Office.

D. To ensure that levels of environmental effects predicted in the EIS are not exceeded, COE will comply with the Monitoring and Adaptive Management Plan provided as Appendix D of the EIS. The Monitoring and Adaptive Management Plan will ensure the accuracy of the predicted environmental impacts, assess the effectiveness of the mitigation features, and provided for modification of the Project as needed.

5.14 Essential Fish Habitat

The Corps evaluated the project impacts on Essential Fish Habitat. The Corps believes that with the mitigation and monitoring plans in place, the proposed action is not expected to cause adverse impacts to Essential Fish Habitat or EFH species (see Section 5.07, above), including fish accessibility to habitat. Impacts are expected to be minor on an individual project and cumulative effects basis. The Essential Fish Habitat analysis is found in Appendix S of the EIS. The NMFS reviewed the SHEP EFH analysis and provided comments. The comments of the NMFS on the SHEP EFH evaluation and the Corps' responses are also included in Appendix S. The Corps intends to implement the EFH recommendations as outlined in the responses to comments contained in Appendix S.

5.15 Cumulative Impacts of the Proposed Action

The Corps performed a cumulative impacts analysis of the impacts of existing, proposed and potential projects in the Savannah area to place in better perspective the expected impacts from the Savannah Harbor Expansion Project. The cumulative impacts analysis is found in Appendix L of the EIS. A brief summary of the findings of this cumulative impact analysis is as follows:

The scoping process for the cumulative impact analysis resulted in the identification of six major resources or issues of concern in the Savannah Harbor estuary that should be evaluated in this analysis. These six resources were wetlands, fisheries, dissolved oxygen, groundwater, endangered species, and Tybee Island and the nearshore area. For each issue or resource, the cumulative impact analysis included a discussion of geographic scope, historical basis (baseline condition), past actions/stresses, present condition, present actions/stresses, capacity to withstand stress, future actions/stresses, incremental impacts, and alternatives to avoid, minimize, or mitigate cumulative effects.

The **first** major concern addressed in the SHEP cumulative impact assessment was wetlands. The wetlands analysis was divided into three parts: (1) the impounded wetlands in the Savannah National Wildlife Refuge, (2) tidal freshwater marsh, and (3) other wetland communities (brackish, salt marsh) in the Savannah Harbor estuary.

The SNWR manages about 5,700 acres of diked impoundments for waterfowl. These impoundments include about 3,000 acres of freshwater pools which include both draw down pools and permanently flooded pools. Freshwater (salinity of 0.5 ppt or less) is obtained from Lucknow Canal just off Little Back River and passed through a freshwater control system to the SNWR impoundments as well as several adjacent landowners.

The SNWR commenced operations in 1927 when the authorized depth of the Savannah Harbor Navigation Channel was 26 feet MLW. Since that time, four harbor deepening projects have occurred (1937, 1958, 1975 and 1994) which have increased the authorized depth of the project to 42 feet MLW. Additionally, the Tidegate and Sediment Basin Project was completed in 1977 which concentrated much of the sediment from the navigation channel in the Sediment Basin where it could be easily dredged and deposited into adjacent disposal areas. All of these improvements caused an upstream movement of saltwater. During the Planning stages of the Tidegate and Sediment Basin Project, it became apparent that construction of the project would increase upstream salinity levels to the point that the SNWR would not have a dependable source of freshwater. Consequently, the project included construction of a freshwater control system for the SNWR which is in use today. The authorized freshwater control system was not fully constructed, and salinity levels in the vicinity of the SNWR were higher than originally expected. The Tidegate was taken out of operation in March 1991 to reduce salinity levels in Back River and Little Back River near the SNWR. Recently, the Corps completed a major rehabilitation of the freshwater control structures located on the SNWR.

Future stresses that could affect the ability of the SNWR to obtain freshwater from the intake on Little Back River include construction of the SHEP, other harbor development projects, and sea level rise. Model studies conducted during the SHEP GRR/EIS indicate that all of the deepening alternatives evaluated would increase salinity levels in the vicinity of the intake at the SNWR without some form of mitigation. Consequently, all of the deepening alternatives evaluated during the SHEP contain flow diversion features which would increase the amount of freshwater coming down Little Back River and decrease the amount of saltwater coming up Back River. Implementation of these flow diversion measures would allow the SNWR continued access to freshwater in Little Back River.

The only other potential future harbor development project in Savannah Harbor is a proposed Jasper County Marine Terminal. Conceptual plans for this project indicate that it would be a container facility sited in what is now CDFs 14A and 14B in Savannah Harbor at about River Mile 6. If the SHEP is constructed, the deepened entrance channel and inner harbor channel would serve the needs of a Jasper facility. If the SHEP is not constructed, the developers would be required to deepen the entrance channel and inner harbor channel to the facility at River Mile 6. Deepening the inner harbor channel to River Mile 6 (compared to the SHEP which would deepen the inner harbor channel to Mile 18.6) would be expected to have only a minimal effect on the movement of saltwater to upstream areas. Consequently, construction of a Jasper County

Marine Terminal would not be expected to have adverse effects on the SNWR with respected to increased salinity levels.

Sea level rise will also cause salt water to move farther upstream and increase salinity levels in the SNWR. Model studies (assuming a 50 cm rise in sea level and average flows over 50 years) indicate that salinity levels at the SNWR intake will increase from 0.14 ppt to 0.45 ppt (10% exceedance).

The second wetland issue evaluated concerns the remaining tidal freshwater marsh located in the Savannah Harbor estuary. Freshwater tidal marsh is considered very valuable from a fish and wildlife production standpoint, and it is much rarer in the Savannah Harbor estuary when compared to saltmarsh and brackish marsh. The US Fish and Wildlife Service estimates that about 12,000 acres of tidal freshwater marsh were present in the Savannah Harbor estuary in 1854. Based on other map surveys and reports, the amount of tidal freshwater in the Savannah Harbor estuary appears to have dwindled to about 8,000 acres in 1940, and about 6,000 acres in 1974. Model studies conducted during the SHEP indicate that about 4,072 acres of tidal freshwater marsh remain in the estuary between the I-95 crossing of the Savannah River and the mouth of Back River. Most of the remaining tidal freshwater marsh is located between the I-95 crossing and the Highway 25 crossing (near the upstream limit of the Savannah Harbor Navigation Project) in the vicinity of the SNWR. The reduction of tidal freshwater marsh in the Savannah Harbor estuary can be traced to numerous factors including conversion of wetlands to rice fields, industrial and commercial development, conversion of wetland areas to dredged material disposal sites, sea level rise, and harbor deepening. While deepening the navigation channel does not destroy marsh, the resulting increase in the upstream movement of saltwater causes tidal freshwater marsh to give way to more salt tolerant types of wetland vegetation.

Future stresses that could impact the tidal freshwater marsh in the Savannah Harbor estuary include construction of the SHEP, other future harbor development projects, prolonged droughts, and sea level rise.

Model studies conducted during the SHEP revealed that all channel deepening alternatives would impact tidal freshwater marsh in the estuary due to an increase in upstream salinity levels. The flow diversion plan included in SHEP would greatly reduce this impact. However, there would still be some impacts to tidal freshwater marsh for the 45, 46, 47 and 48-foot projects ranging from 32 to 337 acres. An evaluation of the estuary revealed that there are no opportunities to restore areas or reestablish tidal freshwater marsh to mitigate for the loss of tidal freshwater marsh. Consequently, the remaining mitigation for the impacts to tidal freshwater marsh would involve the purchase and preservation of lands in the estuary that are ecologically valuable and of value to the SNWR. These lands would be purchased and given to the USFWS to be managed in perpetuity.

As previously discussed, the only other known potential future harbor development in Savannah Harbor is a proposed Jasper Terminal which would be located around River Mile 6. Development of this facility would be expected to have only a minimal effect on upstream salinity levels. Thus, construction of this facility would not directly adversely affect tidal freshwater marsh in the estuary. The landside infrastructure needed to support the facility could result in the loss of some tidal freshwater marsh.

Prolonged droughts can also greatly impact the amount of tidal freshwater marsh in the estuary. Saltwater is able to move farther up river as the amount of freshwater entering the estuary is reduced. The result is that tidal freshwater marsh can be replaced by more salt tolerant species of plants. Over time, sea level rise will produce the same effects, as saltwater moves further into the estuary.

The third wetland issue evaluated concerns the remaining wetlands in the Savannah Harbor estuary, i.e., brackish marsh and salt marsh. Most of the brackish marsh in the estuary is located between the Highway 25 crossing (mile 21.5) and River Mile 17.0. Salt marshes are generally found downstream of River Mile 17. Most of the past impacts to these wetland types can be attributed to industrial development and use of these areas for the deposition of dredged material. Large expanses of wetlands along the banks (especially on the north side) have been diked and filled with dredged material. Loss of brackish marsh and salt marsh has been somewhat offset by conversion of freshwater marsh to brackish and salt plant species because of the upstream movement of saltwater. Estimates of salt marsh and brackish marsh in the Savannah harbor estuary developed for EPA for the Total Maximum Daily Load for Dissolved Oxygen in Savannah Harbor indicate there are about 5,903 acres of brackish marsh and approximately 23,510 acres of salt marsh in the estuary.

Future stresses that could impact the remaining salt and brackish marsh in Savannah Harbor include construction of the SHEP and other harbor development activities.

Construction of the SHEP would result in the loss of about 15.68 acres of brackish marsh. Approximately 3.0 acres of brackish marsh would be lost where excavation is required to expand the Kings Island Turning Basin, approximately 8.48 acres of brackish marsh would be excavated as a result of removal of the Tidegate Structure end walls and an additional 4.2 acres of brackish marsh would be removed due to other project excavation requirements. In keeping with the Corps' no net loss of function policy regarding wetlands, the SHEP provides in-kind mitigation for these wetland losses. The project provides for a 40.3 acre wetland restoration site in Disposal Area 1S located at about River Mile 20 which would provide more wetland compensation than is required.

Other development activities in Savannah Harbor could also adversely affect wetlands.
A proposed Jasper Marine Terminal could be sited in what is now CDFs 14A and 14B, which are used for the disposal of dredged material from the Savannah Harbor Project. Based on recent conceptual plans for this facility, approximately 7.5 miles of rail infrastructure (to connect with the existing rail line) and 5.7 miles of new roadway to connect the facility to US Highway 17 would be required. Much of the area to be crossed by the new rail line and roadway is wetlands. The roadway and rail improvements would require a Section 10 and Section 404 Permit from the Charleston District Corps of Engineers Regulatory Branch.

If a Jasper County Marine Terminal is constructed in CDFs 14A (728 acres) and 14B (725 acres), the loss of sediment disposal capacity would have to be mitigated before the Federal

Government would release its dredged material disposal easements in these two areas. This could result in additional impacts to wetlands if replacement of this capacity involves construction of new disposal areas in wetlands. In view of wetland protection laws and wetland mitigation requirements, this avenue would be difficult. Construction of the landside infrastructure to support a Jasper County Marine Terminal could result in a substantial direct loss of salt and brackish marsh.

The **second** major concern addressed in the SHEP cumulative impact analysis concerned fisheries. More specifically, the Striped bass, American shad, and Southern flounder were selected as the primary species of concern.

A Striped bass sports fishery is located in the lower Savannah River. Studies in the early 1960s and 1970's indicated that the primary spawning area for Striped bass in the Savannah River system was the tidal freshwater zone located in Little Back River adjacent to the SNWR. Studies indicate that production of Striped bass eggs declined by about 95% between 1977 when the Tidegate and Sediment Basin Project became operational and 1989. Large population declines were observed in other estuaries along the east coast during that same time period. Operation of the Tidegate and Sediment Basin Project increased salinity levels in Striped bass spawning grounds and altered current velocities and pathways of water movement in the middle and lower estuary. Essentially most eggs spawned in the Savannah River estuary were transported downstream beyond Hutchinson Island into areas with toxic salinity levels within 30 to 48 hours of being spawned. Striped bass eggs hatch within 40 to 60 hours and thus larvae were exposed to toxic salinity levels before they became strong enough to swim out of the area.

The Tidegate was taken out of operation in 1991, which lowered salinity levels in traditional Striped bass spawning grounds. The Georgia DNR-WRD conducted a stocking program in the lower Savannah River from 1989-2002. Studies indicate that successful Striped bass reproduction has occurred and both GA DNR and SC DNR have reopened the recreational fishery in the estuary for Striped bass.

Populations of American shad have been severely stressed. Although many factors can be attributed to the decline of American Shad numbers, loss of traditional upriver spawning grounds and overfishing are probably the most contributing reasons. The NMFS has taken steps to reduce the fishing pressure on this species to allow populations to recover.

Populations of Southern flounder have experienced stress due to overfishing. Steps have been taken to reduce fishing pressure on the Southern flounder in some of the Atlantic coastal states which has helped the population of this species to recover.

Future harbor development projects such as the SHEP and a Jasper County Marine Terminal could have adverse impacts on fish habitat in Savannah Harbor.

Studies conducted during the SHEP indicate that the project would not affect Southern flounder and would have a negligible impact on American shad. Model studies conducted during the SHEP indicate that the project would adversely impact Striped Bass spawning, egg, and larvae habitat. Most of this impact can be attributed to an increase in salinity and a decrease in dissolved oxygen levels that would result from the SHEP. Construction of the flow diversion measures and injection of oxygen would significantly reduce the magnitude of these impacts. However, there would still be a loss of Striped bass spawning habitat (2.9% or 30 acres), egg habitat (9.4% or 157 acres) and larvae habitat (5.6% or 32 acres) associated with the 44-foot project compared to 16.1% or 167 acres, 10.8% or 181 acres and 3.5% or 20 acres for the 48-foot project, respectively. The Fisheries Interagency Coordination Team felt that these residual impacts warranted mitigation. Consequently, the SHEP mitigation plan provides for annual funding to the Georgia DNR-WRD to stock Striped bass fingerlings in the lower Savannah River to help maintain this sports fishery.

As previously discussed, construction of a Jasper County Marine Terminal would likely have very little effect on upstream salinity levels. Consequently, construction of such a facility would not be expected to have any major impacts on upstream fish habitat. Construction of a Jasper facility could adversely affect fish habitat due to marsh impacts that might occur due to rail and road infrastructure requirements.

The **third** major concern addressed in the SHEP cumulative impact assessment was the dissolved oxygen regime in Savannah Harbor. The specific area of concern is that portion of the Savannah River between the Seaboard Coastline Railroad Bridge (Mile 27.4) and Fort Pulaski (Mile 0.0). Although water quality in the Savannah Harbor is generally good, low levels of dissolved oxygen are experienced in the summer months. Over time, the degradation of the dissolved oxygen regime in Savannah Harbor can be attributed to numerous factors including point source discharges from both industrial and municipal sources, non-point runoff, natural loading from adjacent marshes, and harbor deepening. This segment of the river failed to meet the dissolved oxygen criterion established by Georgia for a Coastal Fishing water use designation based on data collected during the summers of 1997 and 1999. Consequently, this section of the river is on the State of Georgia Section 303(d) list of impaired waters.

Future stresses that could impact dissolved oxygen levels in the harbor include construction of the SHEP, construction of a proposed Jasper County Marine Terminal and continued discharges of industrial and municipal wastewater and pollution from non-point sources.

As stated above, past harbor deepening has contributed to the low dissolved oxygen levels in Savannah Harbor. Studies conducted during the SHEP indicate that harbor deepening would adversely impact the dissolved oxygen regime in Savannah Harbor if not mitigated. Consequently, the SHEP mitigation plan includes installation and operation of an oxygen injection system in three locations to supplement dissolved oxygen levels during the summer months. Studies indicate that this system would eliminate the incremental effects of the SHEP on the dissolved oxygen regime in Savannah Harbor.

Construction of a proposed Jasper County Marine Terminal would require deepening of the inner harbor channel to about River Mile 6. Deepening of the inner harbor channel to River Mile 6 would be expected to have only minimal impacts on the dissolved oxygen regime in Savannah Harbor.

In 2010, the US EPA published a Draft Revised Total Maximum Daily Load (TDML) for dissolved oxygen in Savannah Harbor from River Mile 0.0 to Mile 27.4. The Draft TMDL is established to implement the applicable water quality standards which include the newly adopted Georgia dissolved oxygen criteria and the existing South Carolina dissolved oxygen criteria for Savannah Harbor. Implementation of this dissolved oxygen TMDL will improve water quality conditions in Savannah Harbor. The revised draft TMDL requires a reduction in loading from about 600,000 lbs/day Ultimate Oxygen Demand to about 130,000 lbs/day.

The **fourth** issue of importance addressed in the SHEP is the potential impacts of the project on groundwater resources. More specifically, it is the potential for the project to impact the principal drinking water aquifer in the coastal area -- the Upper Floridan aquifer. Since the 1800s, increasing withdrawals of water from the Upper Floridan aquifer to support development in the coastal region has caused a cone of depression to form in the Savannah area and lowered the water level in the aquifer to as much as 100 feet below sea level. The long-term pumping of the Upper Floridan aquifer in the Savannah area and surrounding coastal areas has lowered groundwater levels and reversed the seaward hydraulic gradient that existed before development. Consequently, lateral encroachment is observed as the westward movement of the freshwater/saltwater interface toward the center of pumping (Savannah). Sustained pumping in the Savannah area has also resulted in a downward hydraulic gradient and induced significant head differences between the surficial aquifer and the confined Upper Floridan aquifer. This effect has resulted in the downward intrusion of water through the Miocene (protective layer over the aquifer) into the aquifer.

Future stresses to the upper Floridan aquifer center around the continued pumping of groundwater from aquifer to supply both drinking and industrial water use needs. In response to this concern, the Georgia DNR-EPD will not issue any new withdrawal permits for the upper Floridan aquifer in Chatham County as well as the southern portions of Bryan and Effingham Counties. The Georgia DNR-EPD has also reduced the total permitted volumes from pumping in Chatham County from the upper Floridan aquifer by 10 MGD.

Concerns were expressed during the SHEP studies regarding potential impacts on groundwater that could result from the dredging which would remove some of the protective layer (Miocene) of the Upper Floridan aquifer. This could enhance the movement of water through the Miocene. Since most of the water in the navigation channel is saltwater, this could increase chloride levels in the aquifer.

Several studies were conducted during SHEP to address these concerns. Construction of the current Savannah Harbor Navigation Channel has removed about 5 feet of the confining layer (Miocene) in some reaches of the channel. However, GIS analysis of confining material through time and groundwater model studies indicate that historical dredging has probably had minimal influence on the rate of saltwater intrusion. Three-dimensional model runs indicate that the expected increase in the downward flow of saline water from the area underlying the navigation channel due to deepening would be very minimal.

Information developed during the groundwater studies for the SHEP can be extrapolated and applied to construction of a proposed Jasper County Marine Terminal. Construction of this facility (provided the scope of channel deepening is not increased) would not result in a significant increase in the movement of saltwater through the confining layer into the aquifer.

The **fifth** area of concern evaluated in the SHEP cumulative impact analysis was endangered species. More specifically, the Shortnose sturgeon was determined to be the primary species of concern in the Savannah Harbor estuary for the SHEP.

There are no estimates of the historic population size of Shortnose sturgeon from a national perspective. Likewise, the present population of Shortnose sturgeon in the Savannah River is unknown. Approximately 97,000 Shortnose sturgeon (19 % tagged) of various sizes were stocked in the Savannah River between 1984 and 1992 to evaluate the potential for Shortnose sturgeon stock enhancement. Subsequent surveys showed little evidence of reproduction. The 1999 population in the Savannah River was estimated at 3,000 fish. The fish are readily found by resource agencies when sampling is specifically targeted for them. Although the Savannah River Shortnose sturgeon population is considered to be improving since this species was placed on the endangered species list in 1967, the apparent low level of recruitment remains a concern.

The decline in Shortnose sturgeon populations can be attributed to a number of factors. Construction of mainstream dams on the Savannah River blocked access to traditional spawning grounds in shoal areas above Augusta, Georgia. Over-fishing, starting in colonial times and continuing into the 1950s also contributed to population declines of this species. Although the Shortnose sturgeon was rarely a targeted fishery, many were taken as a by-product of other fisheries such as the Atlantic surgeon and the American shad. Other factors influencing Shortnose sturgeon populations in the Savannah River include discharges of contaminants, thermal pollution and impingement on cooling water intake screens, etc.

The construction and maintenance of the Savannah Harbor Navigation Project has also impacted Shortnose sturgeon adult and juvenile habitat. The project has not affected Shortnose sturgeon spawning habitat, since their spawning habitat is located well upstream. Deepening of the Savannah Harbor Navigation Project has impacted adult and juvenile habitat because of impacts to dissolved oxygen and salinity levels. Adult Shortnose sturgeon can still be found throughout the estuary from River Mile 3.4 to 30.4. Juvenile Shortnose sturgeon are found in the upper parts of the estuary from about Mile 18.8 to Mile 29.5. From an endangered species standpoint, no critical Shortnose sturgeon habitat has been designated in the Savannah River.

Future stresses to the Shortnose sturgeon in the Savannah River center around the lack of access to traditional spawning grounds and construction of the SHEP. Studies conducted during the SHEP indicate that the project would adversely affect adult and juvenile Shortnose sturgeon winter habitat. Most of these adverse impacts center around an increase in upstream salinity levels and a decrease in dissolved oxygen levels that would result from implementation of the SHEP. Consequently, the SHEP mitigation plan includes flow diversion measures to reduce salinity levels and the injection of oxygen to increase dissolved oxygen levels. However, impacts to Shortnose sturgeon habitat would still occur for most of the channel depths evaluated even with implementation of these mitigation measures. For the 47-foot channel, approximately 6.9% (-266 acres) of Shortnose sturgeon adult winter habitat and about 7.6% (-251.0 acres) of Shortnose sturgeon juvenile winter habitat would still be impacted with the mitigation features in place. Shortnose sturgeon adult summer habitat is expected to increase about 6.5% (+89 acres) due to the effects of oxygen injection.

Investigations revealed that there are no further measures that could be implemented in the lower Savannah River to offset the remaining effects of the SHEP on the Shortnose sturgeon. Loss of access to traditional spawning grounds in the Savannah River is one of the primary factors that has contributed to the population decline of the Shortnose sturgeon. Consequently, the remaining mitigation for the impacts of the SHEP on the Shortnose sturgeon consists of the construction of a fishway at the New Savannah Bluff Lock and Dam. The preferred design is an off-channel rock ramp. Construction of this fishway would provide Shortnose sturgeon the opportunity to move upstream around the dam thereby providing this species access to an additional 20 miles of potential spawning and foraging habitat.

Construction of the off-channel rock ramp at New Savannah Bluff Lock and Dam (NSBL&D) could provide additional benefits for Shortnose sturgeon access to traditional spawning grounds. Measures are in place to provide fish passage at two small dams above NSBL&D which are the Augusta Diversion Dam and Stevens Creek Dam. However, there is no need to implement fish passage measures at these two upstream dams unless fish passage is first provided at NSBL&D. If fish passage structures are provided at all three facilities, Shortnose sturgeon and other species of anadromous fish would have access to an additional 35 miles of potential spawning and foraging habitat in the Savannah River.

The **sixth** major concern addressed in the SHEP cumulative impact analysis is the Tybee Island Beach as well as the Tybee Shelf. The Tybee Shelf is part of a large ebb-shoal complex associated with the Savannah River inlet. Ebb shoals form as a balance of sediment that is jetted out of an inlet by offshore (ebb) currents and sediment that is returned to the inlet by onshore (flood currents) and waves. These ebb shoals are the pathway for sediment to travel around an inlet to the down-drift beach (Tybee Island).

The Corps conducted a study in 2007 to determine if the Savannah Harbor Navigation Project (mainly construction and maintenance of the entrance channel) is adversely affecting or has adversely affected the shores of Tybee Island. Based on the findings in the report, construction and maintenance of the Savannah Harbor entrance channel (including the two large jetties at the entrance) causes deflation of the Tybee Shelf, and the entrance channel serves as nearly a complete sink for any sediment moving from north to south along the shelf. The result is erosion on the north end of Tybee Island. Although some of these effects can be attributed to natural coastal processes, about 78.5% can be attributed to construction and maintenance of the entrance channel and the two large jetties at the mouth of the river.

In view of these findings, concerns were expressed that construction of the SHEP could exacerbate these effects and increase the erosion problem on the north end of Tybee Island. Additional studies were conducted which concluded that construction of the SHEP would have little impact on the shoreline of Tybee Island, the deepening would not change the overall pattern of sediment transport in the region, and the channel deepening would have negligible effect on the Tybee Shelf.

Based on the expected SHEP impacts and implementation of the project's mitigation plan, and the analysis contained in Appendix L, significant cumulative adverse impacts are not expected from the incremental impact of the SHEP when considered together with other past, present, and reasonably foreseeable future projects in the area.

5.16 Aesthetic and Recreational

The proposed action would not adversely impact any existing aesthetic values in the project area. Rifle Cut would be closed as one of the flow-altering measures in the mitigation plans. That feature would reduce salinity movement from Middle River to Back River. The cut is used by fishermen to pass between those two rivers. The amount of such use is unknown. With this blocked passageway, recreational boating access to Back River would be more difficult with implementation of the proposed depth alternatives.

The oxygen injection systems would be constructed at least 100 feet from the shoreline behind vegetation to screen their view from the river. Narrow openings would occur through the vegetation for pipe and maintenance access.

5.17 Recreational and Commercial Fishing

As indicated within Section 3.08, about 10.6 MCY of sediment excavated to deepen the ocean bar channel would be placed within the Savannah Harbor ODMDS. This would not interfere with recreational or commercial fishing operations.

A boat ramp would be constructed on Hutchinson Island to mitigate for the closing of Rifle Cut. Concrete rubble from the Tidegate would be deposited in intertidal areas along the estuarine riverbanks to produce fish habitat.

No significant adverse impacts to either recreational or commercial fishing are anticipated by the proposed action.

5.18 Socio-economic Resources

The harbor deepening project is expected to reduce the cost of shipping containerized goods through the port. This is described in detail in the GRR-Economic Appendix. This should enhance the competitiveness of the businesses that transport goods through the port in that manner.

Most of the high ground areas bordering the Savannah Harbor are being used or are zoned to be used for port-related industry or as dredged sediment placement areas. The proposed action does not involve an upstream expansion of the harbor. No conflicts with existing land use plans are anticipated. SC DHEC-OCRM does not presently have a Special Area Management Plan for the Savannah River, Savannah Harbor, or Jasper County.

No adverse effects on employment, tax, and property value are expected from implementation of the proposed harbor deepening. Some temporary jobs may be available during construction.

5.19 Protection of Children and Environmental Justice

Executive Order 12898 addresses Environmental Justice in minority and low-income populations. Federal agencies are "to the greatest extent practicable and permitted by law" identify and address "as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States."

Executive Order 13045 requires the Protection of Children from environmental health risks and safety risks. It states that the Federal government would review the effects of its proposed actions on children, because they may suffer disproportionately from environmental health risks and safety risks. Federal agencies are to "identify and assess environmental health risks and safety risks that may disproportionately affect children;" and "ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."

5.19.1 Overview

The Corps collected and analyzed information concerning the potential impact on minority populations, low-income populations, and children from the proposed Savannah Harbor Expansion Project, including demographics, proposed road improvements, and potential impacts on air quality, traffic, noise, and lighting. The information and analyses presented below demonstrate that the proposed action complies with Executive Orders 12989 and 13045 and would not cause disproportionately high and adverse impacts on minority populations, low-income populations, or children. Approval and construction of harbor deepening may benefit the environmental justice population because the project would sustain and may increase employment opportunities for minority and low-income populations in Garden City, metro-Savannah, and Jasper County.

Throughout the extensive public involvement process that began in 1999 until the release of the DEIS, representatives of the environmental justice population have not expressed concerns about the project. The project has held over 70 public meetings including meetings of the Stakeholders Evaluation Group, plus numerous committee meetings and Interim meetings. Three of those full meetings were held in Garden City within an area of concern for environmental justice issues – two meetings at the Masters Inn and one at the GPA Annex 1 located on Highway 25. Two public workshops were held at the beginning of the project (NEPA scoping) to identify issues that the public believed would be important during the course of the study. No one identified impacts to environmental justice communities or children as issues of concern. Upon release of the DEIS, several respondents, including the Keck School of Medicine and Citizens for Environmental Justice, submitted comment letters stating that the project would disproportionately impact Environmental Justice communities near Savannah Harbor. The Corps disagrees and detailed responses to their comments are included in Appendix A.

5.19.2 Demographics of Chatham County and Jasper County

The proposed project is located in Chatham County, Georgia and Jasper County, South Carolina. The City of Savannah is the largest community within Chatham County. According to US Bureau of Census 2006-2008 American Community Survey Estimates, the County has an estimated population of approximately 256,000. Minorities comprise approximately 45% of the population, most of whom are African Americans (40% of the County's population). Garden City -- where extensive existing shipping facilities are expanding to meet demand -- had a total population of approximately 11,400, of which approximately 53% were minorities (45% are African American). Port Wentworth (located northwest of the Garden City Terminal) had a population of 3,276, of which about 18% were minorities. The median household income was $45,000 for Chatham County residents, $33,000 for Garden City residents, and $51,000 for Port Wentworth residents. More than 80% of Garden City residents earned less than $75,000 per year. Section 4.13 provides additional economic information.

Hardeeville is the largest community in Jasper County. According to US Bureau of Census 2009 American Community Survey Estimates, the County has an estimated population of approximately 23,221. Minorities comprise approximately 48.4% of the population, most of whom are African Americans (46.6% of the County's population). In 2000, Hardeeville had a total population of 1,793, of which approximately 54.21% were minorities (40.83% were African American). Ridgeland, the County seat, had a population of 2,518, of which about 55.36% were minorities (49.17% are African American). The median household income was $39,000 for Jasper County residents, $29,000 for Hardeeville residents, and $28,000 for Ridgeland residents.

Any individual with total income less than an amount deemed to be sufficient to purchase basic needs of food, shelter, clothing, and other essential goods and services is classified as poor. The amount of income necessary to purchase these basic needs is the poverty line or threshold and is set by the Office of Management and Budget (US Census 2010). The 2010 poverty line for an individual under 65 years of age is $11,344. The poverty line for a three-person family with one child and two adults is $15,030. For a family with two adults and two children the poverty line is $22,491 (US Census 2010). A population density map for Chatham and Jasper Counties is shown in the figure below.

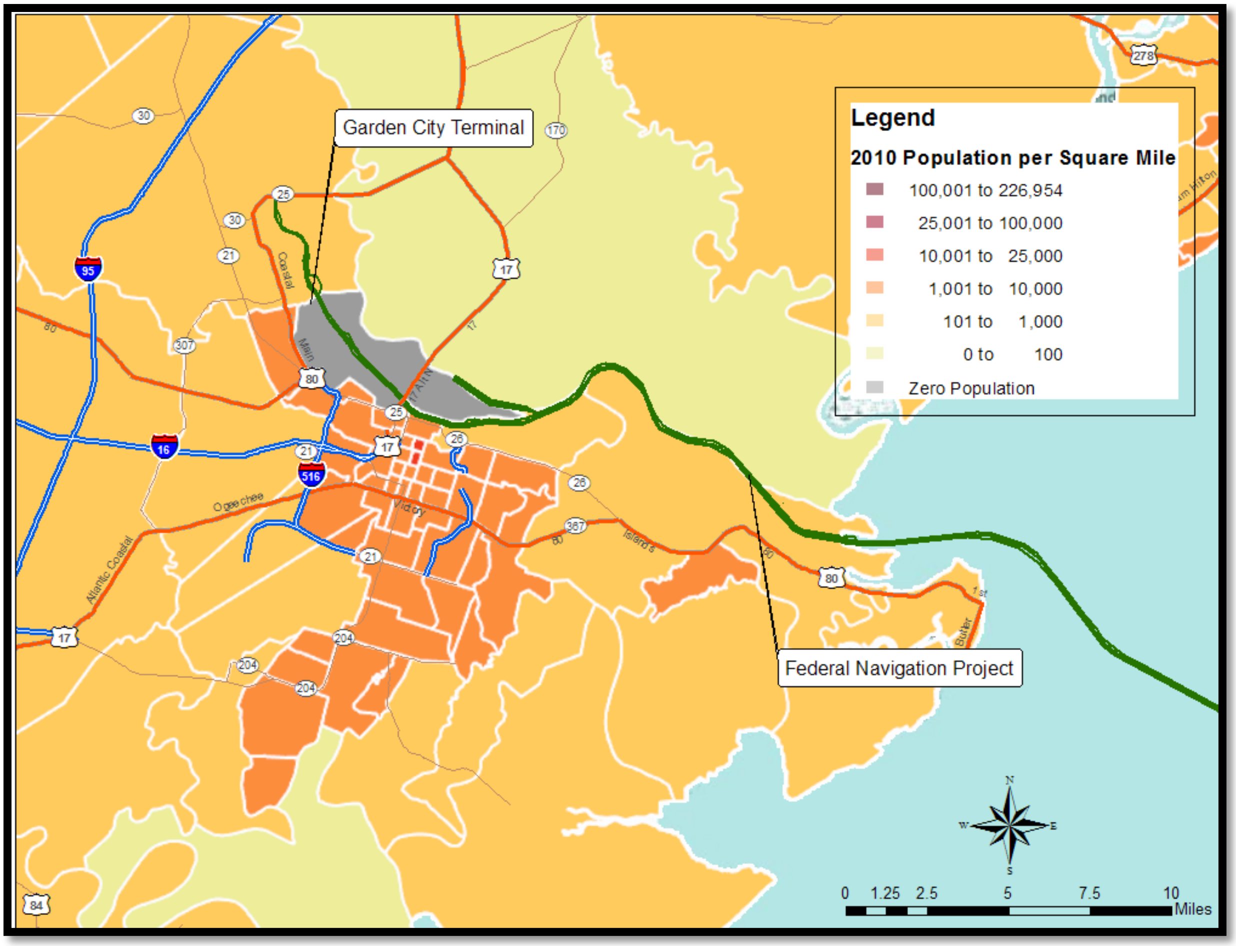

Figure 5-56. Population density map for Chatham County, GA and Jasper County, SC.

The following two figures show the location of various poverty levels within the vicinity of the upper end of the harbor, where the Garden City Terminal is located and most of the effects of the existing container terminal are experienced. The first figure shows that the closest area with the highest poverty level (40-100 percent) is located roughly a mile from the terminal. Similarly, the second figure shows the same area as being the closest one with the highest category of minorities (40-100 percent). Other areas with similar characteristics are located further away from the terminal.

Poverty Levels by Percentage 0 - 10 10 - 20 20 - 30 30 - 40 40 – 100

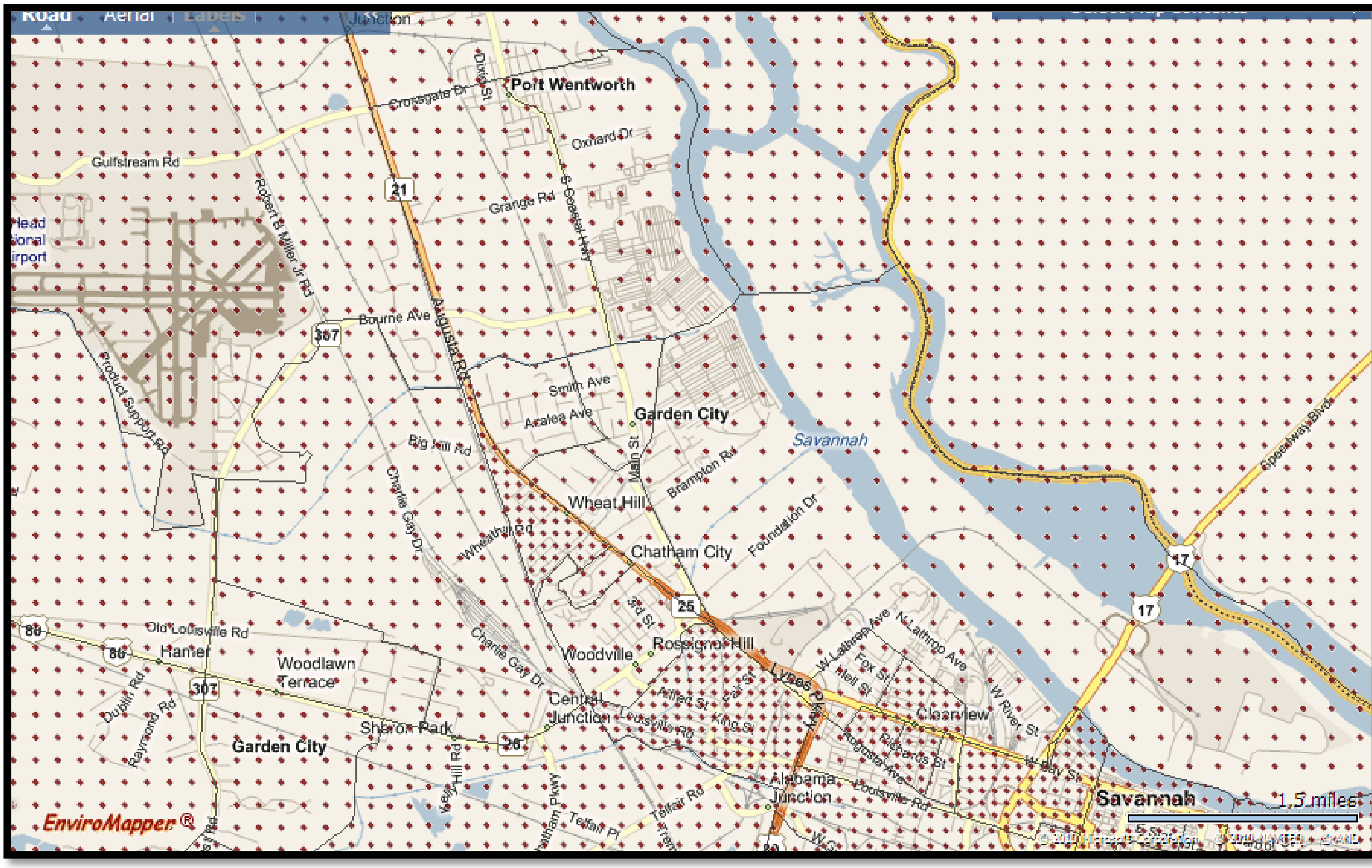

Figure 5-57. Poverty levels within the vicinity of the upper end of Savannah Harbor.

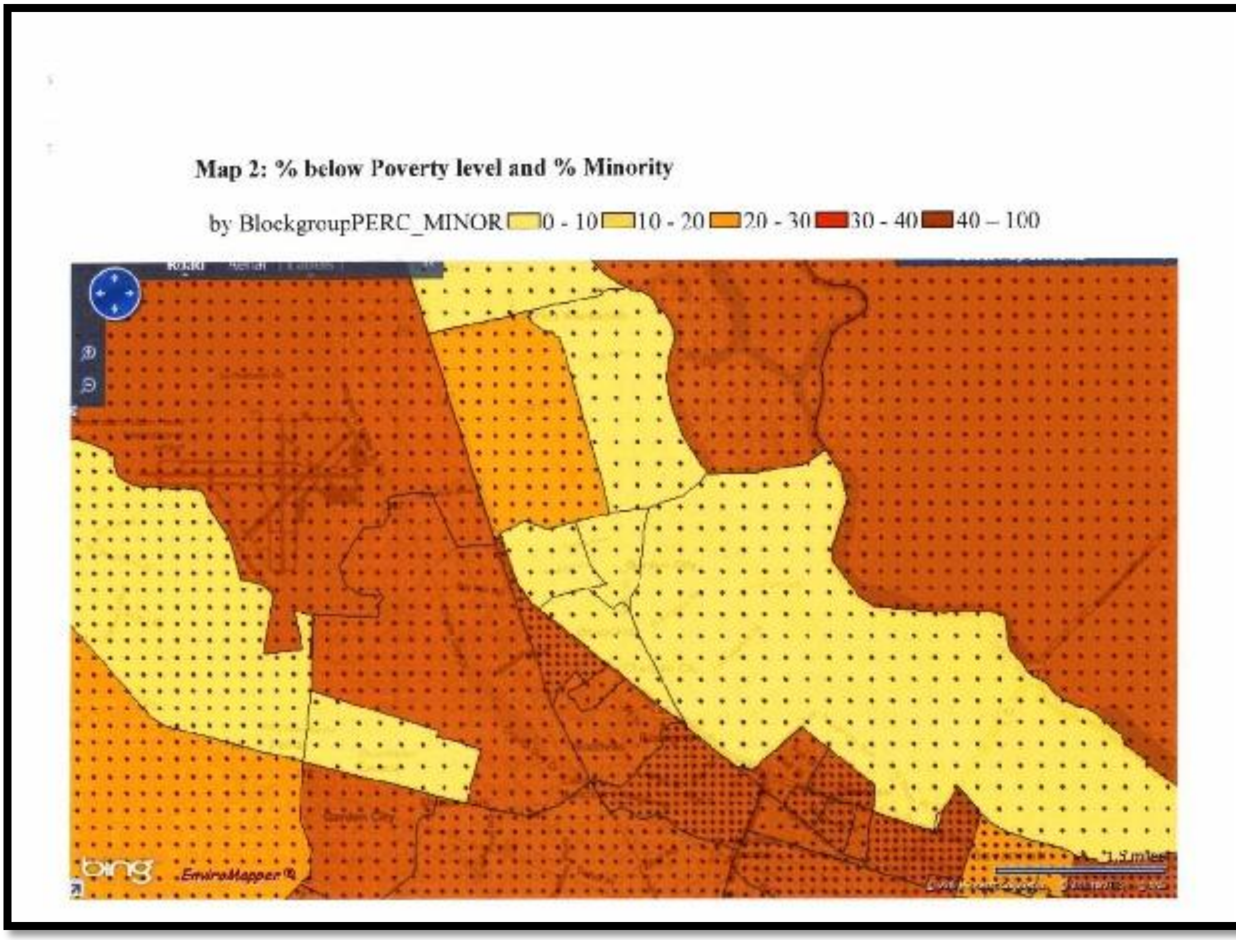

Figure 5-58. Poverty Levels within the vicinity of the upper end of Savannah Harbor.

The figure below shows the locations of schools, hospitals and child care facilities, along with the navigation channel where the majority of the construction would occur and the existing Garden City Terminal. These facilities are dispersed throughout the community and are not located disproportionately near the navigation channel of the Garden City Terminal.
The proposed project includes dredging the Federal Navigation Project to accommodate larger Post-Panamax ships. The harbor deepening alternatives consist of deepening the navigation channel from the ocean past the City's Historic District to the existing Garden City Terminal. The dredging activities, including deposition of the dredged sediment, will not have significant impacts on any populations, including minority populations and low-income populations. The dredging activities would be focused in the Savannah River. Sediment deposition activities would be focused in existing CDFs in South Carolina or in the approved ODMDS. No construction activities would occur on land at the Garden City Terminal.

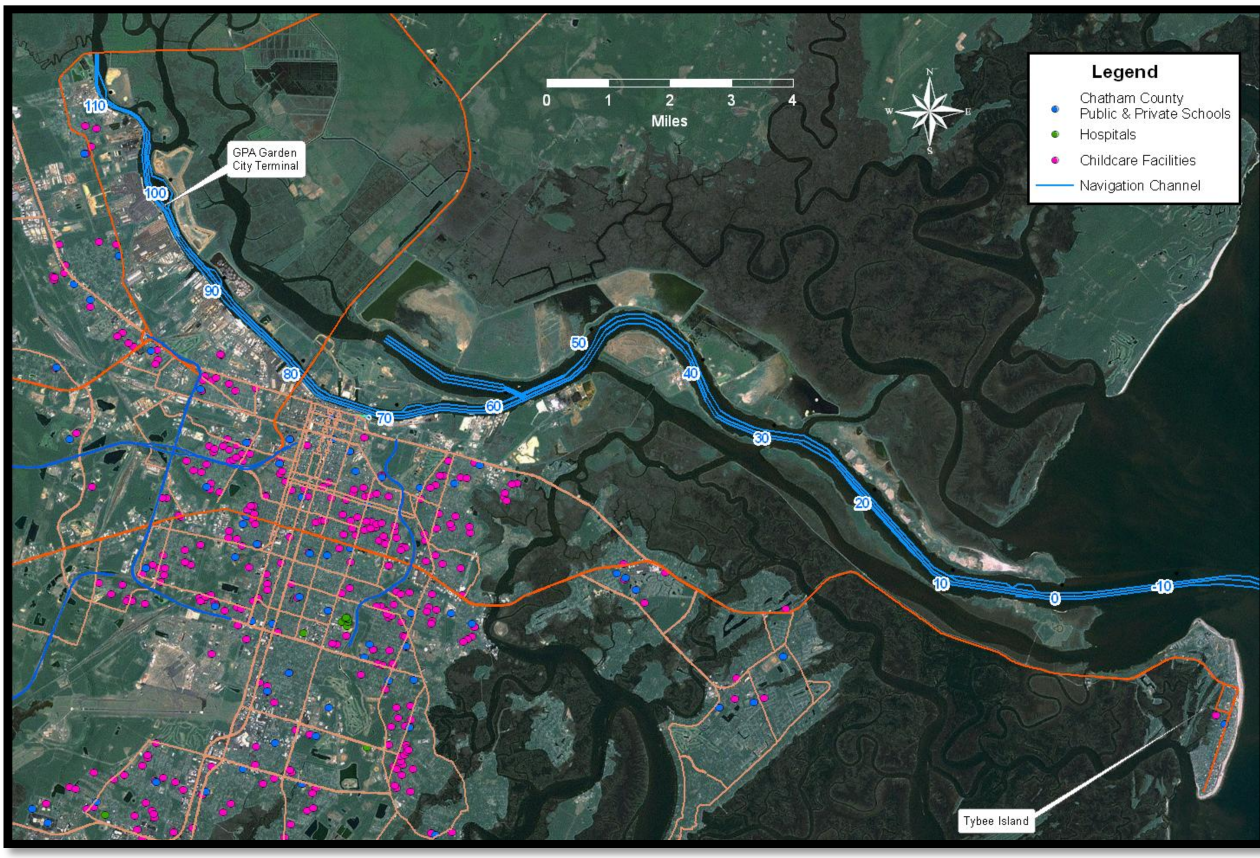

Figure 5-59. Locations of schools, hospitals and child care facilities along the navigation channel.

As summarized in Section 4.13, the area from the Atlantic Intracoastal Waterway downstream to the mouth of the Savannah River is undeveloped land. Neither the dredging activities nor the transit of larger vessels will impact local populations in this segment of the project. The area along the Georgia side of the Savannah River upstream of the mouth of the river and downstream from the City's Historic District is occupied largely by heavy industry and shipping facilities. The industrialized uses continue from Elba Island upstream beyond the Garden City Terminal. The residential area along River Street (located in the center of Savannah) contains a relatively affluent community. The section below provides a detailed discussion of the demographics of the project area and potential impacts to environmental justice communities. As a result, dredging activities and shipping activities will not have a disproportionate impact on environmental justice populations in Georgia, because they are essentially absent from the areas adjacent to the proposed construction.

The South Carolina side of the Savannah River consists of agriculture, silviculture and some recreation uses. Most of the South Carolina side of the river had been marsh, which has been converted for use as confined dredged material disposal facilities (CDFs). Such facilities extend from the Atlantic Intracoastal Waterway upstream to Highway 17 (Talmadge Bridge). The area from the Atlantic Intracoastal Waterway downstream to the mouth of the Savannah River is either CDFs or the Tybee National Wildlife Refuge. There is no residential development near the river. Some residential development has recently occurred in Jasper County on high ground in areas somewhat removed from the river. The section below provides a detailed discussion of the demographics of the project area and potential impacts to environmental justice communities. The dredging activities and shipping activities will not have a disproportionate impact on environmental justice populations in South Carolina, because they are absent from the areas adjacent to the proposed construction.

5.19.3 Demographics Analysis in the Project Area

Using 2010 and 2000 US Census data, the Corps expanded the demographics analysis to determine if there were disproportionate populations of environmental justice communities (minority, juveniles, or low-income) along the length of the navigation channel and adjacent to Garden City Terminal when compared to two base areas: surrounding towns and cities and Chatham and Jasper Counties as a whole. Data sets were collected from census.gov. Year 2000 census data was used for the low-income analyses, as 2010 data was not available at the time of publication.

For the minority and juvenile populations, the Area of Interest used for comparison was comprised of 2010 census tracts that were adjacent to the Garden City Terminal (Chatham County tracts 1, 3, 6.01, 106.01, 106.03, 106.05, 107, 116, and 9800) and the remainder of the navigation channel (Chatham County tracts 101.01, 111.07, 111.03 and Jasper County tract 9502.01).

Similar methodology was used to develop the comparison areas for the low-income analyses using year 2000 census data. As defined by OMB, the poverty level for a family of 4 was determined to be $22,491.

The Area of Interest was compared to two Base Areas: the populations of the surrounding towns and cities (Savannah, Garden City, Port Wentworth, Pooler, and Jasper County tract 9502.01) and the populations of Chatham and Jasper Counties.

The population distributions for a given tract were added, and each demographic of interest was converted to a percentage of the total population for a given area. The percentages were then used to calculate ratios to compare the differences between the Area of Interest and the Base Areas. A ratio of 1.0 indicates that the population distributions are equal for each given area. If the resulting ratios for the Area of Interest to a given Base Area is less than 1.0, then the populations within the Area of Interest contains LESS of a percentage of a given environmental justice community when compared with the surrounding cities and/or counties. If the ratio is much greater than 1.0, then the populations within the Area of Interest contain MORE of a percentage of a given environmental justice community than the surrounding cities and/or counties. For all the comparisons completed, the ratios ranged from 0.7 to 1.2 (see figures below). Out of the six comparisons, only one of the computed ratios was greater than 1.0 (low-income families when compared to Chatham and Jasper Counties), and the ratio was still close to unity.

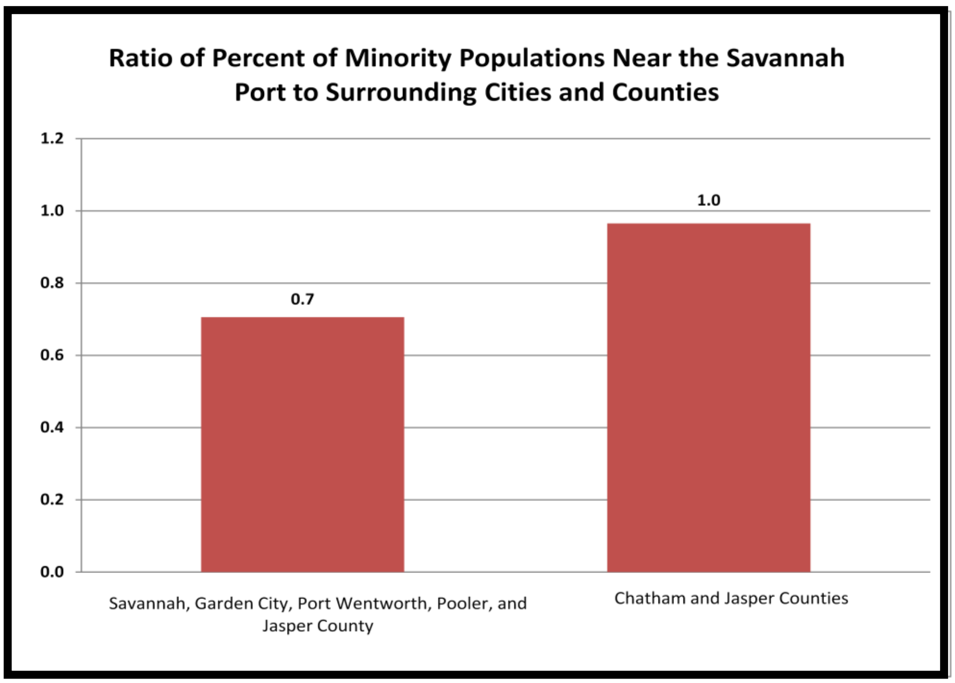

Figure 5-60. Ratio of percent of minority populations near the Savannah port to the surrounding cities and counties.

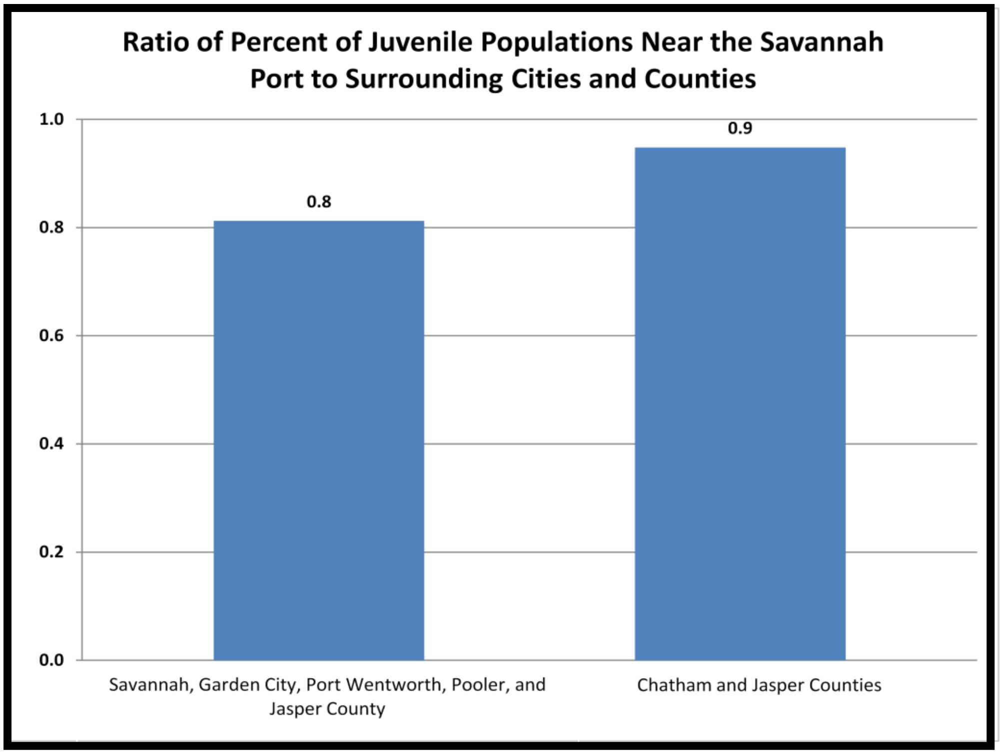

Figure 5-61. Ratio of percent of juvenile populations near the Savannah port to the surrounding cities and counties.

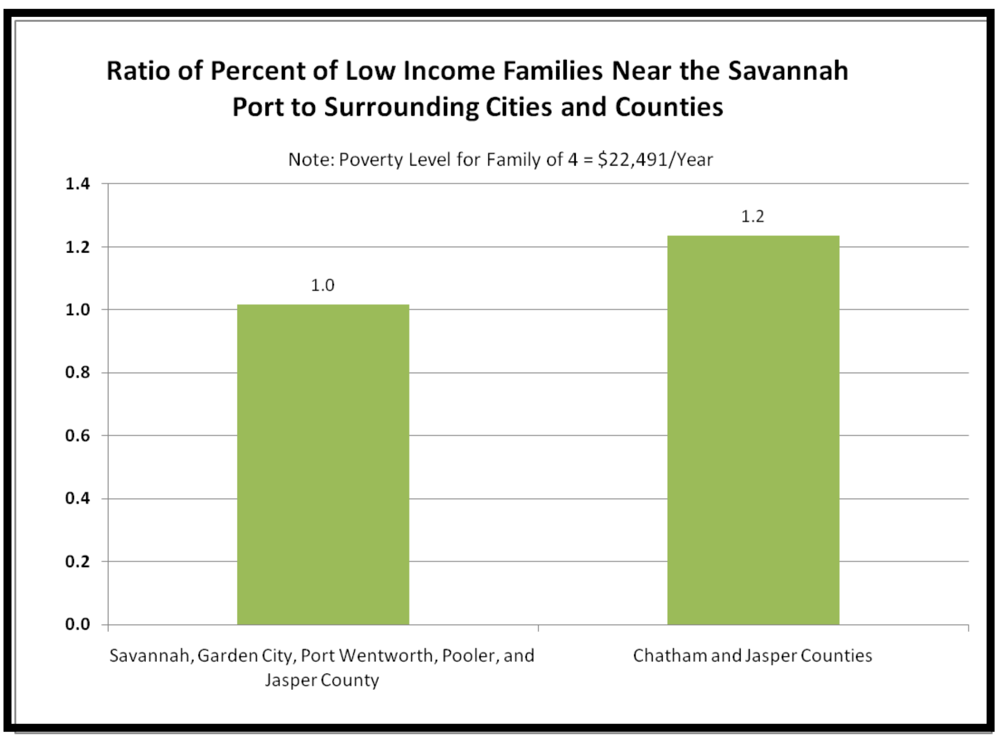

Figure 5-62. Ratio of percent of low-income families near the Savannah port to the surrounding cities and counties.

The results of the data indicate that the Area of Interest, i.e. the area potentially impacted by the project, does not contain disproportionate populations of minority, juvenile, or low-income communities when compared to the surrounding cities or counties. On the basis of the analysis described above, construction of the proposed project and port operations do not have a disproportional impact on areas of high concentration of low-income and minority populations. Nonetheless, a number of environmental justice considerations are presented below.

5.19.4 Landside Transportation of Cargo

No increases in cargo are expected to occur as a result of the proposed harbor deepening. As a result, the project would not affect the number of containers that move through the areas that surround the port. The economic benefits of the project would result from the use of larger, more cost-effective container ships, not an increase in the number of containers.

5.19.5 Terminal Infrastructure

The Garden City Terminal is located on a 1,250 acre site upstream of the Historic District of the City of Savannah. It currently is the largest container port on the East and Gulf Coasts. The terminal presently handles roughly 2.6 million TEUs per year, which are moved by either truck or rail. Truck movements predominate (82 percent) and average about 4,900 truck movements per day. The Corps expects the volume of containers handled at the Garden City Terminal to continue to increase until the terminal reaches its capacity of 6.5 million TEUs around 2032. The Economics Appendix of the GRR describes the Corps projections for cargo traffic through the port.

Cargo volumes have increased substantially in the past. In response, GPA has taken many actions to increase the efficiency of the cargo handling. They acquired larger cranes and equipment to move the containers within the terminal. They invested in newer cargo-handling equipment, which produce less air emissions. They rearranged the alignment of the container stacks to allow more efficient movement of the boxes. Expansions of the entrance/exit gates and state-of-the-art computer systems reduced the time it takes trucks to enter and leave the terminal, thereby reducing truck idling time and its associated air emissions.

The terminal now has two intermodal rail yards for two Class I carriers (Norfolk Southern and CSX) located on the property. The Garden City Terminal is the only US port terminal with two Class I rail service providers located on terminal. Approximately 18% of the cargo now moves through the terminal by rail. Since rail moves cargo with less fuel than trucks, use of rail reduces the total diesel emissions from the port operations. GPA plans to increase the percentage of containers that are handled by rail in the future.

GPA and the State have made substantial investments to increase the efficiency of cargo movement within the terminal and through the immediate surrounding areas. Although traffic volumes have increased over time, those investments have also minimized the effects of that cargo movement -- including the social and environmental effects (air quality) -- on the surrounding communities, some of which have high minority populations and high poverty levels.

GPA continues to work closely with the State of Georgia to develop more improvements to the highway system outside the terminal. GPA has developed a plan that would provide expressway connection of Interstate highways directly to the Terminal. In 2010, the State of Georgia approved $120 million in bond revenue for use toward completing the Jimmy DeLoach Highway from Interstate 95 to the Garden City Terminal. The project entered the construction phase in December 2011, and is scheduled to be completed by the base year of the project. Additionally, the Georgia Department of Transportation's long-term highway plan includes construction of the Brampton Road Connector which will provide direct access from the Garden City Terminal to Interstate 516 and connections to Interstate 16. Once these road construction projects are completed, the GCT will have one of the best linkages to the Interstate highway system of any US port. Those road improvements are shown in the following figure. The completion of those roads will remove terminal traffic from neighborhoods and lessen congestion and the accompanying air quality impacts.

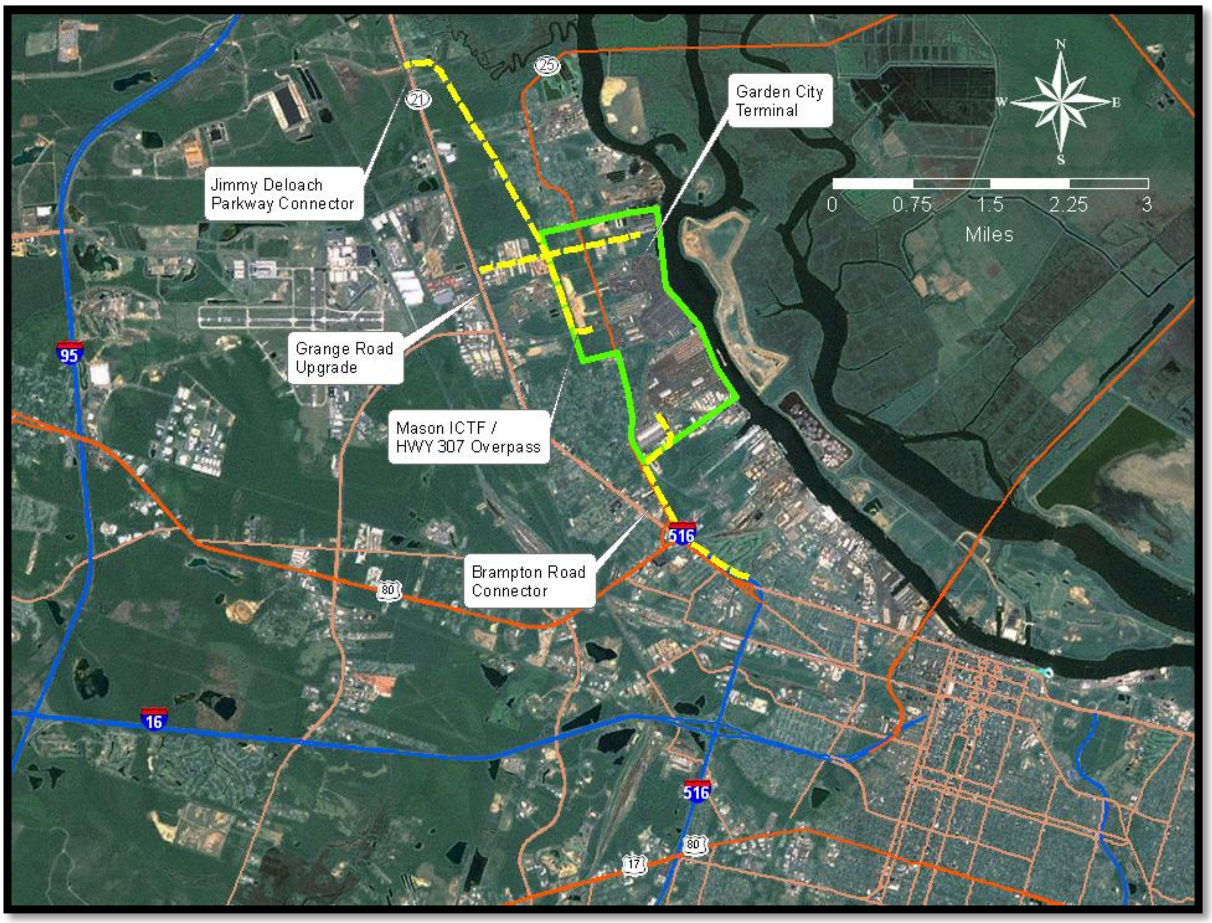

Figure 5-63. Proposed road improvements in the vicinity of Garden City Terminal.

5.19.6 Terminal Operations

GPA has programs that avoid, minimize and mitigate air quality, traffic, noise and lighting impacts on surrounding neighborhoods from operation of the Garden City Terminal. These programs are described below.

5.19.6.1 Diesel Fuel Programs. GPA continually evaluates methods to reduce diesel consumption and emissions. These actions protect the environment and the local population. Examples include the following:

A. GPA has converted the older ship-to-shore cranes to electric and purchased new cranes that run off of electricity. Of the 23 ship to shore cranes, 21 are electric which avoids the use of 1.9 million gallons of diesel each year.
B. The Garden City Terminal is the largest shipper of refrigerated cargo on the east coast and has installed electric refrigerated container racks which eliminate the use of diesel generators for the refrigerated containers. The use of these racks in place of generators avoids the consumption of nearly 2.4 million gallons of diesel annually.
C. In 2010, EPA awarded GPA a Diesel Emissions Reduction Grant to repower 17 rubber tire gantry cranes (RTGs), which is one of the primary types of container handling equipment. By repowering these RTGs, GPA will avoid using 129,000 gallons annually throughout the life of the equipment. In January of 2012, the GPA board approved the purchase of four electric-powered rubber-tired gantry cranes (ERTG) which will introduce a cleaner and more efficient method of operation. GPA plans to convert all its RTGs to ERTGs by 2022.
D. GPA recently conducted a pilot project on use of a diesel additive in the container handling equipment. The study showed that the additive reduced fuel consumption and lowered emissions. GPA now uses the additive in all container handling equipment. This avoids use of 100,000 gallons of diesel fuel annually.
E. The Garden City Terminal has a total of 33 on-road truck container interchange lanes divided between two locations on the terminal, which have processed over 8,200 gate transactions on a single day. GPA’s facility master plan includes construction of a third set of gates which would then provide access to the terminal from the east, west and south, thereby spreading out traffic and reducing waiting times at the gates. The dispersal of truck traffic reduces congestion and its accompanying air emissions. GPA expects to implement this improvement within the next 10 years.
F. Containers are shipped by rail using the two Intermodal Container Transfer Facilities (rail yards). At those facilities, trains are built for particular destinations as far west as Chicago. This effort reduces transit times of up to 3 days and avoids central train yard switching of cars, thereby reducing emissions. Moving freight by rail emits three times less NOx and PM than on-road trucks. With the only East Coast ICTFs located on the container terminal, GPA’s on-dock rail volumes have increased 135% over the past five years (2008).
G. During periods of heavy cargo volumes, GPA coordinates extended gate hours (earlier morning and later evening hours and Saturdays) to decrease on-road and terminal congestion. This improves productivity, reduces truck idling, and decreases diesel emissions.

H. Forklifts of 15,500 pound capacity or smaller (86) are now fueled with LP gas, rather than diesel.

As a result of programs GPA implemented throughout the Garden City Terminal, approximately 4.5 million gallons of diesel and the associated emissions are avoided on an annual basis. While GPA has increased the total volume of containers moved, the gallons of diesel per container handled decreased 54% from FY01 to FY10.

The reduction in air emissions in the movement of cargo through the port reduces local and multi-state regional air pollution. The improved air quality benefits the thousands of personnel on GPA terminals and on neighboring industrial sites, as well as those who reside in nearby Georgia and South Carolina communities.

5.19.6.2 Noise and Lighting. The GPA currently has programs in place to avoid or reduce noise and lighting impacts on surrounding neighborhoods. The noise abatement includes construction of berms that absorb and deflect noise. GPA has reduced lighting at the facility, which conserves energy, and lessens lighting impacts on surrounding neighborhoods.

5.19.6.3 Employment. GPA directly employs approximately 950 workers, having added approximately 300 positions to service growth in cargo volumes over the last three years. Minorities comprise approximately 46% of GPA employment. To handle the projected future growth in cargo volume, the terminal is expected to need approximately 175 additional positions by 2020. The International Longshoremen Association employs workers at the terminal. The Longshoremen are represented by three local unions. Just one of the locals -- Local 1414 -- employs approximately 1,887 people, 99% which are minority. Forty percent of the members of that union reside in South Carolina. Growth is expected also in the several thousand person workforce that serves the surrounding logistics operations that handle and warehouse port cargo. The skill sets for those new positions will vary, but they should provide numerous opportunities for workers with less education. The jobs will benefit lower income populations in the metro-Savannah region. Employees working at port-related businesses are likely to reside in Garden City and throughout the metro-Savannah area.

5.19.7 Consideration of Other Terminal Locations

EIS Section 3.0 and Appendix O, and GRR Section 6.0 and Appendices A and D, describe the process the Corps used to identify and evaluate alternatives to address the navigation problems being experienced in the harbor. Both structural and non-structural methods of reducing navigation problems were considered. Potential alternative terminal locations were investigated in the South Atlantic region (other South Atlantic ports) and along the Savannah River (eight terminal locations). The proximity to major north-south and east-west highways and the support of rail are major factors that favor the Garden City Terminal over other locations along the Savannah River navigation channel. Other potential locations would require significant infrastructure projects. This would include projects that would minimize the additional traffic volumes on local roads and near neighborhoods, and to support rail transport of cargo. Sites located in Georgia south of the City's Historic District would likely result in significant increases in truck traffic on local streets in the Historic District and surrounding neighborhoods in route to the major expressways located west of the City of Savannah. Potential air emissions and noise that would occur from increased ground transportation of cargo from the alternative downstream sites through Savannah environmental justice neighborhoods was also considered.

5.19.8 Summary of Project Effects on Environmental Justice Populations and Children

The proposed harbor deepening would not increase the number of containers moving through the port in a given year. Although the GRR Economics Appendix predicts an increase in the number of containers moving through the port over time as a result of increasing demand, that increase is expected to occur in the Without Project Condition – independent of a harbor deepening project.

According to the commodity forecast found in the GRR Economics Appendix, the port will reach its landside cargo handling capacity near 2030 when the total number of TEU's reaches 6.5 million. It is anticipated that without deepening (i.e., the -42 foot depth) more vessels would be required to transport this cargo. With deepening of the harbor to the -47 foot depth, the total number of vessels would decrease (when compared to without project conditions) as the vessels would be able to load more deeply under the improved conditions.

Since the number of containers per year is not predicted to increase as a result of deepening, no landside changes in emissions would occur as a result of the deepening. The Corps predicts a reduction in the number of vessels used to transport the number of containers predicted for each year (when compared to without project conditions) if the harbor is deepened. As a result, total air emissions would decrease in a given year if the harbor is deepened (when compared to without project conditions). Since overall air emissions in the port would decrease slightly as a result of the project (when compared to without project conditions), there is no technical need for the project to conduct a detailed analysis of how those emissions disperse. Additionally, since there would be an overall decrease in emissions (including air toxics) (when compared to without project conditions), the Corps does not expect any National Ambient Air Quality Standards (NAAQS) violations as a result of the harbor deepening. Therefore, a risk-based assessment of the health effects associated with the proposed action is not warranted. Any potential adverse effects of the presently permitted air emissions would be reduced if the harbor is deepened because of the reduction in vessels (when compared to without project conditions).
GPA is expected to continue its efforts to increase the speed of container movement through the terminal. With the State's help, GPA is also expected to continue their efforts to increase the speed of container movement through the surrounding area by improving road access to the terminal and increasing the proportion of containers handled by rail. GPA will continue their efforts to increase fuel efficiency. These actions will reduce the effects of the additional cargo on air quality and the surrounding communities. The increase in container volumes should require an increase in personnel. Since some of the work would not require specialized training, minority and low-income populations should see increases in employment.

The Corps evaluated potential project impacts of the proposed harbor deepening and found that the information shows that the proposed action would not cause disproportionately high and adverse impacts to minority populations, low-income populations, or children. Schools, hospitals and child care facilities are dispersed throughout the community and are not disproportionately located near the navigation channel or the Garden City Terminal, so disproportionate impacts to children are not expected.

5.20 Other Items/Factors of Concern

5.20.1 Noise

The harbor area contains a mixture of industrialized areas, an urban tourist area along River Street, and a natural area in the Savannah National Wildlife Refuge. Dredging operations do not produce substantial amounts of noise, as the dredge engines are typically well within the vessel and shielded from the outside.

As discussed previously, the mitigation plan for the project includes the injection of oxygen to remove the incremental effects of the deepening on the dissolved oxygen regime in Savannah Harbor. This would require the construction and operation of three oxygen injection systems. Two would be placed on Hutchinson Island while the other system would be placed upstream near Georgia Power's Plant McIntosh. Comments received from EPA on the DEIS included concerns about operational noise levels that would be associated with operation of the oxygen injection systems. EPA requested that noise levels during operation be modeled and the anticipated seasonal schedule for operation be documented. The oxygen injection systems would be operated during the summer months when dissolved oxygen levels in Savannah Harbor are normally low.

In response to this request, the Corps prepared a noise analysis to address operation of the proposed oxygen injection facilities and their potential impacts on nearby receptors. A review of all industrial sources of noise associated with the project at both Plant McIntosh and the International Paper (Hutchinson Island) oxygen injection locations was modeled, propagated, and added to the existing estimated background noise levels to determine the level of effects.

Georgia has no state-wide noise regulations. However, both Chatham and Effingham counties maintain noise ordinances which set strict not-to-exceed noise thresholds. Table 5-50 shows the not-to-exceed sound levels per the county ordinances.

Table 5-51. Maximum Permissible Sound Levels per County Ordinances

Georgia Pacific Site - Effingham County		
Receiving Property Category	**Time**	**Sound Level Limit (dBA)**
Residential, public space, institutional, or noise sensitive area	7:00 a.m.—9:00 p.m.	60
	9:00 p.m.—7:00 a.m.	50
Commercial or business	7:00 a.m.—9:00 p.m.	70
	9:00 p.m.—7:00 a.m.	60
Industrial or manufacturing	At all times	80
International Paper Site - Chatham County		
Receiving Property Category	**Time**	**Sound Level Limit (dBA)**
Residential, public space, institutional, or noise sensitive area	7:00 a.m.—10:00 p.m.	60
	10:00 p.m.—7:00 a.m.	55
Commercial or business	All Times	65
Industrial or manufacturing	At all times	75

Sources: Effingham County, Georgia, Code of Ordinances. Part II, Chapter 30, Sections 30-43

Chatham County, Georgia, Code of Ordinances. Part II, Chapter 30, Sections 30-43

Existing sources of noise near the proposed oxygen injection sites include local road traffic, industrial activities, boating activities, high altitude aircraft overflights, and natural noises such as rushing water, leaves rustling and bird vocalizations. Existing noise levels were estimated for the proposed project site and surrounding areas using the techniques specified in the "American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present" (ANSI, 2003). Table 5-51 outlines the closest noise-sensitive areas (NSA) such as residences, schools, churches and hospitals, and the estimate existing noise levels at each location. The noise levels are shown as Day-night Sound Level (DNL) which is defined as the average sound energy in a 24-hour period with a 10-decibel penalty added to the nighttime levels (10 p.m. to 7 a.m.) and Equivalent Sound Level (Leq) which is the average sound level in decibels. There are no NSAs within 2,000 of either oxygen injection site.

Table 5-52. Estimated Background Noise Levels for Nearby Noise Sensitive Areas

Distance (Feet [Meters])	Direction	Description	DNL	L_{eq} (Daytime)	L_{eq} (Nighttime)
Plant McIntosh Site					
2,290 (700)	Northwest	Residence	55.0	53.0	47.0
2,740 (835)	Northwest	Residence	55.0	53.0	47.0
8,485 (2,590)	Southeast	Residence	45.0	43.0	37.0
15,200 (4,640)	East	Residence	45.0	43.0	37.0
International Paper Site					
Distance (Feet [Meters])	**Direction**	**Description**	**DNL**	**L_{eq} (Daytime)**	**L_{eq} (Nighttime)**
9,890 (3,015)	Northeast	Residence	45.0	43.0	37.0
11,880 (3,620)	East	Residence	45.0	43.0	37.0
10,870 (3,315)	West	Residence	55.0	53.0	47.0
4,875 (1,485)	Southwest	Residence	55.0	53.0	47.0

Source: ANSI, 2003.

The proposed oxygen injection systems are in the preliminary design stage and a complete equipment list and manufacturers' specifications are not available. In general, the water pumps would dominate the noise producing equipment associated with operation of the facilities. A demonstration project of the oxygen injection equipment was conducted that used four 400 horsepower pumps mounted on the barge deck. The rated decibel levels for each pump were 72-76 dB for each pump at 30 feet. It is expected that the vertical pumps planned for the permanent installations would generate approximately 65 dB for each pump (MACTEC, 2008). Noise that would be generated by operation of eight 400 horsepower pumps was estimated at 100% capacity (i.e. full load) operating 24 hours per day 7 days per week. The results are shown in Table 5-52. This represents the cumulative noise impacts of the proposed facility where the several pieces of equipment would be collocated. Sound level data for the proposed engines were derived using empirical formulas based on process and mechanical equipment data. Notably, operation of the system would only be necessary during the warmer months.

Table 5-53. Noise Levels Associated with Operation of Proposed Oxygen Injection Systems

Georgia Pacific Site							
			Sound Level (dBA)[1]				**Exceeds County Noise Limits [Yes/No]**
Distance (Feet [Meters])	**Direction**	**Description**	**Existing DNL**	**Estimated Future DNL**	**Estimated Future L_{eq} (Daytime)**	**Estimated Future L_{eq} (Nighttime)**	
2,290 (700)	Northwest	Residence	55.0	55.5	53.5	47.5	No
2,740 (835)	Northwest	Residence	55.0	55.3	53.3	47.3	No
8,485 (2,590)	Southeast	Residence	45.0	45.0	43.0	37.0	No
15,200 (4,640)	East	Residence	45.0	45.0	43.0	37.0	No
International Paper Site							
			Sound Level (dBA)[1]				**Exceeds County Noise Limits [Yes/No]**
Distance (Feet [Meters])	**Direction**	**Description**	**Existing DNL**	**Estimated Future DNL**	**Estimated Future L_{eq} (Daytime)**	**Estimated Future L_{eq} (Nighttime)**	
9,890 (3,015)	Northeast	Residence	45.0	45.0	43.0	37.0	No
11,880 (3,620)	East	Residence	45.0	45.0	43.0	37.0	No
10,870 (3,315)	West	Residence	55.0	55.0	53.0	47.0	No
4,875 (1,485)	Southwest	Residence	55.0	55.1	53.1	47.1	No

Source: Bies, 2003.
Notes: [1] There would be no perceptible change over the existing noise environment at any noise sensitive receptor.

Operation of the oxygen injection systems would be audible to operators of the facilities, and depending on the wind conditions, to nearby areas. However, there would be no perceptible change in the overall existing noise environment at any noise receptor. The DNL would increase approximately 0.5 dBA at the nearest NSA to the Plant McIntosh site and 0.1 dBA at the nearest NSA to the International Paper site. These future levels would be for all intensive purposes identical to the existing noise conditions, and would not constitute a perceptible change in the noise environment. The noise levels would not exceed the local regulatory thresholds at either location.

5.20.2 Man-made and Natural Resources, Community Cohesion, and the Availability of Public Facilities and Services

Dredging in the Savannah Harbor navigation channels is not expected to cause significant interference with commercial and recreational boat traffic. The mobility of a hopper dredge avoids interference with regular commercial ship traffic. When a hydraulic pipeline dredge is used on the entrance channel, the pipeline from the dredge to the nearshore placement area would likely be submerged until it is close to the placement location. Regular commercial use of the harbor would not be stopped during the construction period. All dredge pipelines would be marked to let commercial and recreational boaters know of their presence. Work barges and other appurtenances associated with a pipeline dredge operating in open water would be moored in a manner to minimize interference with boat traffic in the area. Impacts to natural resources are discussed in Sections 5.01-5.09. Impacts to cultural resources are discussed in Section 5.10.

5.20.3 Climate Change

For this analysis, sea level rise and its potential effects were examined in detail and considered to be the most important factor to determine potential effects of the proposed action relating to climate change. The Corps performed impact analyses for several rates of sea level rise. The results of those analyses and their associated impacts are summarized in Sections 5.01 and 5.15 of this EIS, and Section 7.5 of the GRR. Appendix C describes the results of the detailed analyses that the Corps performed concerning various sea level rise scenarios.

The potential effects of other facets of climate change, including changes in storm frequency, intensity, and duration, are uncertain at present and the effects on a particular project site are even more unknown. Since agency agreements do not exist on the type of effects climate change may cause in this region, evaluating how those new conditions might impact the proposed project and quantifying the extent of those impacts would be difficult and speculative. The District examined literature on global warming that made specific predictions for the Savannah River Basin (Lettenmaier, 1999). The projected effects are expected to vary by the climate change scenario used and the time period being considered. As an overall summary, Lettenmaier predicts "For the Savannah system, the primary factor affecting system performance in most categories was runoff changes – both magnitude and variability." Lettenmaier states that the 2050 scenario was based on the assumption of a large incremental increase (~1,000 cfs) in required minimum flow at Augusta, to support a new raw water pumping facility. The Corps does not believe that assumption is valid. For all scenarios, runoff variability increased progressively and significantly as compared to the base case. Lettenmaier also states "M&I supply reliability was insensitive to the changes in runoff associated with the climate scenarios."

In recognition of the uncertainties in predicting future events, the Corps performed various sensitivity analyses. Those scenarios varied by resource and included evaluation of potential project impacts to dissolved oxygen and wetlands under average and drought flows; to Striped bass habitats under average, high and low river flows; and to wetlands under various amounts of sea level rise. The District consulted with the Interagency Coordination Teams to identify scenarios that the natural resource agencies believed would be required to evaluate harbor deepening in sufficient technical depth so that they would reasonably understand the likely impacts from implementation of the project and the sensitivity of those predictions to other conditions. The Interagency Coordination Teams recommended sensitivity analyses to evaluate this project that include a sufficient range of conditions to address potential changes in conditions resulting from climate change.

5.20.4 Displacement of People, Businesses, and Farms

It is possible that land acquired for mitigation would be owned by a business or contain a residence. Since the precise properties to be acquired have not been determined at this time, but would be selected from a list previously identified by the USFWS for acquisition, the sites could contain a small number of residences. The sites could also be owned by a for-profit corporation or be run as a farm. These impacts are expected to be minimal, as <5 total properties are expected to be acquired for mitigation.

5.20.5 Community and Regional Growth

No additional cargo is expected to pass through the harbor as a result of the proposed project. Therefore, the project should have no adverse effects on community and regional growth. No increase in the growth rate of development at Tybee Island is expected as a result of the proposed action. Additional visitation to the Savannah National Wildlife Refuge could occur as a result of the expansion of the Refuge through the addition of mitigation lands. However, no increases in visitation are claimed as project benefit. No significant impacts to community and regional growth are expected from the proposed project.

5.20.6 Public Safety

As a public safety measure, boating would be prohibited near the operating construction equipment (excavation and sediment placement location). Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short term impacts could occur, no long-term adverse effects are anticipated. Commercial shipping would continue in the Federal navigation channel. The Corps would provide information to the US Coast Guard so they could issue a “Notice To Mariners” prior to initiation of construction and each major change in the construction. This would make the boating public aware of the construction areas, so they could avoid those locations. The public would be excluded from landside construction areas. No significant adverse impacts to public safety are expected from the proposed project.

5.20.7 Invasive Species

As discussed in Chapter 4, the introduction of non-native or invasive species can have detrimental effects on an ecosystem. Invasive species have been introduced into new areas through the discharge of ballast water from deep-draft vessels. Increasing the amount of ballast water exchange within the port is the primary avenue through which the proposed harbor deepening could have an adverse effect on this issue. E.O. 13112, Invasive Species, charges the Federal government with not authorizing, funding, or implementing actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

The proposed harbor deepening is not expected to increase the number of vessels that call at the port of Savannah. The economic analysis forecasts a decrease in the number of vessels with a deeper channel over that which would have been necessary to move the same volume of cargo through the port using a smaller fleet of vessels. Since there is no increase in the number of vessels expected to call as a result of the proposed deepening, there would be no additional risk from invasive species through ballast water. The existing risk is managed by the US Coast Guard. All vessels entering the Port of Savannah (no matter their size) will have to comply with NISA and the US Coast Guard guidelines mandated by this regulation. Failure to comply with these measures will result in civil penalties. Continued interest in this issue is appropriate, as invasive species have been shown to have large environmental effects on native US species, and exotic species have been identified at the port.

Invasive species can also enter the port as insect larvae in pallets or in soil containing seeds or plants. The increase in TEUs expected to pass through the port of Savannah would occur with or without the SHEP. Consequently, construction of the SHEP would not exacerbate the risk of invasive species entering the port in this manner.

5.21 <u>Mitigation Planning</u>

Mitigation planning consists of the following three major steps:

A. Avoid Impacts
B. Reduce Impacts
C. Replace/Compensate for impacts that cannot be avoided or reduced

The project includes design features to avoid environmental impacts, as well as features that reduce the amount of impacts that otherwise occur.

The Corps has developed mitigation for impacts that could not be avoided or reduced further to wetlands, dissolved oxygen, Shortnose sturgeon, and Striped bass. These were discussed

previously in this EIS. The process through which the individual mitigation measures and the overall mitigation plans were developed are described in Appendix C.
The Corps has developed a Monitoring and Adaptive Management Plan to identify if the project produces adverse effects that are greater than expected and ensure the mitigation plans are successful. That plan is located in Appendix D.

The Corps believes the SHEP Mitigation Plan and Monitoring and Adaptive Management Plan provide adequate mitigation for those adverse impacts that cannot be avoided or further reduced.

5.22 Utility Crossings, Structures, and Aids to Navigation

A preliminary analysis indicates that no utilities or structures will be impacted by the proposed deepening of the harbor. The Corps contacted the US Coast Guard and they indicated that they would need to purchase and install new navigational markers for the approximately 38,000-foot extension to the existing ocean bar channel (from Stations -60+000 B to -97+680 B). If the proposed construction of the deepening project inadvertently damages any aids to navigation (i.e., existing beacons, electronic components in the lighted buoys or their hulls), the Corps would work with the Coast Guard to move, repair, and/or replace those navigational markers.

5.23 Coastal Barrier Resources Act

The Georgia-South Carolina coast is typified by coastal barrier islands located in front of expansive estuarine salt marshes, which in turn front the mainland. The barrier islands which are located within 10 miles of the harbor entrance are listed from the north as follows: **SC:** Hilton Head, Daufuskie, Turtle, Oysterbed; **GA:** Tybee, and Little Tybee. If the boundaries are expanded to 20 miles, St. Phillips Island is added in South Carolina and Wassaw Island is added in Georgia. This region is unique in its lack of commercial development of its barrier islands. Of the eight islands listed within a 20-mile radius, only two are significantly developed -- Hilton Head and Tybee Islands. Several receive special protection from the Federal government by their designation as units in the Coastal Barrier Resources Act -- St. Phillips, Daufuskie and Turtle Islands in South Carolina, and Little Tybee Island in Georgia. Turtle Island is within Unit SC-10P and Little Tybee Island is within the Unit GA-N01 of the Coastal Barrier Resources System.

Two other barrier islands are National Wildlife Refuges: Oysterbed Island in South Carolina, and Wassaw Island in Georgia. The islands also receive protection through various state laws or regulations. Turtle Island is owned by the State of South Carolina and is managed as a Wildlife Management Area. Little Tybee Island is owned by the State of Georgia and is managed as a Heritage Trust. Tomkins Island, a man-made island located in SC at the entrance to Savannah Harbor, is designated as a Heritage Trust Preserve.

Operation of the harbor has not resulted in significant adverse effects to most of these barrier islands. The southerly littoral drift essentially precludes impacts to islands located to the north. The existing Savannah Harbor Navigation Project was recently identified by ERDC as being the cause of 79 percent of the reduction in sediment volume on the Tybee shelf and shoreline. The region's large tidal flows dominate hydraulic conditions at the inlets, so potential impacts to Tybee Island from removal of channel sediments from the nearshore sand sharing system are not easily distinguishable from other events that cause erosion at Tybee. No changes in shoreline erosion were identified after the last deepening of the harbor. No measurable adverse impacts to the Tybee Island shoreline or any nearby ocean shoreline are expected to occur from implementation of the proposed harbor deepening.

The Coastal Barrier Resources Act (CBRA) of 1982 (PL 97-348) and the Coastal Barrier Improvement Act of 1990 (PL 101-591) restrict federal expenditures in those areas comprising the Coastal Barrier Resources System (CBRS). Designated maps showing all sites included in the system in Georgia and South Carolina show Little Tybee Island (GA Unit N01) and Turtle Island (Unit SC-10P) to be within the Coastal Barrier Resource System and protected under the Coastal Barrier Improvement Act of 1990. Turtle Island, SC (Unit SC-10) is located north and Little Tybee Island (Unit GA-N01) is located southwest of the study area. Neither would be directly affected by the proposed deepening alternatives. The proposed action is in compliance with CBRA.

5.24 Hazardous and Toxic Wastes

None of the sediments that would be excavated during the proposed harbor deepening are considered to be or include hazardous or toxic wastes. Pursuant to ER 1165-2-132, dredged material and sediments beneath navigable waters proposed for dredging qualify as hazardous or toxic wastes only if they are within the boundaries of a site designated by the EPA or a state for a response action (either a removal action or a remedial action) under CERCLA, or if they are a part of a National Priority List (NPL) site under CERCLA. The Savannah Harbor has not been designated for a CERLCA (Superfund) response action nor is it listed on the NPL. Dredged material from Corps Civil Works projects is excluded from the definitions of hazardous waste, 40 CFR 261.4 (g); 33 CFR 336.1, 336.2. Potential impacts from excavating such materials would be evaluated in either a Section 404 (Clean Water Act) or Section 103 Evaluation (Marine Protection Research and Sanctuaries Act -- MPRSA).

Dredged material and sediments beneath the navigable waters proposed for dredging will be tested and evaluated for their suitability for disposal in accordance with the appropriate guidelines and criteria adopted pursuant to Section 404 of the Clean Water Act and/or Section 103 of the Marine Protection Research and Sanctuaries Act. The Corps has fulfilled the requirements for compliance with the Clean Water Act. See Section 5.02, Appendix H, and Appendix M. The Corps will provide its Section 103 Evaluation to EPA Region 4 for review and approval prior to initiating dredging.

Three rounds of sediment sampling and analysis were performed for the Savannah Harbor Expansion Project. Each round built on the results of the previous work. The second round of sampling was performed in 2005 and the analysis was completed in 2006. The conclusions from that evaluation were that the only sediment contaminant of concern for this project is naturally-occurring cadmium found in Miocene clays that would be dredged and/or exposed during construction. The highest concentrations of cadmium (average 21.45 mg/kg) are found between Stations 16+000 and 45+000 (River Mile 3.0 to 8.5) and medium concentrations (average 6.67 mg/kg) are found between Stations 45+000 and 94+000 (River Mile 8.5 to 17.8). Even if the sediment was not naturally-occurring, the cadmium concentrations found are well below levels that would result in classification as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). The environmental effects of excavating and depositing those sediments in a CDF are summarized in Section 5.08.4 and are described in detail in Appendix M.

During various inspections of the riverbanks, Savannah District staff identified areas along the river containing industrial debris and petroleum contamination. Those areas would not be affected by the proposed harbor deepening, but could serve as a source of contamination in the river.

The proposed action would not result in adverse impacts from hazardous or toxic wastes.

5.25 Summary of Environmental Consequences

The following is a summary of adverse effects which cannot be avoided should the SHEP be implemented**.**

5.25.1 Direct Adverse Impacts

For the purposes of this section, a project's direct adverse impact is defined as an effect on the environment in the project area that is immediately attributable to the project and caused directly by the project. With the 47-foot depth alternative, the following direct adverse impacts would occur:

A. Loss of 15.68 acres of brackish marsh due to project excavation requirements
B. Increase in chloride levels at the City of Savannah's water intake (municipal and industrial) during low flows and high tides
C. Adverse impacts (salinity) to Striped Bass habitat
D. Adverse impacts (salinity) to Shortnose sturgeon habitat
E. Minor increase in saltwater intrusion into the aquifer
F. Temporary, localized dredging and disposal impacts on water quality, benthic communities, etc. during construction
G. Conversion of 223 acres (after mitigation) of tidal freshwater marsh to brackish marsh
H. Conversion of 740 acres (after mitigation) of saltmarsh to brackish marsh
I. Adverse impacts to the remains of the CSS *Georgia*

5.25.2 Indirect Adverse Impacts

For the purposes of this section, an indirect impact of a project can be defined as an effect on the environment in the project area that is not immediately attributable to the project but is caused indirectly by the project. In the case of SHEP, deepening the existing harbor could cause an increase in vessel calls in Savannah Harbor, and an increase in goods moving through Savannah harbor which in turn could lead to the need for more and larger facilities to handle the increased vessel traffic and cargo. SHEP economic studies indicate that the growth of cargo moving through the Port of Savannah will occur with or without the project. Consequently, the construction of support facilities (warehouses, distribution centers, etc.) associated with this growth in cargo will continue regardless of harbor deepening. Construction of the SHEP would increase efficiency for both the existing vessels that call at the port as well as the larger vessels expected in the future. Construction of the SHEP is expected to actually decrease the number of vessels calling at the Port of Savannah as the larger vessels replace the smaller, aging vessels.

5.25.3 The Relationship Between Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

5.25.3.1 Wetlands. Construction of the SHEP would result in the excavation of 15.68 acres of brackish marsh regardless of which channel depth is selected. These wetlands would be permanently lost. However, mitigation for this loss involves the restoration of estuarine emergent wetlands that have been adversely impacted by the past deposition of dredged material. Approximately 40.3 acres of brackish marsh would be restored in Disposal Area 1S in Savannah Harbor to compensate for this loss. Approximately 28.8 acres of this marsh restoration would be required as mitigation for SHEP impacts while the remaining 11.5 acres of restored marsh could be used for any additional wetland mitigation requirements of either the SHEP or operation and maintenance requirements associated with the Savannah Harbor Navigation Project. Consequently, there would be no net loss of wetlands (actually a net gain in brackish marsh).

Construction of the 47-foot alternative would result in the conversion of 223 acres of tidal freshwater marsh to brackish marsh and 740 acres of saltmarsh to brackish marsh. Once the 47-foot channel is constructed, it will likely be maintained at that depth for an extremely long period of time. Consequently, the conversion of freshwater tidal marsh and saltmarsh to brackish marsh is a long-term impact. However, it should be noted that while this marsh conversion will change some of the plant species in these marshes, they would remain as functioning wetlands in the Savannah Harbor estuary.

5.25.3.2 Biological Resources. Construction of the proposed 47-foot project would result in some short term impacts to fish and wildlife resources especially during the construction process. Long-term impacts to fish and wildlife resources would occur in regards to the loss of Striped bass spawning, egg and larval habitat in the Savannah Harbor estuary due to the increase in upstream salinity levels and decrease in dissolved oxygen that would be caused by construction of the project. Since there are no known actions that could totally ameliorate this impact, the project provides funds to increase the stocking rate of this species in the Savannah River. Although this impact could be removed by not maintaining the 47-foot channel, it can be assumed that the channel would be maintained on an annual basis if it is constructed.

5.25.3.3 Endangered Species. Long-term impacts (increase in salinity) to Shortnose sturgeon foraging habitat in the upper Savannah Harbor estuary would result from construction of the project. However, based on findings in their BO, the NMFS believes that the Shortnose sturgeon will adjust by moving to upstream foraging habitat not impacted by the project. However, they cautioned that this may take a few years until the habitat has stabilized. They also believe that construction of the fish passage structure at New Savannah Bluff Lock and Dam would satisfactorily compensate for those impacts and may increase the long-term spawning success of the Shortnose sturgeon.

Impacts to Loggerhead and Kemp's ridley sea turtles are expected to occur during construction of the SHEP because of anticipated takes during hopper dredging of the entrance channel. The NMFS predicts up to 16 Loggerhead and 11 Kemp's ridley sea turtles may be lost when the entrance channel is deepened. However, based on their knowledge of these species current populations and reproduction traits, they do not anticipate any long-term adverse effects to the recovery goals for these two species.

5.25.3.4 Chloride Levels at the City of Savannah's Water Intake on Abercorn Creek. Construction of the project would increase chloride levels at the City of Savannah's water intake on Abercorn Creek during periods of low flows in the Savannah River and high tides. The project's mitigation plan includes the construction of a raw water storage impoundment that would allow the City to store water for use during periods of high chloride spikes.

5.25.4 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Land Use Plans, Policies and Controls for the Area Concerned

The SHEP involves deepening an existing Federal Navigation Channel. The dredged material would be placed in the existing CDFs in Savannah Harbor or the ODMDS. The proposed project does not conflict with current uses of the harbor area or land use plans.

Without mitigation, the proposed project would conflict with the objectives of the Savannah National Wildlife Refuge because construction of the project would increase salinity levels in the upper estuary in the vicinity of the Refuge. The main mission of the Savannah National Wildlife Refuge is to provide feeding and freshwater resting habitat for migratory waterfowl. Maintenance of freshwater habitat in their impoundments requires that they have access to freshwater (0.5 ppt) at their water intake off Little Back River. The SHEP mitigation plan includes the diversion of freshwater into Back River, which will maintain acceptable salinity concentrations at that intake. As a result, with mitigation, the project does not conflict with the USFWS's objective of providing freshwater habitats for migratory waterfowl.

The proposed project without mitigation would also conflict with the objective of the US Environmental Protection Agency to improve dissolved oxygen levels in Savannah Harbor, because construction of the project would lower dissolved oxygen concentrations in the harbor. Dissolved oxygen concentrations are low during the summer months in Savannah Harbor. EPA issued a revised TMDL for Savannah Harbor providing for a reduction in Ultimate Oxygen Demand from about 600,000 pounds a day to 130,000 pounds per day. The SHEP mitigation plan includes the construction and operation of three oxygen injection systems. Operation of these systems during the summer months would remove the incremental impacts of the SHEP on the dissolved oxygen regime in Savannah Harbor. As a result, with mitigation, the project does not conflict with EPA's objective of improving dissolved oxygen levels in the harbor.

Conceptual plans have been developed for a Jasper County Marine Terminal (container port) to be located in what is now CDF 14A and 14B (about River Mile 6). Some of the comments received on the SHEP DEIS expressed concern that use of CDF 14A and 14B for deposition of dredged material from construction of the SHEP would conflict with that proposed project. On the contrary, the engineering consultant retained by the SC and GA Port Authorities to pursue development of a terminal stated in March 2011 that placement of sediment into CDF 14A and/or 14B would provide much of the fill that would be required should a terminal be constructed at those sites. That consultant also stated that a deeper channel (such as is proposed in SHEP) would be required for a Jasper County Marine Terminal to be successful. As a result, the SHEP would not conflict with the potential development of a new container terminal in Jasper County.

5.25.5 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources refers to the use of resources that are either non-renewable or recoverable. In the case of SHEP, examples of such resources include the fossil fuels that would be required to run the equipment to construct the project and the loss of biological resources (fish, other marine and aquatic life that would be incurred during construction). The loss of biological resources during construction would be mainly confined to the immediate construction area, which is the entrance channel, inner harbor channel and the areas where the various mitigation features would be constructed. Although difficult, restoration of the 15.68 acres of brackish marsh that would be excavated as part of the project could be performed. Therefore, that impact is not considered irreversible. Similarly, the expected impacts to Shortnose sturgeon and Striped bass habitat are not considered irreversible commitments of resources because those habitats could be recovered by allowing the deepened harbor to shoal in to its present depths.

An irretrievable commitment of resources is the loss of use of a renewable resource. The conversion of 223 acres of tidal freshwater wetlands and 740 acres of saltmarsh to brackish marsh are not considered to be irretrievable commitments of resources. Although these marsh habitats would undergo a change in plant species, these marshes would remain as fully functioning wetland systems in the Savannah Harbor estuary.

5.25.6 Energy Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

Energy requirements for the proposed project would include fuel for the dredges, labor transportation, and other construction equipment. The flow-altering components of the mitigation plans would be relatively self-sustaining and not require yearly maintenance activities. Annual maintenance is expected to be needed at the fish bypass at the New Savannah Bluff Lock and Dam. That maintenance is expected to consist of removing woody debris from the fish bypass.

Electrical energy would be consumed during operation of the oxygen injection systems that are part of each depth alternative’s mitigation plan. That requirement would be substantial, but would not require addition of any new electrical generating facility. Using 10 Speece cones operating 110 days per year, the yearly energy demand would be 5,487,000 KwHr/year. Using records published for the average residential electrical use in Georgia in 2008 (1,148

KwHr/month), the electrical demand of the oxygen injection systems is roughly equivalent to that of 1,320 additional homes during the 110 day operating period. With a cost of $0.09/kwHr, the annual cost for electricity would be $494,000.

No other project feature would produce a substantial effect on energy requirements or conservation.

The SHEP would allow the larger Post-Panamax vessels to use the harbor more efficiently in the future. These larger ships carry more cargo than the older, smaller vessels that they will eventually replace. Consequently, the Corps predicts that less ships will call at Savannah with the 47-foot channel, when compared to the Without Project Condition. The newer, larger vessels are also mandated to have more efficient engines. Therefore, construction of the 47-foot channel in conjunction with fewer and more efficient vessels calling on the Port Of Savannah may reduce energy requirements associated with port operations.

5.25.7 Natural or Depletable Resource Requirements and Conservation Potential

The sediments to be excavated to deepen the Navigation Project are a depletable resource associated with the proposed project. Fuel used by the construction equipment is a natural resource that would be consumed. Fuel used by the equipment required to maintain the harbor and its mitigation features is also a natural resource that would be consumed. Impacts to wetlands, fish and water quality have been discussed previously in this EIS. The electrical energy that would be used to operate the oxygen systems would be substantial, but the demand would continue over several months, so it could be provided by the fuels that the power company uses to generate its base loads. The use of these natural and/or depletable resources is not considered an unacceptable adverse impact of proposed project.

5.25.8 Urban Quality, Historic and Cultural Resources, and the Design of the Built Environment

Urban areas abutting the Savannah Harbor project include the cities of Tybee Island, Savannah and Garden City. The Corps evaluated potential impacts of the proposed harbor deepening and concluded that the proposed action would not cause disproportionately high and adverse impacts to minority populations, low-income populations, or children. Schools, hospitals and child care facilities are dispersed throughout the community and are not disproportionately located near the navigation channel or the Garden City Terminal, so disproportionate impacts to children are not expected.

The Corps also evaluated potential project impacts on cultural and historic resources, including sites on the National Register of Historic Places such as the Fort James Jackson National Historic Landmark, the Confederate ironclad CSS *Georgia*, the <u>Savannah National Historic Landmark District, and the Fort Pulaski National Monument</u>. These four resources are located in or along the Savannah River, with its existing Federal Navigation Project. With implementation of the Programmatic Agreement and completion of the surveys and investigations described in the EIS, the SHEP would be in compliance with Section 106 of the National Historic Preservation Act, and no unacceptable adverse impacts to historic properties would occur.

5.25.9 Selected Means to Mitigate Adverse Environmental Impacts

The mitigation plan includes the following components:

A. Restoration of 40.3 acres of brackish marsh at Disposal Area 1S
B. Construction of flow rerouting features at McCoys Cut, Rifle Cut, Middle and Little Back Rivers, and the Sediment Basin
C. Removal of the Tidegate
D. Construction of an oxygen injection system
E. Construction of a raw water storage impoundment
F. Restoration of access for Shortnose sturgeon and other anadromous fish species to historic spawning areas at the Augusta Shoals through construction of a fish bypass at the New Savannah Bluff Lock and Dam
G. Increase in the number of Striped bass fingerlings stocked in the estuary
H. Recovery and preservation of the remains of the CSS *Georgia*
I. Construction of a public boat ramp on Hutchinson Island

5.26 <u>Construction Sequencing</u>

A simplified construction schedule is shown below in Figure 5-64. The sequence of construction events includes consideration of the environmental impacts of the project, conditions of the NMFS Biological Opinion, the Georgia and South Carolina water quality certification, and other applicable environmental, cultural, and hydraulic factors. A summary of the conditions considered are listed below.

A. Environmental

1. Construction of McCoy Cut diversion structure must occur between May 15 and November 1.
2. No hopper dredging conducted in the entrance channel between April 1 and 14 December.
3. No inner harbor dredging conducted upstream of Station +63 between April 1 and May 15.
4. CSS *Georgia* must be removed prior to dredging in that area (Stations 58+500 to 59+000).
5. Small dredge must be used to construct broad berm at mouth of sediment basin.
6. Mechanical dredge must be used for deepening the McCoy Cut/Middle/Little Back River areas.
7. Cadmium-laden sediments should be distributed evenly across the CDF (14A and or 14B). Sediments must be maintained in a wet condition until capped and tested.
8. Hutchinson Island oxygen injection system must be operational prior to commencement of dredging in the inner harbor.
9. Plant McIntosh oxygen injection system must be operational no later than one year after commencement of dredging in the inner harbor.
10. Real estate acquisition process for fish bypass must commence prior to/concurrent with start of entrance channel dredging.

11. Construction of fish bypass must start prior to/concurrent with start on inner harbor dredging and be operational within two years after construction start date.
12. No downstream in-water work conducted near fish bypass between February 1 and May 31.
13. No blasting at Tidegate will be conducted without agency coordination.
14. Striped bass payment made prior to commencement of dredging.

B. Hydraulic

1. Construction of raw water storage impoundment prior to construction of the McCoy Cut diversion structure.
2. Construction of sediment basin sill and broad berm prior to removal of Tidegate.
3. Construction of plug at the lower arm near McCoy Cut prior to construction of diversion structure.
4. Rock fill at Rifle Cut, lower western arm of McCoy Cut, and sediment basin sill could be concurrent.
5. Construction of boat ramp should occur prior to closure of Rifle Cut.

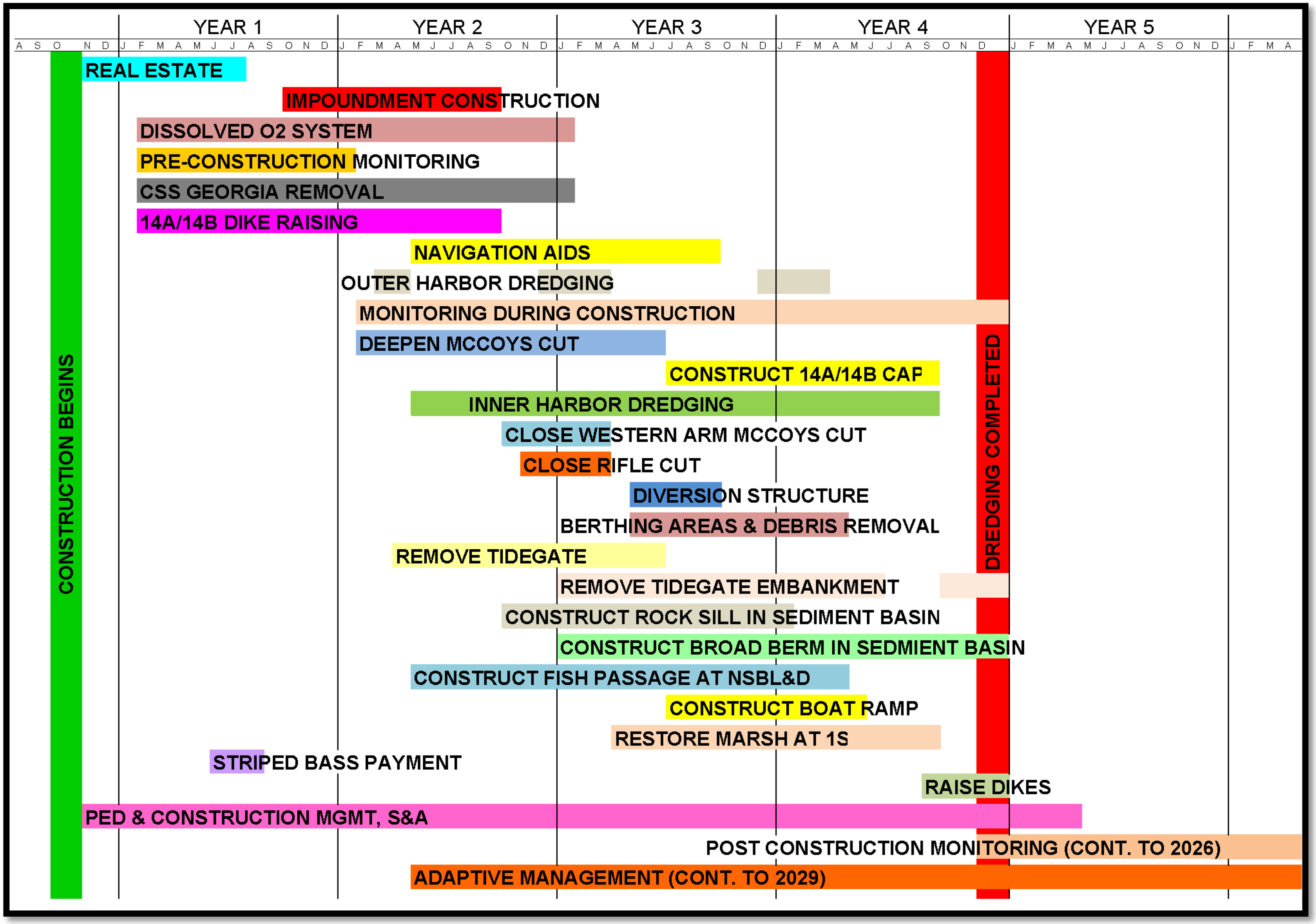

Figure 5-64. Sequence of construction for the Selected Plan.