US Army Corps
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Savannah District

Noyes Cut Section 1135 Ecosystem Restoration Study
Satilla River Basin, Georgia
Draft Integrated Feasibility Study and Environmental Assessment

U.S. Army Corps of Engineers
Savannah District
Planning Branch
Savannah, Georgia

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EXECUTIVE SUMMARY

The non-Federal sponsors, Georgia Department of Natural Resources (GADNR) and the Satilla Riverkeeper, in collaboration with Dover Bluff residents, requested that the Savannah District investigate under Section 1135 the best way to restore the Satilla River estuary system.

In 1933, the U. S. Army Corps of Engineers (USACE) widened and deepened Noyes Cut as part of the Inland Waterway. In 1940, USACE constructed the Atlantic Intracoastal Waterway (AIWW) from Umbrella Creek through the lower reach of Dover Creek. In total, eight man-made cuts account for the degraded ecosystem in the study area.

Those cuts changed the water circulation patterns in the estuary, altering patterns of tidal exchange; disrupting gradual salinity gradients from the headwaters to the mouth of the creeks; and limiting access to headwaters for estuarine species due to channel sedimentation.

The estuarine species historically found in Dover and Umbrella Creeks include shrimp (white and brown), river herring, American shad, blue crabs, eastern oyster, and striped bass. All of these species would benefit from the restoration of tidal flows, water depths, and salinity gradients in the area. Shad, herring, and striped bass require freshwater for spawning, while blue crabs, oysters, and shrimp require brackish water for successful reproduction.

To improve the quality of the existing aquatic habitat for resident species and increase connectivity for migratory species in the upper reaches of the Dover and Umbrella Creek watersheds, the study team recommends closing cuts to restore historic flow patterns in the watershed.

The study team assessed, evaluated, and compared the following final array of action alternatives: closing Noyes Cut alone; closing Dynamite Cut and Old River Run (ORR); and closing Noyes Cut, Dynamite Cut, and ORR.

The team compared the cost effectiveness of the ecosystem benefits for each alternative. The study team identified two cost effective alternatives: Alternative 6 (closing Dynamite Cut and ORR) and Alternative 7 (closing Noyes Cut, Dynamite Cut, and ORR). The team identified Alternative 7 as the Tentatively Selected Plan because it would provide the greatest amount of ecosystem restoration benefits and the best ecosystem for migratory fish spawning habitat.

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ACRONYMS

Acronyms	Definition
AAHU	Average Annual Habitat Units
AIWW	Atlantic Intracoastal Waterway
BMP	Best Management Practices
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
CZM	Coastal Zone Management
DNR	Department of Natural Resources
DO	Dissolved Oxygen
EA	Environmental Assessment
EO	Executive Order
EPA	United States Environmental Protection Agency
EPD	Environmental Protection Division
ERDC	US Army Engineer Research and Development Center
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
FWCAR	Fish and Wildlife Coordination Act Report
GADNR	Georgia Department of Natural Resources
GPA	Georgia Ports Authority
H&H	Hydraulic and Hydrologic
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Codes
IPAC	Information, Planning, and Conservation System
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAA	No Action Alternative
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
NGO	Non-Government Organizations
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRHP	National Register of Historic Places
OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
ORR	Old River Run near Bull Whirl Cut
PA	Programmatic Agreement
PDT	Project Delivery Team
PPA	Project Partnership Agreement
ppt	parts per thousand

RCRA	Resource Conservation and Recovery Act
SHPO	State Historic Preservation Officer
TMDL	Total Maximum Daily Load
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WRDA	Water Resources Development Act

1 Introduction

1.1 Purpose of Study Report*[1]

The U.S. Army Corps of Engineers (USACE), Savannah District (CESAS), has prepared this integrated Feasibility Report and Environmental Assessment (EA) to evaluate the potential impacts of closing man made cuts to restore hydrology in the Dover and Umbrella Creeks section of the Satilla River estuary. This EA was prepared in accordance with the National Environmental Policy Act of 1969, Council on Environmental Quality's Regulations (40 CFR 1500-1508), and USACE Engineer Regulation ER 200-2-2. This EA provides sufficient information on the potential adverse and beneficial environmental effects to allow the Savannah District Commander to make an informed decision on the appropriateness of an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI).

1.2 Study Authority

The study authority is Section 1135 of the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), as amended, which is intended for modifications to existing Federal projects for environmental benefits. Under this authority, USACE may plan, design, and construct modifications to existing USACE projects (or areas degraded by USACE projects) to restore aquatic habitats for fish and wildlife. The man-made cuts made as part of the Federally-authorized Atlantic Intracoastal Waterway (AIWW) project caused unexpected ecological degradation. The modifications proposed in this study would be part of the AIWW project and are designed to restore the ecological functions of the ecosystem.

Noyes Cut is a part of the Federally authorized AIWW project, and has been obsolete since 1939. Some alternatives include deauthorization of Noyes Cut, which would occur concurrent with approval of this project. Noyes Cut is currently not part of the active or Alternative AIWW navigation channel, so closure of this cut would not impair or change the Federal project.

1.3 Study and Project Area*

The study area is located in southern Georgia, in Camden County, just south of the town of Brunswick, Georgia. It includes Noyes Cut, Dover and Umbrella Creeks, as part of the lower Satilla River estuary (Figure 1 and Figure 2). The area that could be benefited by the proposed project consists of approximately 4518 acres and encompasses the tributaries and associated Spartina marsh above the Noyes Cut closure area (Figure 2 and Figure 3). Dover and Umbrella Creeks are meandering tidal channels generally running parallel to the Satilla River. The Satilla River (along with salt marshes, hammocks, sand bars, and mud flats) makes up the northern portion of the St. Andrews Sound estuary. Tidal marshes and creeks are some of the most ecologically

[1] An **asterisk (*)** in the table of contents and heading notes paragraphs that are required for National Environmental Policy Act (NEPA) compliance.

productive ecosystems providing critical habitat for fish and shellfish of commercial and recreational importance. Tidal marshes also provide a rich food source for both resident and migratory birds including osprey and eagles and they are utilized for many traditional, low impact recreational activities. The lands adjacent to Dover and Umbrella Creeks are sparsely populated with some residential developments along the creeks that include Dover Bluff Community, Piney Bluff Community, and River Marsh Landing.

The Alternate AIWW route provided a safer inland passage for small boats than the open waters of St. Andrews Sound (Figure 2 and Figure 4). The Alternate AIWW route is illustrated in Figure 2 and Figure 4:

- It leaves the main AIWW route at Jekyll Sound
- goes up the Little Satilla River
- through Umbrella Cut
- along Umbrella Creek
- through Dover Cut
- along Dover Creek
- through Alt AIWW Cut
- then heads down the Satilla River
- and reconnects to the main AIWW route

Figure 1 - Study Area within the Satilla River Basin (Yellow)

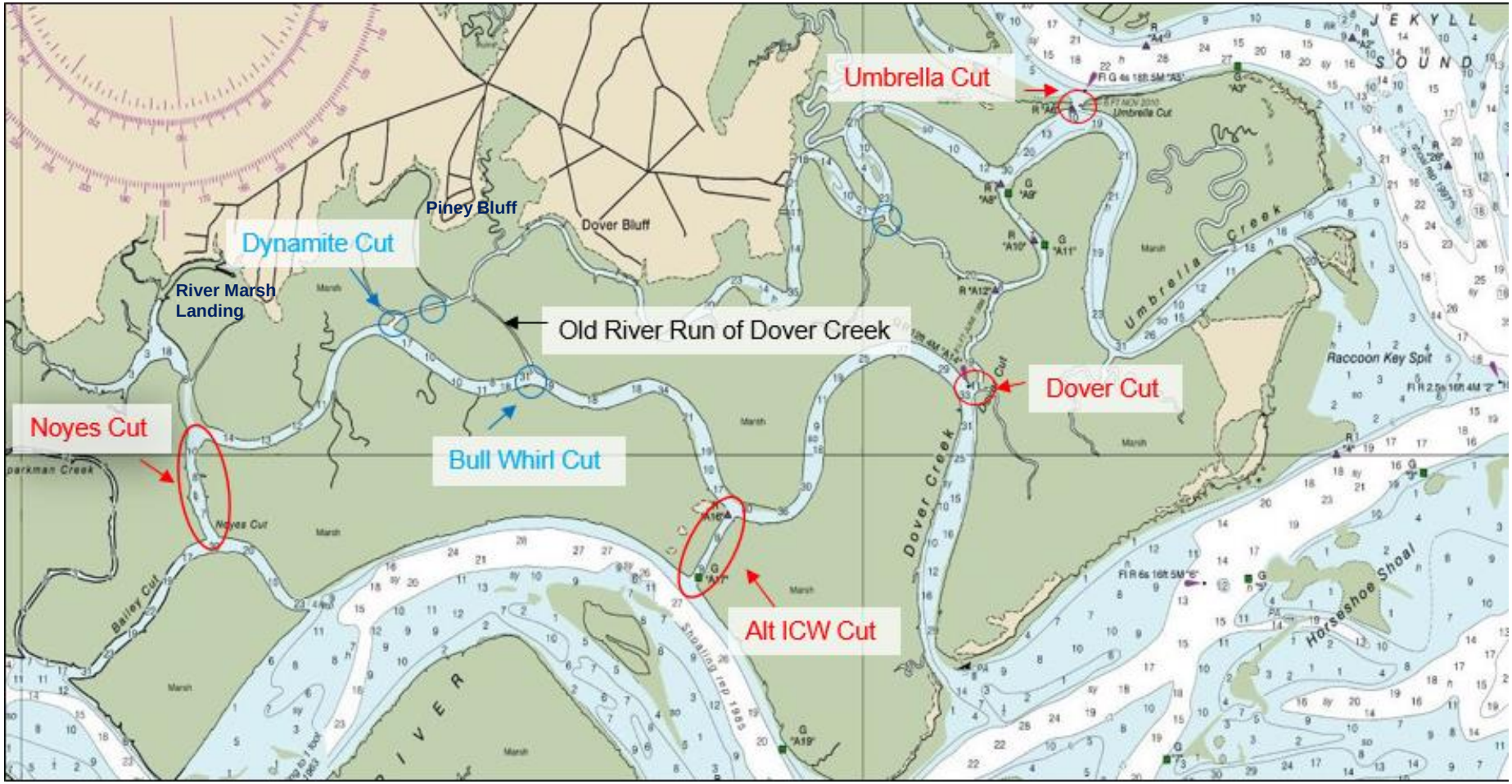

Figure 2 - Satilla River estuary with series of navigation cuts.
Congress authorized cuts depicted in red. Blue cuts were created by local citizens.

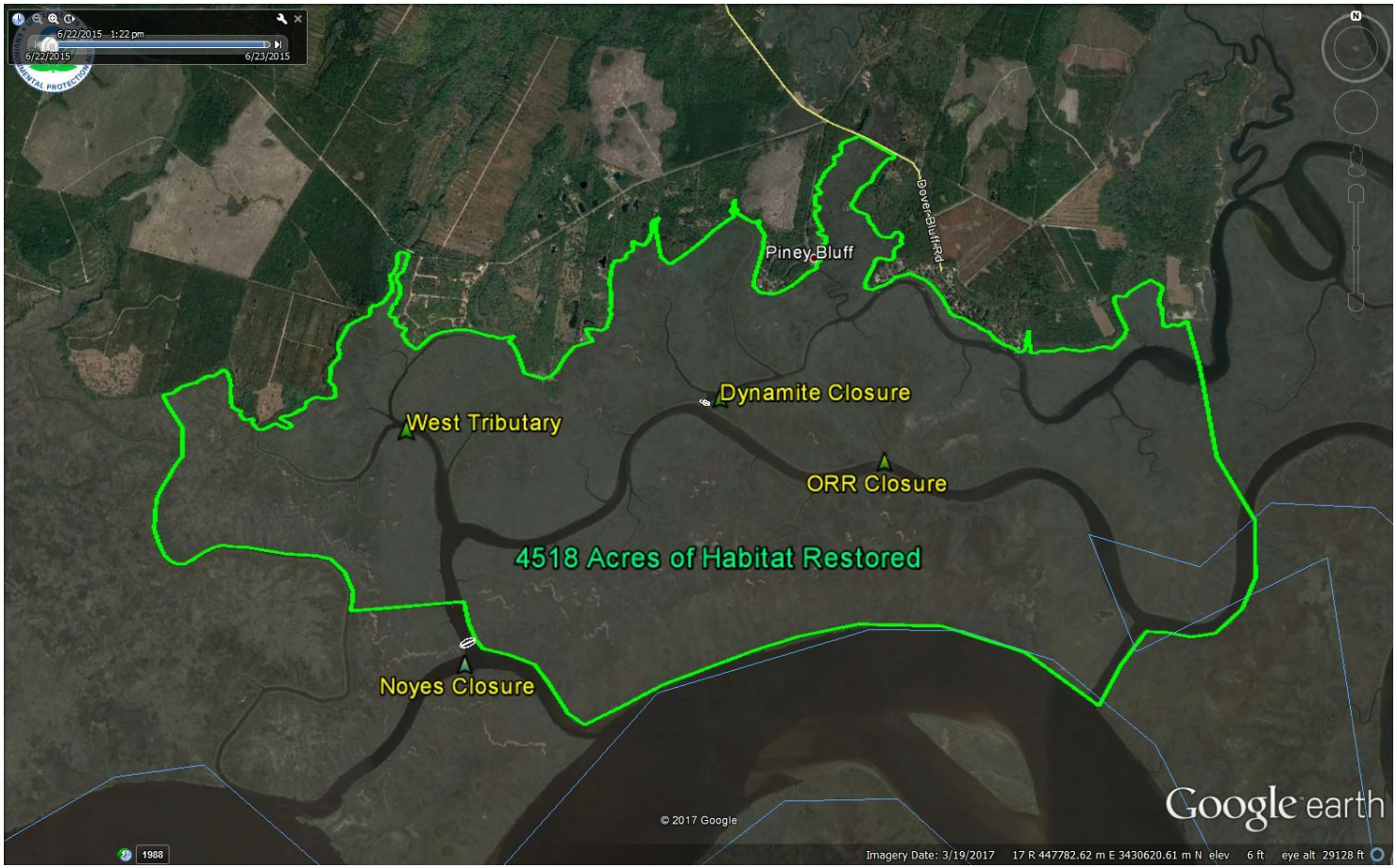

Figure 3 - Noyes Cut Closure, West Tributary, Restored Area

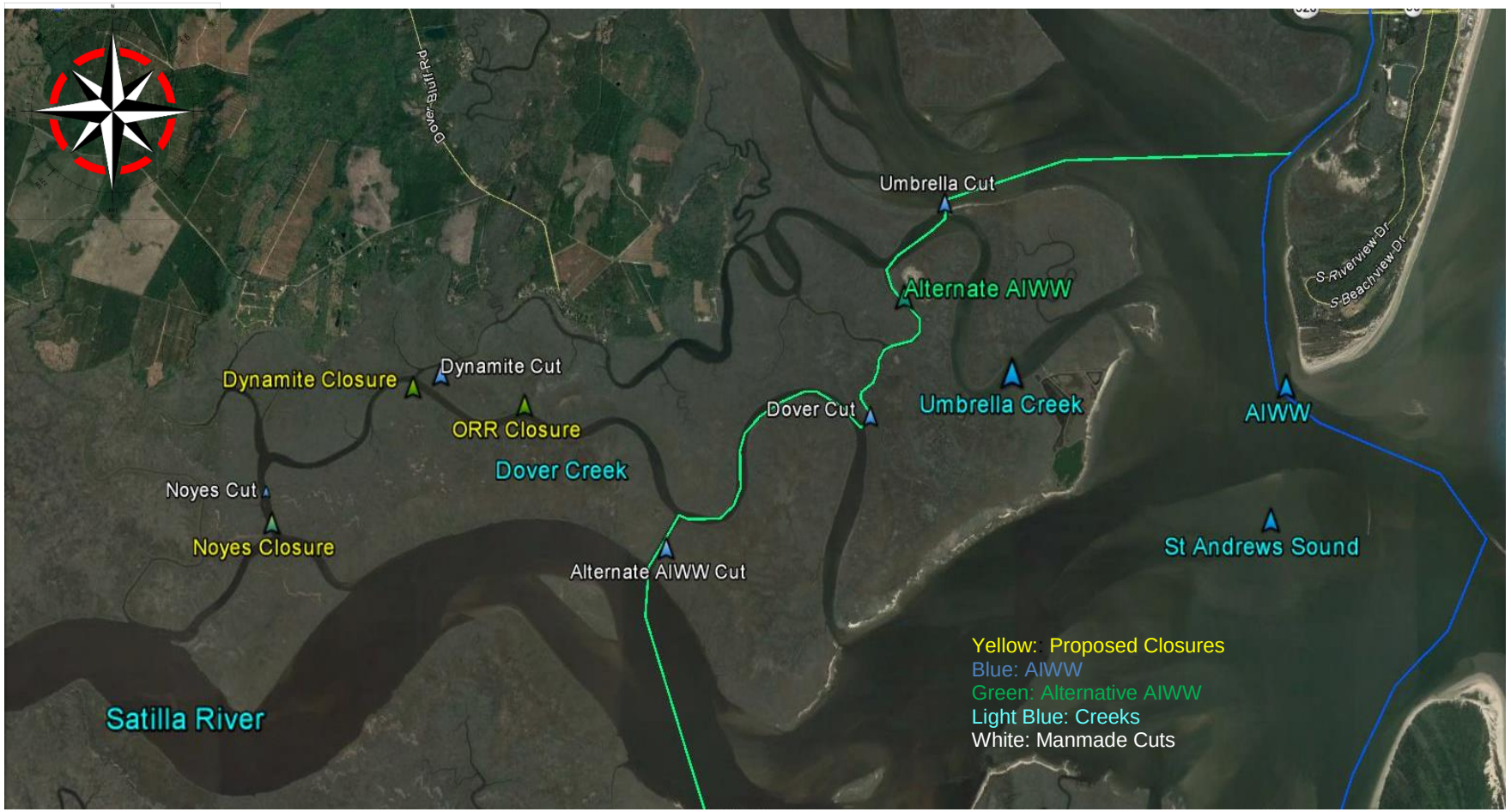

Figure 4 - AIWW and Alternate AIWW

1.4 Purpose and Need

The purpose of the project is to restore aquatic habitat (wetlands and tidal creeks) degraded by the AIWW in the vicinity of Umbrella and Dover Creeks of the Satilla River estuary and improve salinity gradients that improve directional cues for migratory fish, shrimp, and crabs. The project is needed because past actions for the AIWW altered salinity gradients by allowing a large volume of Satilla River water to enter upriver portions of tidal creeks through the short pathway of Noyes and Dynamite Cuts.

This large volume of brackish water overwhelms the freshwater that enters the headwater area and causes the salinity to be nearly constant throughout most of Umbrella and Dover Creeks. Additionally, tidal flows through multiple creeks and cuts cause a tidal node where sediment deposition clogs channels. Reducing tidal flows through Noyes Cut and Dynamite Cut should restore water depths in Umbrella and Dover Creeks, which have silted in as a result of changes in circulation patterns. This sedimentation has restricted access to portions of the estuary for shrimp, shellfish, and migratory fish.

A benefit of closing the man-made cuts is restoring the natural tidal flows that typically occur along the length of unaltered tidal creeks. This distribution should redistribute the sediments, creating a sandier, deeper creek bottom, and restore gradual salinity gradients from the headwaters to the mouth. Salinity gradients serve as important directional cues for orienting migratory fish and shellfish.

Estuarine species historically found in Dover and Umbrella Creeks include shrimp (white and brown), river herring, American shad, blue crabs, eastern oyster, and striped bass (see Table 2 for a more comprehensive list). All of these species should benefit from restoring historic tidal flows, water depths, and salinity gradients in the area. Shad, herring, and striped bass require freshwater for spawning, while blue crabs, oysters, and shrimp require brackish water for successful reproduction. Potential indirect long-term benefits of restoring depths and flows may include increased dissolved oxygen (DO) levels, decreased Total Suspended Solids (TSS), and improved nutrient exchange between the Satilla River, St. Andrews Sound, and the Atlantic Ocean.

In addition to the intended ecosystem benefits, ancillary benefits may include the return of sport fishing and commercial fishing/crabbing in Dover and Umbrella Creeks for the aforementioned species. Deep water access would also be restored to residential developments adjacent to the estuary that currently have access only at high tide.

1.5 History

The Satilla River estuary contains a complex network of tidal channels. From 1900 to 1939, eight man-made cuts (Figure 2) were made between natural channels to increase the accessibility of the tidal creeks for the timber industry and to provide safer inland routes for smaller water craft. Some of these cuts were authorized as part of an inside waterway from Savannah, GA to Fernandina, FL, now known as the AIWW. The AIWW

between Savannah, Georgia, and Fernandina, Florida, was initially authorized by the River and Harbor Act of August 2, 1892 (House Document 41, 52nd Congress, 2nd Session) which provided for a 7-foot channel.

The River and Harbor Act of July 25, 1912 (House Document 1236, 60th Congress, 2nd Session) incorporated alternate routes previously improved as separate projects and auxiliary channels in the waterway between Savannah, GA and Fernandina, FL. In 1915, USACE excavated cuts at Umbrella Creek and Dover Creek, dredging channels 4 feet deep at mean low water, 85 feet wide, and of a total length of 1,130 feet. The River and Harbor Act of July 3, 1930 (Senate Document 43, 71st Congress, 2nd Session) authorized a channel 5 feet deep and 50 feet wide connecting Baileys Cut (a natural auxiliary to Satilla River) to Dover Creek, and the cut was completed in 1933. The cut, known locally as Noyes Cut, had been excavated in 1910 by Camden County to create a safe inland route for small watercraft travelling from the Satilla River to Brunswick, GA, which allowed vessels to avoid the rough waters in St. Andrews Sound.

In 1939, USACE completed Satilla Cut (or Alternative AIWW Cut), which connected the lower reach of Dover Creek with the Satilla River, creating a shallow, protected route (Figure 2 and Figure 3). The protected route with 3 feet project depth leaves Brunswick Harbor and follows Jointer Creek, Jekyll Sound, Little Satilla River, Umbrella Cut, Umbrella Creek, Dover Cut, Dover Creek, Satilla River, Todd Creek, and Floyd Creek to Cumberland River. A channel 5 feet deep and 50 feet wide connects Baileys Cut of Satilla River and Dover Creek. This route made Noyes cut obsolete and is now referred to as the Alternate AIWW.

Old River Run (ORR), which is near Bull Whirl Cut, (Figure 2), is a remnant of Dover Creek. This reach of Dover Creek has been greatly changed by the aforementioned man-made cuts over the last century, and ORR is currently in the process of completely filling in due to the natural processes of sedimentation. This sedimentation in ORR and the overall change to the ecosystem in the area are due to hydrologic changes caused by the multitude of man-made cuts. This reach is converting into tidal marsh from the historic tidal creek.

In 1979, as part of the Satilla River Basin Study, hydraulic analysis examined six (6) alternatives to address the shoaling problem. The report recommended plugging the oxbow cut on Dover Creek, and connecting Dover and Umbrella Creeks on the ebb side of the closure at a cost of $1.3 million. Economic analysis of the recommended plan identified no net benefits.

In 1983, the USACE Savannah District studied shoaling at Umbrella Creek. Numerical modeling was used to determine potential causes of shoaling and courses of action. This study set the groundwork for the demonstration project authorized in the Water Resources Development Act of 1986. The Water Resources Development Act of 1986 authorized USACE to complete a demonstration project in the Satilla River Basin to close Noyes Cut and Bull Whirl Cut with earthen plugs and monitor for a 10-year period.

The Energy and Water Development Act of 1990 authorized funding for additional study of the Umbrella Creek area. In May 1990, the Savannah District completed a preliminary study of the shoaling in Umbrella Creek/Dover Bluff and determined a better course of action was to close Bull Whirl Cut first due to environmental and navigational impacts. The Corps further deduced that Noyes Cut could potentially be closed at a later date unless the 10-year monitoring showed closing it unnecessary.

In 1991, this study was terminated from the USACE Savannah District and the remaining funds were reprogrammed. As a result, in the Federal Register, Vol. 68, No 123 (38022), the demonstration project for the Satilla River Basin to close Noyes Cut and Bull Whirl Cut was de-authorized.

1.6 Other Planning Studies, Reports, or Efforts

- McMahon, George F. Chief, Coastal and Waterways Engineering Station. Hydrodynamic Analysis from Man-made Cuts, Dover Bluff, Satilla River Basin, Camden County, Georgia. Savannah District USACE. September 1983 (which is incorporated herein by reference).

- USACE Savannah District Planning Division. Umbrella Creek Section 1135 Preliminary Restoration Plan. February 2004.

- USACE Savannah District Planning Division. Section 1151 of WRDA 1986 Umbrella Creek Demonstration Project. May 10, 1990.

1.7 Study Sponsor

USACE is conducting this study in partnership with the non-Federal sponsors, which are the Georgia Department of Natural Resources (DNR) and the Satilla Riverkeeper.

2 Existing Conditions and Affected Environment*

2.1 Environmental Setting

The Satilla River estuary contains a complex network of tidal channels. Man-made cuts changed the hydraulic circulation patterns in the estuary by (1) altering local patterns of tidal exchange; (2) disrupting gradual salinity gradients from the headwaters to the mouth of the creeks; and (3) reducing access to headwaters for estuarine species due to channel sedimentation. These have significantly degraded the watershed habitat. Dover and Umbrella Creeks are the primary creeks within the system and serve as both key habitats and primary routes for movement of organisms and water.

Salinity gradients provide a variety of estuarine and migratory species the directional cues for local movement and long-distance migration essential for completing their life cycles. Additionally, tidal flows through multiple creeks and cuts cause a tidal node

where sediment deposition clogs channels. Reduced tidal flows through Noyes Cut and Dynamite Cut should restore water depths in Dover and Umbrella Creeks, which has silted in as a result of changes in circulation patterns. This sedimentation has restricted access to portions of the estuary for shrimp, shellfish, and migratory fish.

Umbrella and Dover Creeks are part of the lower Satilla River tidal estuary.
The Satilla River (along with salt marshes, hammocks, sand bars, and mud flats) makes up the northern portion of the St. Andrews Sound estuary. Shallow subtidal creeks and mudflats surround the tidal marshes. Tidal marshes and creeks are some of the most ecologically productive ecosystems providing critical habitat for fish and shellfish of commercial and recreational importance. Tidal marshes/creeks also provide a rich food source for both resident and migratory birds including osprey and eagles and they are utilized for many traditional, low impact recreational activities. The tidal marshes in the study area consist primarily of saltmarsh cordgrass (*Spartina alterniflora*).

This estuarine habitat provides a site for abundant primary production that supports a rich diversity of plankton, benthic invertebrates, and small fish, which are food sources for higher level consumers such as wading birds, larger fish, blue crabs, and shrimp. Commercial crabbing is still active in this area, but occurs at much less than historical levels. The large tidal flushing of the area results in the wide dispersal of the products of the marshes' primary production to the ocean.

Aside from some residential developments along uplands adjacent to Dover and Umbrella Creeks, the area is sparsely populated. An adjacent area of over 1,000 acres of forested uplands that is undeveloped provides valuable wildlife habitat and a habitat corridor connecting forested uplands with the tidal open water and marsh habitat. Portions of this land adjacent to Dover Bluff have been operated as a hunting club for a number of years, resulting in higher quality habitat for native wildlife. This land use results in higher quality habitat by both preserving the native forest ecosystem and through plantings designed to increase foraging habitat for wildlife.

The Satilla River basin is characterized by mild winters and hot summers. Mean annual precipitation ranges from 46 to 54 inches per year. Rainfall is fairly evenly distributed throughout the year, but a distinct dry season occurs from mid-summer to late fall. Rainfall is usually greatest in March and least in October. The mean annual temperature is about 68 degrees Fahrenheit (Satilla River Basin Management Plan 2002).

2.2 Relevant Significance

This section contains a description of relevant resources that could be impacted by the project. The important resources described in this section are those recognized by laws, executive orders, regulations, and other standards of National, state, or regional agencies and organizations; technical or scientific agencies, groups, or individuals; and the general public. **Error! Reference source not found.** provides summary information of the institutional, technical, and public importance of these resources**.**

Table 1 – Relevant Resources

Resource	Institutionally Important	Technically Important	Publicly Important
Wetlands	Clean Water Act of 1977, as amended; Executive Order 11990 of 1977, Protection of Wetlands; Coastal Zone Management Act of 1972, as amended; and the Estuary Protection Act of 1968., EO 11988, and Fish and Wildlife Coordination Act.	They provide necessary habitat for various species of plants, fish, and wildlife; they serve as ground water recharge areas; they provide storage areas for storm and flood waters; they serve as natural water filtration areas; they provide protection from wave action, erosion, and storm damage; and they provide various consumptive and non-consumptive recreational opportunities.	The high value the public places on the functions and values that wetlands provide. Environmental organizations and the public support the preservation of marshes.
Aquatic Resources/ Fisheries	Fish and Wildlife Coordination Act of 1958, as amended.	They are a critical element of many valuable freshwater and marine habitats; they are an indicator of the health of the various freshwater and marine habitats; and many species are important commercial resources.	The high priority that the public places on their esthetic, recreational, and commercial value.
Wildlife	Fish and Wildlife Coordination Act of 1958, as amended and the Migratory Bird Treaty Act of 1918	They are a critical element of many valuable aquatic and terrestrial habitats; they are an indicator of the health of various aquatic and terrestrial habitats; and many species are important commercial resources.	The high priority that the public places on their esthetic, recreational, and commercial value.
Threatened and Endangered Species	The Endangered Species Act of 1973, as amended; the Marine Mammal Protection Act of 1972; and the Bald Eagle Protection Act of 1940.	USACE, USFWS, NMFS, NRCS, EPA, and GA cooperate to protect these species. The status of such species provides an indication of the overall health of an ecosystem.	The public supports the preservation of rare or declining species and their habitats.

Resource	Institutionally Important	Technically Important	Publicly Important
Cultural Resources	National Historic Preservation Act of 1966, as amended (54 USC 2106); the Native American Graves Protection and Repatriation Act of 1990; and the Archaeological and Historical Preservation Act of 1974 (16 USC 469-469c)	Resources are tangible remains of past human activity. They may yield information about past environments and societies. Their association or linkage to past events, to historically important persons, and to design and construction values; and for their ability to yield important information about prehistory and history	Public supports protection and enhancement of cultural resources as a way to learn about cultures, history and traditions
Recreation Resources	Federal Water Project Recreation Act of 1965 as amended and Land and Water Conservation Fund Act of 1965 as amended	Provide high economic value to local, state, and national economies.	Public makes high demands on recreational areas. There is a high value that the public places on fishing, hunting, and boating, as measured by the large number of fishing and hunting licenses sold in Georgia; and the large per-capita number of recreational boat registrations in Georgia.
Aesthetics	USACE ER 1105-2-100, and National Environmental Policy Act of 1969, the Coastal Barrier Resources Act of 1990, Wild and Scenic Rivers Act of 1968, and the National and Local Scenic Byway Program.	Visual accessibility to unique combinations of geological, botanical, and cultural features that may be an asset to a study area. State and Federal agencies recognize the value of tidal salt marsh ecosystems.	Environmental organizations and the public support the preservation of natural pleasing vistas.
Air Quality	Clean Air Act of 1963	State and Federal agencies recognize the status of ambient air quality in relation to the NAAQS.	Virtually all citizens express a desire for clean air.
Water Quality	Clean Water Act of 1977, Fish and Wildlife Coordination Act, Coastal Zone Mgt Act of 1972.	USACE, USFWS, NMFS, NRCS, EPA, and States DNRs and wildlife/fishery offices recognize value of fisheries and good water quality. The national and state standards established to assess water quality	Environmental organizations and the public support the preservation of water quality and fishery resources and the desire for clean drinking water.

The following resources have been considered and found to not be adversely affected by the alternatives under consideration: essential fish habitat; terrestrial resources, including prime and/or unique farmlands; hydrology and floodplain, Hazardous Toxic and Radioactive Waste (HTRW), and socio-economic resources including demographics, economic conditions, water supply, and community cohesion.

The condition of the study area placed it as #8 on the Georgia Water Coalition's Dirty Dozen list in 2012 (Georgia Water Coalition 2012). The Georgia Water Coalition Dirty Dozen is a list of the 12 worst offenses against Georgia's water. The report concluded that the unnatural cuts from the early 1900's are "wreaking havoc on migrating fish, blue crabs and boating routes near the mouth of the Satilla River."

In the March 21, 2013 Legislative Session, the Georgia Senate and the Georgia House of Representatives passed Resolution 267 to become a Joint Resolution (13: LC 40 0308). This resolution urged USACE to close Noyes Cut to restore the migrations of fish in the Satilla River and tidal creeks and improving routes for boaters (Georgia Senate/House Resolution 2013).

Scarcity and Significance of Resource: Shad and river herring are anadromous fish that spend the majority of their adult lives at sea, only returning to freshwater in the spring to spawn. Historically, shad and river herring spawned in virtually every river and tributary along the coast. Species such as shad have historically been found in large seasonal runs to upstream spawning grounds in the study area.

Shad and river herring once supported the largest and most important commercial and recreational fisheries along the Atlantic coast. Since colonial times, the blockage of spawning rivers by dams and other impediments, combined with habitat degradation and overfishing, have severely depleted shad and river herring populations. In general, populations of these two species have declined exponentially (as demonstrated in Figure 5) over the last several decades in the southeast (ASMFC 2016 and NMFS 2014).

Commercial landings for these species have declined dramatically from historic highs. Commercial landings by domestic and foreign fleets peaked at 140 million pounds in 1969. Since 2000, domestic landings totaled less than four million pounds in any given year, with a historic low of 823,000 pounds occurring in 2006. In 2005, the directed at-sea fishery for American shad was closed, and subsequent landings from the ocean are only from the bycatch fishery. In 2015, approximately 414,921 pounds of American shad were landed, while an estimated 1.3 million pounds of river herring were landed.

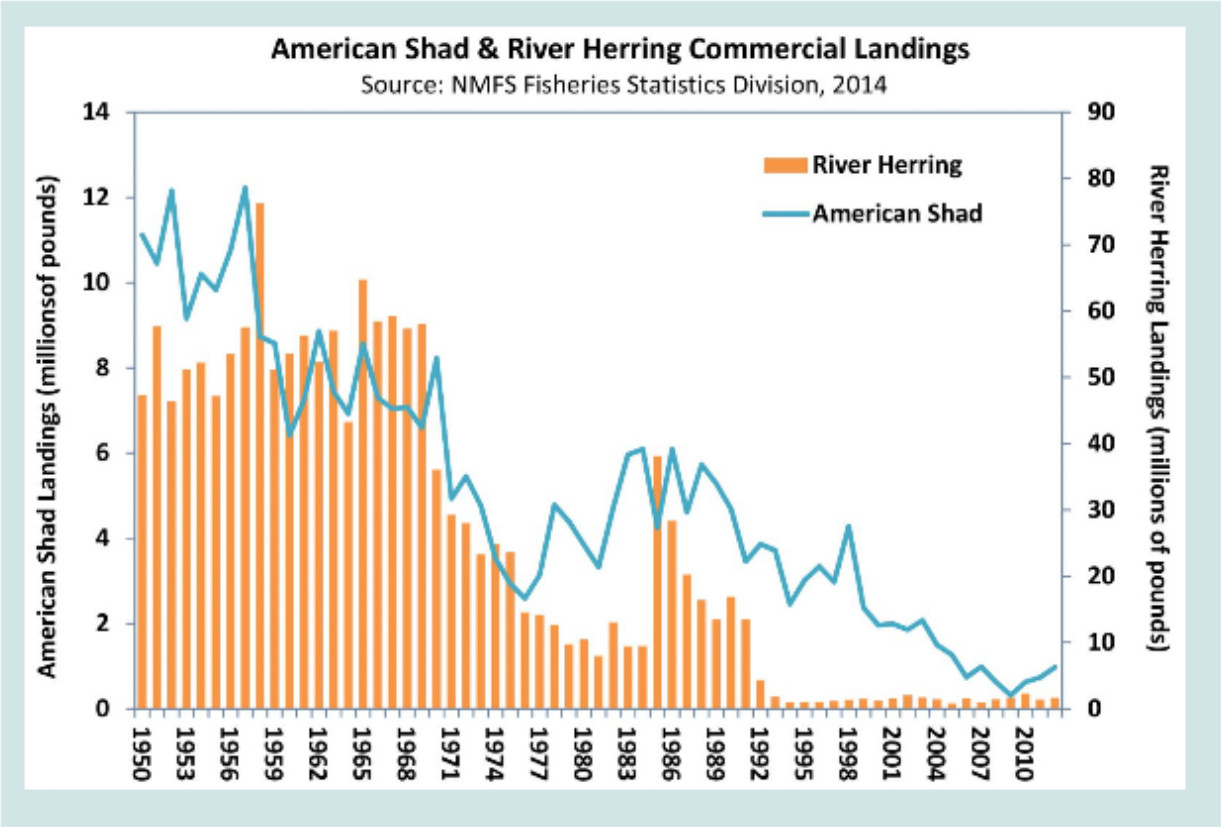

Figure 5 - Decline in American Shad/River Herring since 1950

2.3 Relevant Resources

2.3.1 Hydrology and Floodplains

Executive Order (EO) 11988 has an objective to avoid, to the extent possible, long, and short-term adverse impacts associated with occupancy and modification of the base floodplain. Further objectives are the avoidance of direct and indirect support of development in the base floodplain wherever there is a practicable alternative and protection and restoration of natural floodplain functions. The USACE regulation for implementing EO 11988 (ER 1165-2-26) defines the base floodplain as the 100-year or one percent chance floodplain. The alternatives analyzed in this document would only involve restoration of historic tidal circulation patterns and would not alter the floodplain hydrology.

Historical man-made cuts changed the circulation patterns in the estuary and (1) altered local patterns of tidal flows; (2) disrupted gradual salinity gradients from the headwaters to the mouth of the creeks; and (3) increased local sedimentation within Umbrella Creek. Currently, salinity gradients are altered by a large volume of Satilla River water. This large volume of brackish water entering through the short pathways of the man-made cuts overwhelms the freshwater that enters the headwater area and causes the salinity to be nearly constant throughout most of Dover Creek. Additionally, tidal flows

through multiple creeks and cuts causes a tidal node where sediment deposition clogs channels.

2.3.2 Aquatic Resources and Aquatic Habitat

Estuarine species historically found in Dover and Umbrella Creeks include shrimp (white and brown), river herring, American shad, blue crabs, eastern oyster, and striped bass. All of these species may benefit from the restoration of tidal flows, water depths, and salinity gradients in the area. Shad, herring, and striped bass require freshwater for spawning, while blue crabs, oysters, and shrimp require brackish water for successful reproduction. A more comprehensive list of species in the study area that may benefit from ecosystem restoration is detailed in Table 2. Additional information about the decline and scarcity of shad and herring may be found in Section 2.2 and demonstrated in Figure 5.

Table 2 - Common Species in study area potentially impacted by project (USACE 2017b)

Fauna Type	Habitat Requirements	Currently present in project impact area	Historically present in project impact area	Habitat Benefited from Restoration
Blue crab (C)	Saltwater for spawning; Brackish water for nursery and adult male habitat	Yes	Yes	Yes
Shrimp (C)	Saltwater for spawning; Brackish water for nursery habitat	Yes	Yes	Yes
Oyster(C)	Brackish water	Yes (small amounts)	Yes	Possible
American/Hickory Shad (G/C)	Saltwater - Freshwater (Spawning)	Yes (small amounts)	Yes, large runs to spawning grounds	Yes
Herring (River, Alewife, blueback) (C)	Saltwater - Freshwater (Spawning)	Yes	Yes	Yes
Striped bass (G)	Saltwater - Freshwater (Spawning)	Yes (Rare)	Yes	Yes
American eel (C)	Freshwater - Saltwater for Spawning	Yes	Yes	Yes
Spotted seatrout (C/G)	Brackish - Freshwater	Yes	Yes	Yes
Red drum(C/G)	Brackish - Freshwater	Yes	Yes	Yes
Snapper Grouper Complex (C/G)	Saltwater - Brackish	Yes	Yes	Yes
Flounder (C/G)	Saltwater - Brackish - Freshwater	Yes	Yes	Yes
White Bullhead (G) *Ameiurus catus*	Freshwater - Brackish	Yes	Yes	Yes
Shortnose Sturgeon (E&T)	Saltwater - Freshwater (Spawning)	Yes (Rare)	Yes (Rare)	Unlikely

Atlantic (E&T) Sturgeon	Saltwater - Freshwater (Spawning)	Yes (Rare/ Juveniles)	Yes (Rare/ Juveniles)	Unlikely
Manatee (E&T)	Freshwater - Saltwater	Yes	Yes	Yes
Wood Stork (E&T)	Saltwater - Freshwater	Yes	Yes	Yes
C- Commercial Species; G - Game Species; E&T - Endangered or Threatened Species (see Section 2.3.6 for more detail on these species)				

2.3.3 Essential Fish Habitat

Essential Fish Habitat (EFH) in the study area consists entirely of tidal saltmarsh and tidal creeks. The structure and function of a saltmarsh are influenced by tide, salinity, nutrients, and temperature. Saltmarsh can be a stressful environment to plants and animals, with rapid changes occurring in these abiotic variables (Gosselink 1980; Gosselink et al. 1974). Although species diversity may be lower than in other systems, the saltmarsh is one of the most biologically productive ecosystems in the world (Teal 1962; Teal and Teal, 1969). The high primary productivity that occurs in the marsh, and the transfer of detritus into the estuary from the marsh, provides the base of the food chain supporting many marine organisms.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) set forth requirements for the National Marine Fisheries Service (NMFS), regional Fishery Management Councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of EFH and a requirement for interagency coordination to further the conservation of Federally-managed fisheries.

Through EFH consultations, NMFS works with federal agencies to conserve and enhance EFH. Consultation is required when a federal agency authorizes, funds, or undertakes an action that may adversely affect EFH. The federal agency must provide NMFS Fisheries with an assessment of the action's impacts to EFH, and NMFS Fisheries provides the federal agency with EFH conservation recommendations to avoid, minimize, mitigate, or otherwise offset those adverse effects. Federal agencies must provide a detailed written explanation to NMFS Fisheries describing which recommendations that it has not adopted.

The Magnuson-Stevenson Fishery Conservation and Management Act requires that Essential Fish Habitat (EFH) areas be identified for each fishery management plan and that all Federal agencies consult with the NMFS on Federal actions that may adversely affect EFH. In coordination with NMFS (Cooksey 2017), Savannah District determined that the EFH species that could be impacted by the alternatives are within the shrimp group and the Snapper-Grouper Complex. The specific species within these two groups are shown in Table 3.

Table 3 - Essential fish Habitat (EFH) Species for the Project Area

Fishery Management Plan (FMP)	Scientific Name of Species	EFH for Life Stages (Estuarine)	Habitat Areas of Particular Concern
Shrimp	Brown shrimp *Farfantepenaeus aztecus*	Post Larvae, Juveniles, and Adults	Penaeid Shrimp HAPC – tidal inlets, state nursery and overwintering habitats
Shrimp	White shrimp *Litopenaeus setiferus*	Post Larvae, Juveniles, and Sub Adults	Penaeid Shrimp HAPC - tidal inlets, state nursery and overwintering habitats
Snapper Grouper Complex	Black Sea Bass *Centropristis striata*	Post Larvae, Juveniles	Estuaries, particularly oyster reefs
Snapper Grouper Complex	Gag grouper *Mycteroperca microlepis*	Post Larvae, Juveniles	Estuaries, particularly oyster reefs
Snapper Grouper Complex	Crevalle Jack *Caranx hippos*	Post Larvae, Juveniles, and Adults	
Snapper Grouper Complex	Sheepshead *Archosargus probatocephalus*	Post Larvae, Juveniles, and Adults	Estuaries, particularly oyster reefs
Snapper Grouper Complex	Gray snapper *Lutjanus griseus*	Post Larvae, Juveniles, and Sub Adults	
Snapper Grouper Complex	Lane snapper *Lutjanus synagris*	Juveniles Sub Adults	

2.3.4 Wetlands

The study area consists entirely of tidal saltmarsh (Jurisdictional Wetlands) and tidal creeks (Jurisdictional Waters of the U.S.). Although species diversity may be lower than in other systems, the tidal saltmarsh is one of the most biologically productive ecosystems in the world (Teal 1962; Teal and Teal, 1969). Tidal marshes and creeks provide critical habitat for fish and shellfish of commercial and recreational importance. This ecosystem also serves as critical nursery habitat for many estuarine and marine species. It is estimated that between 60% and 80 % of the commercially important fish and shellfish species in the southeast have some life stage associated with salt marsh habitats (DeVoe and Baughman 1986; Crowder 1999). The large fishery provides a food source for both resident and migratory birds including osprey and eagles; and the ecosystem is utilized for many traditional, low impact recreational activities.

The extensive salt marshes surrounding the Satilla are generally dominated by salt marsh cord grass, (*Spartina alterniflora)* at lower elevations. Areas that are infrequently flooded are dominated with black needle rush, (*Juncus roemerianus)*. Brackish marshes are dominated by big cordgrass (*S. cynosuroides)* and salt marsh cord grass *(S. alterniflora)* along levees, with monospecific stands of black needle rush (*J. roemerianus)* throughout the mid-marsh. Freshwater marshes typically contain a greater diversity of species, including wild rices, (*Zizania aquatic)* and (*Zizaniopsis miliacae)* (Alber et al. 2003).

The major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife but support an important detritus-based food web (Teal 1962). The high primary productivity that occurs in the marsh, and the transfer of detritus into the estuary from the marsh, provides the base of the food chain supporting many marine organisms. In contrast, the fleshy broad leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and there is a high incidence of direct grazing or feeding on these plants (Odum et al. 1984).

2.3.5 Terrestrial Resources and Wildlife

Reptiles inhabiting the salt marsh include the diamondback terrapin (*Malaclemys terrapin*) and alligators (*Alligator mississippiensis*) occasionally feed in the marsh. Three bird species nest in the marsh: the clapper rail (*Rallus longirostris*); seaside sparrow (*Ammodramus maritimus*); and long-billed marsh wren (*Telmatodytes palustris*). Great blue herons (*Ardea herodias*), common and snowy egrets (*Egretta* spp.), and other wading birds commonly forage in the marsh at low tide. Several mammal species also feed in the salt marsh: raccoons (Procyon lotor), marsh rabbits (*Sylvilagus palustris),* mink (Mustela vison), otter (*Lontra canadensis*), and rice rat (Oryzomys palustris) (Seabrook 2017).

2.3.6 Threatened, Endangered and Protected Species

The Endangered Species Act (ESA) of 1973 (16 USC 1531-1543) regulates activities affecting plants and animals classified as endangered or threatened, as well as the designated critical habitat of such species. Research on the U.S. Fish and Wildlife Service's (USFWS) Information, Planning, and Conservation System (IPAC) website (http://ecos.fws.gov/ipac/) indicated Federally listed species within the Camden County. The USFWS IPAC website also identified critical habitat for many of the endangered and threatened species within the study area.

The recently designated critical habitat for Atlantic Sturgeon does not affect the study area. Based on the most recent (August 16, 2017) Federal Register publication of the final rule and the GIS mapping provided by NMFS on their website, SAS has confirmed that the impact area for the closure structures and the area where hydraulic changes will occur are outside of the designated critical habitat.

Table 4 identifies the species that have been listed by the USFWS and/or the NMFS that have the potential to occur within the study area.

Table 4 - Federal/State Endangered, Threatened and Candidate Species With Potential to Occur in the Study Area

Common Name	Scientific Name	Critical Habitat Designated In Study Area	Federal/State Status
West Indian Manatee	Trichechus manatus	N	T/T
Wood Stork	Mycteria americana	N	T/E
Atlantic Sturgeon[1]	Acipenser oxyrinchus oxyrinchus[1]	N	E/E
Shortnose Sturgeon[1]	Acipenser brevirostrum[1]	N	E/E
E - Endangered T - Threatened N - None Source: This information was obtained from coordination with USFWS/NMFS in April-May 2017 1 - Species under jurisdiction of NMFS			

West Indian Manatee (*Trichechus manatus)* **Federal Status**: Threatened
Manatees inhabit both salt and fresh water of sufficient depth (5 feet to usually less than 20 feet) that includes slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS, 1991) throughout their range. The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce. They may be encountered in canals, rivers, estuarine habitats, saltwater bays, and on occasion have been observed as much as 3.7 miles off the Florida Gulf coast. Manatees may move through the study area in the summer months. More information on this species' life cycle may be found on the USFWS website: https://ecos.fws.gov/ipac/.

During the cooler months between October and April, Florida manatees concentrate in areas of warmer water. Manatees are thermally stressed at water temperatures below 18ºC (64.4ºF) (Garrott et al., 1995); therefore, during winter months, when ambient water temperatures approach 20ºC (68ºF), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water industrial outfalls as far north as southeast Georgia.

Manatees are known to visit the study area in the summer months (April through November) as they migrate up and down the coast. The USFWS advised that manatees can be assumed to be in the study area from April through November (USFWS 2017). The GADNR (GADNR 2017) said a very conservative estimate would be March 1 to November 30 due to the warmer winters and increasing populations of manatees. Management of this protected species falls under the jurisdiction of the USFWS. The USFWS has recommended a construction window outside of the March 1 to November 30 estimate (December through February) in their Draft FWCAR (FWCAR 2017).

Manatees will often be attracted to any type fresh water emission into the river; even emissions as small as a garden hose and will often come up to docks and drink from the hose (Hill 2010). Local residents of Dover Bluff have observed them at their docks during the summer months (Montague 2017c).

Manatees primarily feed on freshwater vegetation along with some seagrasses and require freshwater for drinking. There would be beneficial impacts to their habitat from the increase in quantity of freshwater upstream and the improvement of access/connectivity to these upstream freshwater feeding grounds.

Shortnose Sturgeon (*Acipenser brevirostrum*) **Federal Status**: Endangered

The Shortnose sturgeon (Figure 6) is an anadromous species restricted to the east coast of North America. Throughout its range, Shortnose sturgeon occur in rivers, estuaries, and the sea. It is principally a riverine species and is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional overwintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt) salinity or greater) as adults during the winter. The majority of populations have their greatest abundance and are found throughout most of the year in the lower portions of the estuary and are considered to be more abundant now than previously thought (NMFS 1998).

Figure 6 - Shortnose Sturgeon

Atlantic Sturgeon (juveniles) have been found in Noyes Cut during sampling events, but there have not been any reported occurrences of shortnose sturgeon in the study area (USFWS/NMFS 2017). The shortnose sturgeon occupies similar habitat as the Atlantic sturgeon and could possibly occur within the study area. Recent University of Georgia (UGA) surveys regarding shortnose sturgeon populations in the nearby Satilla River have only found a couple over the last few years (Harrison 2017). Most of UGA's

sampling efforts have been concentrated in the Woodbine to White Oak Creek areas, which are in the area of the closure structures. Any juveniles that are in the area would stay year-round and any adults present would be migrating through the area (Harrison 2017). More information on this species' life cycle may be found on the NMFS website: http://www.fisheries.noaa.gov/pr/species/

Atlantic Sturgeon (*Acipenser oxyrinchus*) **Federal Status**: Endangered

Atlantic sturgeon (Figure 7) spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems. In some southern rivers, a fall spawning migration may also occur.

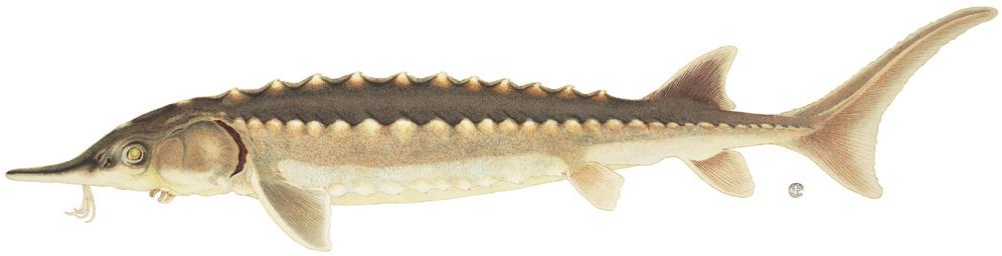

Figure 7 - Atlantic Sturgeon

Atlantic sturgeon spawning is believed to occur in flowing water between the fresh/salt water interface and fall line of large rivers, with optimal depths of 11-27 meters. Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble).

This species has recently been listed as endangered under the Federal Endangered Species Act and critical habitat has been designated. The main stem of the Satilla River has been designated, but neither Dover nor Umbrella Creek has been designated critical habitat. The Atlantic sturgeon occupies similar habitat as the shortnose sturgeon above and could possibly occur in the vicinity of the proposed action. This species migrates more freely between freshwater, estuarine, and marine waters than the shortnose sturgeon. Atlantic Sturgeon (juveniles) have been found in Noyes Cut only during sampling events in the vicinity (Montague 2017c).

UGA's recent findings regarding Atlantic sturgeon populations in the nearby Satilla River indicate a slow increase in numbers over the last few years (Harrison 2017). Most of UGA's sampling efforts have been concentrated in the Woodbine to White Oak Creek areas, which are in the study area. Any juveniles that are in the area would stay year-round and any adults present would migrate through the area (Harrison 2017).

Wood Stork (*Acipenser oxyrinchus*) **Federal Status**: Endangered

Storks reside in freshwater and brackish wetlands, primarily nesting in cypress or mangrove swamps. Wood storks (Figure 8) are the largest wading birds that breed in

North America; they nest up to 60 feet off the ground (in cypress, blackgum, southern willow, and buttonbush trees) in wetland areas of Georgia, South Carolina, and Florida. They feed in freshwater marshes, narrow tidal creeks, ditches, or flooded tidal pools. Particularly attractive feeding sites are depressions in marshes or swamps where fish become concentrated during periods of falling water levels.

Figure 8 - Adult Wood Stork

These birds have a unique feeding technique and require higher prey concentrations than other wading birds. Optimal water regimes for the wood stork involve periods of flooding, during which prey (fish) population's increase, alternating with dryer periods during which receding water levels concentrate fish at high densities. Wood storks are known to frequent the more protected estuarine areas of the study area for feeding. There is no suitable nesting habitat for this species within the study area. The study area is within 13 mile core foraging area for four nearby wood stork nesting colonies (FWCAR 2017).

2.3.7 Air Quality

Air quality at any given location is a function of several factors, including quantity and dispersion rates of pollutants, local climate, topographic and geographic features, and also windblown dust and wildfires. Air pollution can threaten the health of human beings, animals, plants, lakes; as well as damage the ozone layer and buildings, and cause haze that reduces visibility.

The Clean Air Act (CAA), which was last significantly amended in 1990, requires the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA established two types of national ambient air quality standards-primary and secondary. Primary standards are levels established by the EPA to protect public health, including the health of sensitive populations such as asthmatics, children,

and the elderly. Secondary standards are levels established to protect the public welfare, including protection from decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set six National Ambient Air Quality Standards (NAAQS) that regulate six pollutants: carbon monoxide (CO), lead (Pb), nitrogen oxide (NO_x), ozone (O_3), sulfur dioxide (SO_2), and particulate matter ($PM_{2.5}$ and (PM_{10}). Geographic areas have been officially designated by EPA as being in attainment or non-attainment for air quality based on an area's compliance with the NAAQS. The project area is currently in attainment for the NAAQS for all criteria pollutants.

2.3.8 Water Quality

The water quality in the study area is good due to a lack of development activities nearby. There are not any areas designated as areas of concern by the GADNR or EPA (EPA and Satilla Riverkeeper 2017).

The man-made cuts changed the circulation patterns in the estuary and (1) altered local patterns of tidal flows; (2) disrupted gradual salinity gradients from the headwaters to the mouth of the creeks; and (3) increased local sedimentation within Umbrella Creek. Currently, salinity gradients are altered by a large volume of Satilla River water. This large volume of brackish water entering through the short pathways of the man-made cuts overwhelms the freshwater that enters the headwater area and causes the salinity to be nearly constant throughout most of Dover Creek. Additionally, tidal flows through multiple creeks and cuts causes a tidal node where sediment deposition clogs channels.

2.3.9 Cultural Resources

Federal undertakings will comply with the Archaeological and Historical Preservation Act, as amended (54 USC 312501-312508: Preservation of Historical and Archeological and Data), the Abandoned Shipwreck Act of 1987 (PL 100-298; 43 USC 2101- 2106), the National Historic Preservation Act of 1966, as amended (54 USC 300101 et seq.: Historic Preservation) and the Advisory Council on Historic Preservation's implementing regulation, 36 CFR Part 800 (Protection of Historic Properties). Section 106 of the National Historic Preservation Act (NHPA) (54 USC 306108) requires Federal agencies to take into account the effects of undertakings on historic properties. The area of potential effects (APE) for the proposed project consists of Dover and Umbrella Creeks, as well as the tributaries and marshes that surround the creeks and the man-made cuts.

A query of Georgia's Natural, Archaeological, and Historic Resources GIS (GNAHRGIS) database revealed the locations of several archaeological and historic resources within the APE. A 2001 historic structures survey recorded 18 residences in the Dover Bluff Club community north of Umbrella Creek. The bungalow-style homes were constructed in the 1940s-1950s. Five archaeological sites are located at the marsh edge or along tributaries to Umbrella Creek near the communities of Dover Bluff and Piney Bluff. The archaeological sites are prehistoric artifact and shell scatters.

USACE conducted a remote sensing survey of Noyes and Dynamite Cuts in September 2017 to identify and evaluate any submerged cultural resources. Preliminary analysis of the targets revealed several small ferrous objects such as traps, small boat anchors and sections of pipe in Noyes Cut, but no potentially significant resources have been identified. A survey of Dynamite Cut resulted in the identification two anomalies. One anomaly is associated with exposed pilings. The other anomaly is located in the Dover Creek channel southwest of the pilings.

A low water bank line survey of Noyes Cut, Dynamite Cut and ORR failed to locate any potentially significant cultural resources.

2.3.10 Socio-Economics

2.3.10.1 Demographics And Economic Conditions

The project area consists of the opening portion of the Satilla River estuary located within Census Block Group 2 of Tract 101 in Camden County, Georgia. The 2015 American Community Survey estimates the total population of this area at 1,589. This population contains 70.1 percent claiming white ancestry alone, 29.4 percent claiming black or African American alone, and 0.05 percent claiming ancestry of two or more races. Applying 2015 population growth rates developed for Camden County by the Georgia Governor's Office of Planning and Budget yields an expected 2050 population of 2005. The 2015 per capita income for this area was $29,405, while median household income was $54,856. Of the population over sixteen years of age, 67.0 percent were in the civilian labor force. The 2015 unemployment rate was 16.5 percent, which is above state rate of 9.7 percent and the county rate of 8.5 percent.

Further information on study area population, including age, sex, race, housing, families/living arrangements, education, health, local economy, transportation, income, poverty, business, and geography can be found on the U.S. Census Bureau website: http://www.census.gov/quickfacts/table/PST045215/00.

The project impact area consists of Dover and Umbrella Creeks, as part of the lower Satilla River estuary south of the city of Brunswick (Figure 1 and Figure 2) in Camden County. The lands adjacent to the study area are sparsely populated with some residential developments along the creeks that include Dover Bluff Community, Piney Bluff Community, and River Marsh Landing. Dover Bluff is a small residential community of 20-30 homes; and Piney Bluff and River Marsh Landing are failed developments consisting of around 15 homes each.

2.3.10.2 Noise

For purposes of regulation, noise is measured in dBA or A-weighted decibels. This unit uses a logarithmic scale and weights sound frequencies. Table 5 shows typical noise levels and corresponding impressions. Since the project area is very sparsely populated, noise associated with agriculture and forestry practices are the predominant

sources of noise in the project area. Naturally occurring noises (buzzing of insects, bird calls, etc.) are also common within the project area. The background noise in the project area would be at the level of a soft whisper.

Table 5 - Typical Noise Levels and Subjective Impressions

Source	Decibel Level	Subjective Impression
Normal breathing	10	Threshold of hearing
Soft whisper	30	---
Library	40	Quiet
Normal conversation	60	---
Television audio	70	Moderately loud
Ringing telephone	80	---
Snowmobile	100	Very loud
Shouting in ear	110	---
Thunder	120	Pain threshold

2.3.10.3 Recreation

Current recreational activities include boating and fishing for residents of local communities (i.e. Dover Bluff Community, Piney Bluff Community, and River Marsh Landing). Piney Bluff Community and River Marsh Landing are very sparsely populated recent developments, the residents of which have only had limited access to the Satilla River due to the extensive sedimentation that has occurred in the area over the decades since Noyes Cut was constructed (Montague 2017b). Access for Piney Bluff Community and River Marsh Landing has been limited to high tide access in skiffs or larger boats that draw less than 2 feet.

2.3.10.4 Aesthetics

The aesthetic quality in the project area is high, due to the vast amount of undeveloped tidal marsh. In addition, the adjacent upland areas are mostly undeveloped forested areas that are sparsely populated with three residential developments along the creeks that include Dover Bluff Community, Piney Bluff Community, and River Marsh Landing. Due to the quantity and quality of these two ecosystems, there is an abundance of habitat for both resident and migratory birds.

Aesthetics in the study area have been degraded by extensive sedimentation and shoaling within the estuary, due to the impacts from the man-made cuts. Portions of Umbrella Creek that were once 100 yards wide have now narrowed to 10 yards, and inland reaches are dry at low tide. The siltation has also blocked creek access to recreational boating and fishing; and commercial fishermen whose livelihood has historically depended on harvesting seafood from these waters.

2.3.10.5 Water Supply

There are no municipal water or sewage systems in the developed areas that are adjacent to the study area. The local water supply is from wells utilizing the Floridan aquifer.

2.3.10.6 Environmental Justice

The concept of environmental justice is based on the premise that no segment of the population should bear a disproportionate share of adverse human health or environmental effects. Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low Income Populations* requires each Federal agency to make achieving environmental justice part of its mission. Specifically, the agency must identify and address, as appropriate, the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. In addition, EO 1298 requires each federal agency to conduct its programs, policies, and activities so that they do not exclude, deny benefits to, or discriminate against persons (including populations) because of race, color, or national origin.

The high ground adjacent to the Satilla River estuary does not support disproportionate concentrations of minority or low-income communities. Minority or low-income populations do not recreate in this portion of the estuary in disproportionate numbers.

3 Formulation of Alternatives

3.1 Problems, Opportunities, and Constraints

3.1.1 Problems

The 8 man-made cuts have changed circulation patterns in the estuary resulting in the following problems:

- The cuts have altered the local patterns of the tidal exchange; disrupted the gradual salinity gradients and reduced access to the upstream portion of creeks for estuary species by sedimentation; and
- The Noyes Cut original dimensions changed from 50’ wide by 5’ deep to the current conditions at 300-500’ wide by 7-10’ deep.

3.1.2 Opportunities

The opportunities in this study include:

- Restoring natural circulation to the Satilla River estuary;
- Increasing the tidal exchange and restoring the water depths to Dover & Umbrella Creeks; and
- Restoring the salinity gradients, which would provide migratory species directional cues to upstream spawning habitats.

3.1.3 Objectives

The objectives of this Section 1135 environmental restoration project are:

- Restore historic depths and circulation patterns to Umbrella and Dover Creeks;
- Improve aquatic habitat for resident species (e.g., blue crabs, shrimp); and
- Increase connectivity and salinity gradients for migratory species (e.g., striped bass, American eels; and shad, river herring, etc.) in the upper reaches of the estuary.

The amount of habitat improvements from the alternatives was assessed using Savannah District’s approved Habitat Valuation method, which is described in Section 3.3 and Appendix A. This method is based on calculating the amount of tidal flows (exchange volume) in multiple locations throughout Dover and Umbrella Creeks

(Appendix A). Exchange volume serves as an important surrogate for the restoration of salinity gradients, which influence the wide variety of species occurring in the estuary. Additionally, exchange volumes may be used to assess the predictability of the salinity regime in the estuary and the degree to which it represents the unaltered condition needed for estuarine fauna (i.e., expected upstream-to-downstream, fresh-to-saline patterns).

3.1.4 Constraints

1) The presence of Federally protected species within the study area may be a constraint during construction activities associated with closure structures. Construction contractor specifications will include the standard construction limitations provided by the USFWS and NMFS to avoid impacts to listed species.

2) Alternatives that do not include closing ORR present a risk of re-opening this area, which is currently in the process of closing through sedimentation. The re-opening of ORR would result in the loss of most of the hydrologic and ecological benefits predicted in the models. Sedimentation modeling has been used in the study to help manage the risk by predicting the potential for ORR to re-open.

3) The alternatives in this study must not adversely impact navigation within the existing Federal project (AIWW and Alternate AIWW). H&H modeling indicates that the alternatives would not adversely impact the Federal navigation project by increasing shoaling and sedimentation.

There have been no other constraints identified to date in this study.

3.1.5 Assumptions

1) The standard degree of error that is present in the Hydraulic and Hydrologic (H&H) model will not have a major impact on the correlated predictions of the ecosystem benefits.

2) The costs for rocks for closure structures are based on transit by rail to Brunswick Georgia Ports Authority (GPA) (staging area); 20 miles by barge from staging area to construction site.

3) No real estate actions are expected to be required. The staging area, the cuts and wetland where construction would occur are owned by the State of Georgia.

4) For the study area, sea level is predicted to rise 9 inches over the 50-year period of analysis. The tidal marsh in the study area would be very adaptable to increases in sea level rise due to the large tidal range, available sediment supply, and the ability of the existing marsh to create its own sediment from detritus (NOAA 2011). Therefore, no decrease in tidal marsh habitat is projected in the without project condition for the 50-year period.

3.2 Planning Horizon

- All hydrologic data was collected in 2015 and 2016. The model runs were based on a four month period, which was April 1 to July 31 of 2016. More information on the data collected and these models can be found in Appendix B.

- The period of analysis is 50 years from the date of implementation. The implementation date would be the date of completion of the cut closures.

3.3 Alternative Formulation Process

In 2015, the Project Delivery Team (PDT) determined that portions of the estuary have excessive amounts of shoaling. This shoaling is a physical barrier to upstream migration of migratory fish. One alternative that the PDT considered, was dredging Dover and Umbrella Creeks to solve the shoaling problems. However, once the PDT studied this alternative, it was realized that dredging would be too costly due to lack of placement areas and would not change the sediment movement trends.

Next, the PDT considered the following alternatives:

Initial Array of Alternatives

- No Action
- Construct Partial Diversion Structure
- Close Dover Cut
- Close Umbrella Cut
- Close East Side of Bailey's Cut
- Close Noyes Cut
- Close ORR
- Close ORR and Noyes Cut
- Dredge Umbrella and Dover Creeks
- Use Partial Closure of Cuts (for navigation) for all alternatives above

The first four action alternatives (construct partial diversion structure, close Dover Cut, close Umbrella Cut, and close east side of Bailey's Cut) were eliminated early in the plan formulation process because the H&H preliminary assessment of the estuary indicated that these actions would not restore the historic tidal flow patterns. The partial diversion structures were eliminated because of potential safety issues from high velocities through the openings. Dredging was eliminated based on limited locations to place the excavated material. The partial navigation closures were eliminated because they would not completely eliminate the salinity influence from downstream of the cut. The elimination of these alternatives was agreed to at the December 18, 2015, In

Progress Review (IPR) meeting that concluded with narrowing the scope of alternatives (SAD 2015).

As a result of the IPR, the following intermediate array of alternatives was approved for further analysis. These alternatives were consistent with alternatives examined in 1983 (McMahon 1983) that appeared to create the most benefit.

Intermediate Array of Alternatives

- No Action
- Close Noyes Cut
- Close ORR
- Close Noyes Cut and ORR

The initial H&H modeling indicated that closing Dynamite Cut could provide significant contributions in solving the salinity and shoaling issues in Umbrella Creek. On March 19, 2017, USACE, the local sponsor, and stakeholders met to discuss the potential of further investigating Dynamite Cut as another alternative (USACE 2017a). This management measure involves closing Dynamite Cut, either alone or in combination with other cuts. The PDT decided to include Dynamite Cut in the H&H modeling. The H&H modeling showed that closing Dynamite Cut would provide more hydrologic benefits/ecosystem benefits over closing ORR, primarily because ORR has naturally been filling in on its own since the 1983 study. The H&H model analyzed the following draft array of alternatives:

Second Intermediate Array of Alternatives

- NAA – No Action (Baseline/existing conditions models)
- Alt 1 – Close Noyes Cut
- Alt 2 – Close ORR
- Alt 3 – Close Noyes Cut and ORR
- Alt 4 – Close Dynamite Cut
- Alt 5 – Close Noyes and Dynamite Cuts
- Alt 6 – Close Dynamite Cut and ORR
- Alt 7 – Close Noyes and Dynamite Cuts, and ORR

Subsequent H&H sedimentation modeling revealed that closing Dynamite Cut alone was likely to cause ORR to scour and re-open. This re-opening of ORR would cause the loss of most of the hydrologic and ecological benefits. Therefore, closing Dynamite Cut alone (Alt 4) was eliminated. The H&H modeling suggested that the following alternatives would not provide adequate improvements and may cause problems in the estuary: Closing Noyes and ORR (Alt 3); closing ORR (Alt 2); closing Noyes and Dynamite cuts (Alt 5).

Therefore, the PDT eliminated these three alternatives and added the combination of closing Dynamite Cut and ORR to the final array below.

Final Array of Alternatives

- NAA – No Action

- Alt 1 – Close Noyes Cut
- Alt 6 – Close Dynamite Cut and ORR
- Alt 7 – Close Noyes Cut, Dynamite Cut, and ORR

To achieve the project objectives in a cost effective manner, the PDT evaluated and compared the final array of alternatives using habitat units as the non-monetary benefit divided by the project costs.

Savannah District quantified the benefits (Habitat Units [HUs]) from each alternative by calculating the fluctuation of tidal exchange in multiple locations throughout Dover and Umbrella Creeks (Appendix A). Exchange volume serves as an important surrogate for the restoration of salinity gradients, both of which influence the wide variety of species occurring in the estuary. Additionally, exchange volumes may be used to assess the predictability of the salinity regime in the estuary and the degree to which it represents the unaltered condition needed for estuarine fauna (i.e., expected upstream-to-downstream, fresh-to-saline patterns).

Based on changes in tidal exchange within the areas of impact and the costs to make those changes, the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) in Section 3.4 estimated the relative cost efficiency and effectiveness of the alternatives. The CE/ICA analysis was used in combination with the habitat valuation method (Appendix A) to identify cost effective alternatives.

3.3.1 Future without project condition alternative

No Action Alternative (NAA) represents the most likely anticipated future condition (Future Without Project) if there is no change to the man-made cuts in the Satilla estuary.

3.3.2 Description of Alternatives*

Each of the action alternatives would restore (in various degrees) the hydrodynamic environment; which will consequently restore salinity gradients, reduce local sedimentation issues, and increase connectivity for local biota. Alternatives focus on closing a combination of ORR, Noyes Cut, and Dynamite Cut to alter tidal exchange in Dover and Umbrella Creeks (Figure 2). Closing man-made cuts is also anticipated to restore historic conditions of salinity regimes and increase connectivity for local fauna.

3.3.2.1 No Action Alterative (NAA)/Future Without Project Condition

The NAA may result in additional adverse environmental impacts from allowing the continuation of unnatural circulation patterns created by the existing man-made cuts. These cuts have expanded greatly over the decades since their construction and continued expansion may have additional adverse impacts to the salinity gradient and shoaling within Dover and Umbrella Creeks.

3.3.2.2 Alternative 7 (Close Noyes Cut, Dynamite Cut, and ORR)

To achieve the project objectives, this alternative would alter the hydrodynamic environment by closing Noyes Cut, Dynamite Cut, and ORR (Figure 2). The closure structures (Figure 9 and Figure 10) would consist of a combination of rip rap, bedding stone, and sheet pile end walls. The closures are designed with sheet pile tying into the marsh (not across the entire structure) on both ends to minimize environmental impacts within the marsh. Construction of all of the closures would use barges to avoid impacts to surrounding tidal salt marsh.

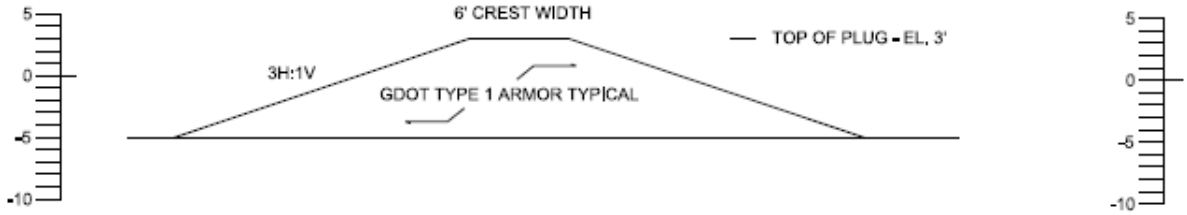

Figure 9 - Conceptual design (Cross Section) of closure structure

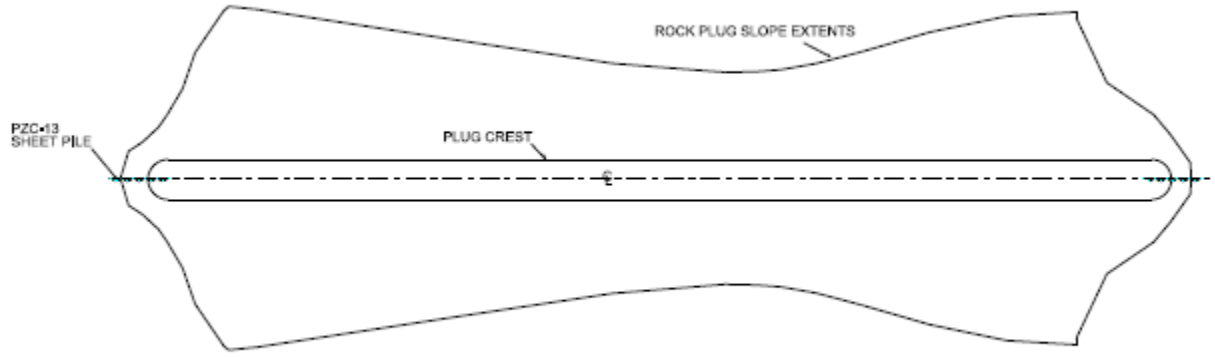

Figure 10 - Conceptual Design (Plan View) of Closure Structure

Noyes Cut is approximately 3100 feet long and 500 feet wide. The Noyes Cut closure structure would be approximately 432 feet long, 72 feet wide, and 11 feet high.

ORR is approximately feet 3000 feet long and 30 feet wide. The ORR closure structure would be approximately 112 feet long, 54 feet wide, and 8 feet high.

Dynamite Cut is approximately 350 feet long and 250 feet wide. The Dynamite Cut closure structure would be approximately 312 feet long, 66 feet wide, and 10 feet high.

All closure structures (Figure 11) would include signage on both sides to warn boat traffic of the danger associated with the closures.

This alternative includes deauthorization of Noyes Cut, as a former active portion of the Federally authorized AIWW project. This deauthorization would occur after approval of this project. Even though Noyes Cut has been obsolete since 1939 (Section 1.5 "History"), it is still technically part of the Federal project.

3.3.2.3 Alternative 6 (Close Dynamite Cut and ORR)

This alternative involves the combination of closing Dynamite Cut and ORR as described in Alternative 7 above, but would not include the closure of Noyes Cut.

3.3.2.4 Alternative 1 (Close Noyes Cut)

This alternative involves the closure of Noyes Cut as described in Alternative 7 above, but would not include the closure of the other cuts in Alternative 7. This alternative also includes deauthorization of Noyes Cut, as a former portion of the Federally authorized AIWW project.

Figure 11 - Locations of Closure Structures

3.4 Cost Effectiveness/Incremental Cost Analysis (CE/ICA)

According to the *Planning Guidance Notebook* ER 1105-2-100, USACE may recommend ecosystem restoration actions that improve degraded ecosystem structure and function. Of particular interest to USACE are restoration projects that improve wetlands, floodplains, and aquatic systems. USACE restoration policy focuses on engineering and water control solutions rather than land acquisition. Possible improvements include, but are not limited to: restoring tidal creeks and tidal pond habitat; restoring tidal hydrology and native wetland vegetation; using dredged material to restore wetlands; and restoring conditions conducive to native species establishment.

The primary objectives of this project are to improve the quality of the existing aquatic habitat for resident species (e.g., blue crabs, shrimp) and increase connectivity for migratory species (e.g., striped bass, American eels, shad, river herring) in the upper reaches of the Dover and Umbrella Creeks watershed.

To achieve these stated objectives, this project would restore the hydrologic connectivity by restoring the historic flow circulation in the watershed. These changes would restore salinity gradients and reduce local sedimentation issues; both of which would improve access to upstream spawning habitat for local migratory species.
In order to comply with the requirements of ER 1105-2-100, a Cost Effectiveness and Incremental Cost Analyses (CE/ICA) must be conducted for ecosystem restoration projects to identify the Cost Effective or “Best Buy” solutions for each possible level of ecosystem output.

The tasks required to conduct the National Ecosystem Restoration (NER) analysis for the Noyes Cut study are described in terms of the seven steps listed in ER 1105-2-100, E-36. In these steps, the CE/ICA are identified separately and begin after the outputs and costs have been determined. The software program, IWR Planning Suite II, developed by the Institute for Water Resources (IWR), was used in prepare the CE/ICA analysis.

The costs used in the CE/ICA were based on the current working estimate of the construction; design & specifications; performance monitoring; Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R); and real estate of the conceptual plans. Per USACE policy, only actual project implementation costs are to be included in the total project cost calculations for the Cost Effectiveness and Incremental Cost Analyses.

Since project benefits are not measured in dollars, the CE/ICA offers the next-best approach to value. The CE/ICA of alternative plans may not identify a unique or optimal solution; but they can lead to a more-informed choice from among alternatives during the decision making process.

In addition to the intended ecosystem benefits, ancillary benefits may include the return of sport fishing and commercial fishing/crabbing in Dover and Umbrella Creeks for the

aforementioned species. Residential deep water access would also be restored to residential developments adjacent to the estuary that currently have access only at high tide. Benefits in addition to the habitat units calculated in the CE/ICA would be obtained by establishing a uniform salinity gradient from the headwater to the sound. These benefits are discussed in more detail in Section 3.4.1 (*Additional Habitat Lift from Salinity Gradient Improvements*).

Step 1 - Display outputs and costs: Calculate average annual outputs (not discounted) and equivalent annual costs (discounted) based on inputs over a 50-year period of analysis. Output values or the average annual change in Habitat Units were calculated by subtracting the Without-Project value from the With-Project value ("With-&-Without Analysis"). The difference between them is the average annual net benefit. Construction costs were calculated in terms of present worth and annualized over a 50-year period of analysis at the current Fiscal Year 2018 (FY18) Federal discount rate of 2.75 percent. Monitoring costs were discounted over a five year period of analysis and added to annualized construction costs in order to calculate total average annual costs.

Outputs:
Habitat Units: The net increase in Average Annual Habitat Units (AAHU) was selected as the output unit of measurement. This ranges from a low of 0 under the No Action Alternative to a high of 1780 under Alternative 7 (Table 6 and Figure 12).

Table 6 - Noyes Cut Ecosystem Restoration Average Annual Habitat Net Benefits

Alternative	Alternative Description	Plan Outputs (AAHU Increase)
Baseline	NAA	0
1	Close Noyes Cut	493
6	Close Dynamite Cut and ORR	1330
7	Close Noyes Cut, Dynamite Cut and ORR	1780

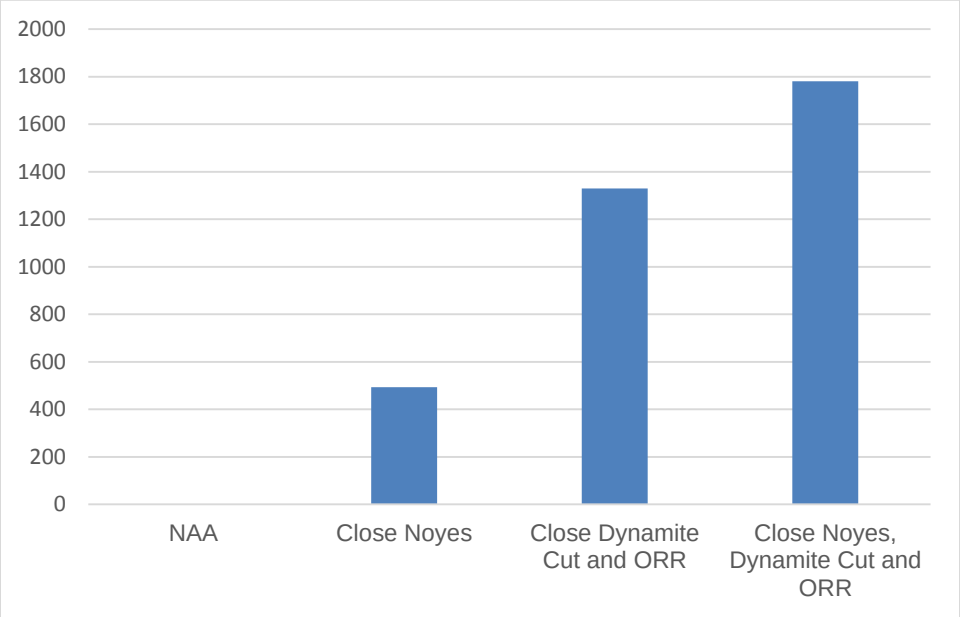

Figure 12 - Noyes Cut Ecosystem Restoration Average Annual Habitat Net Benefits

Cost Estimates:

First Costs: The detailed project construction first costs for each Alternative are presented in Table 7.

Average Annual Equivalent Costs: The average annual equivalent (AAE) costs are based on October 2018 price levels, the current FY18 Federal discount rate of 2.75 percent, and a 50-year period of analysis. This interest rate, as specified in the Federal Register, is to be used by Federal agencies in the formulation and evaluation of water and land resource plans.

Average Annual Costs (AAC): The average annual costs ranged from a low of $0 for the No Action Alternative to a high of $290,537 for Alternative 7. Total average annual cost includes average annual performance monitoring costs as presented in Table 7. Because the construction period for each alternative considered is under two months in duration, no calculation for interest during construction is included.

Table 7 - Noyes Cut Ecosystem Restoration Average Annual Project Costs (FY 2018 Price Level)

	Alternative	Project Construction First Costs**	Average Annual OMRR&R Cost	Monitoring Costs	Total Average Annual Costs*
	NAA	-	-	-	-
1	**Close Noyes**	$3,898,044	$10,000	$350,000	$157,722
6	**Close Dynamite Cut and ORR**	$4,235,636	$10,000	$350,000	$170,227
7	**Close Noyes,**	$7,483,680***	$10,000	$350,000	$290,537

	Dynamite Cut and ORR				

*Discounted over 50 year period
**In conformance with ER 1105-2-100, Project First Costs are used for the CE/ICA as presented in Table 7. These are not equivalent to fully funded Total Project Costs, which are applied for the determination of cost share responsibilities for the sponsor and the Federal Government.
*** First cost in above table is level 4 analysis while TPCS in Appendix H are level 3 analysis.

Step 2 - Identify combinable management measures:
In this step, several possible combinations of management measures were formulated to achieve project objectives. The results of this analysis are presented by the alternatives below.

Alternative:
No Action Alternative: No Federal action would be undertaken to restore the degraded conditions in the project area with the NAA.

Alternative 1: This alternative includes the construction of a plug designed to close Noyes Cut.

Alternative 6: This alternative includes the construction of two plugs designed to close Dynamite Cut and ORR, respectively.

Recent H&H sedimentation modeling revealed that closing Dynamite Cut alone was likely to cause ORR to scour and re-open. This re-opening of ORR would cause the loss of most of the hydrologic and ecological benefits. As such, the combination of Dynamite Cut and ORR plugs was instead added to provide a more ecologically viable alternative to the final array.

Alternative 7: This alternative combines the management measures that compose Alternatives 1 and 6. It includes the construction of a plug designed to close Noyes Cut, and the construction of 2 plugs designed to close Dynamite Cut and ORR, respectively.

Step 3 - Calculate outputs and costs of combinations: All combinations of management measures and scales were sorted in terms of increasing output. This provided the basis for developing a supply curve. All environmental outputs were measured in terms of Average Annual Habitat Units. As indicated in Table 6 and discussed in Step 1 of the previous report section, Alternative 7 provides the most net Habitat Units (1780 AAHU).

Step 4 - Conduct cost effectiveness analysis: A plan is cost effective if no other plan provides the same level of output for less cost and if no other plan provides more output for the same or less cost. This step identifies the least-cost or best solution plan for a given amount (or range) of outputs. This eliminates economically ineffective solutions. Alternatives identified through this comparison are the “cost effective” plans. Figure 13 and Table 8 display the results of this analysis.

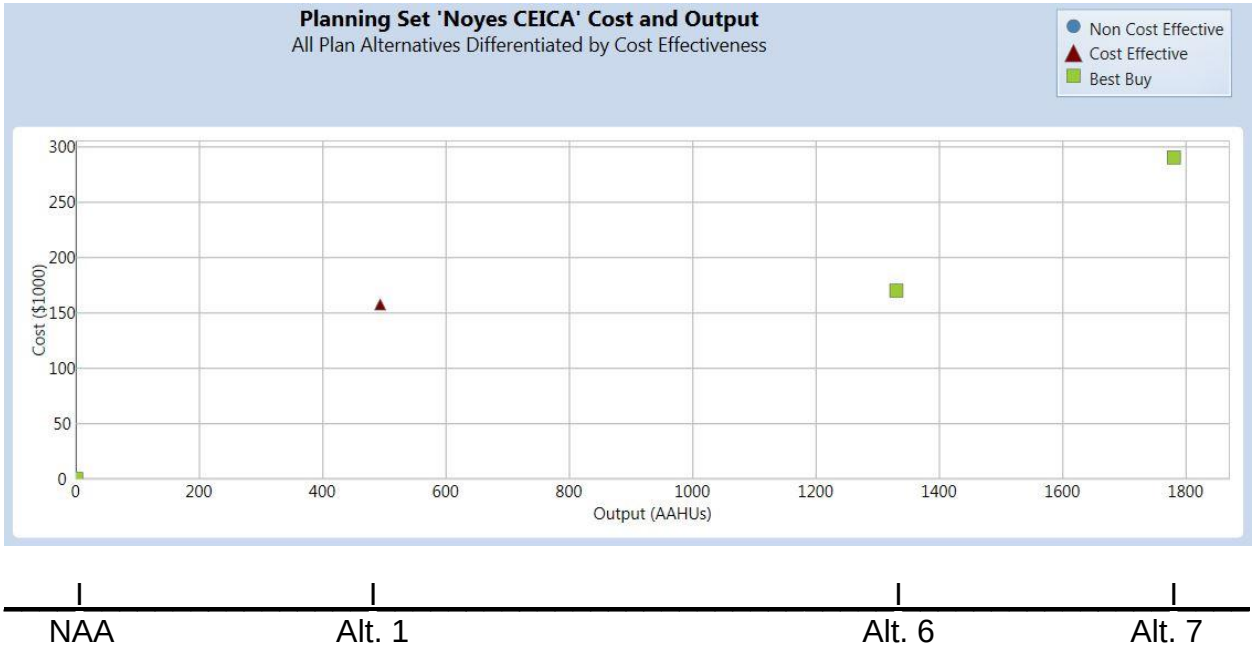

Figure 13 - Cost Effectiveness Analysis

Table 8 - Cost Effectiveness Analysis Data & Results

	Alternative	AAC (FY18 Price Level)	Plan Outputs (AAHU)	Cost Effective
Baseline	NAA	0	0	-
1	Close Noyes	$157,722	493	Yes
6	Close Dynamite Cut and ORR	$170,227	1330	Best Buy
7	Close Noyes, Dynamite Cut and ORR	$290,537	1780	Best Buy

Step 5 - Incremental cost analysis: The ICA identifies the subset of cost effective plans that offer the greatest increases in output for the least increases in cost (the plans that have the lowest incremental costs per unit of output for successively larger levels of output). Those plans that are most efficient in production and superior financial investments are called the "Best Buy" plans. “Best Buy” plans are the most efficient plans at producing the output variable (Habitat Units). They provide the greatest increase in the value of the output parameter variable for the least increase in the value of the cost parameter variable. The first best buy plan is the most efficient plan, producing the most output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the first best buy plan, the second best buy plan is the most efficient plan for producing additional output, and so on.

That is the same as identifying the plans with the lowest incremental cost per habitat unit, also known as a marginal cost analysis. This step considers the most cost effective plans by scale of output, beginning with No Action. It eliminates plans that are smaller in scale than the first "Best Buy" plan. The incremental costs and outputs are first measured against the No Action to determine what is referred to as the first "Best Buy."

Finally, the additional costs for the additional amounts of output (incremental cost) produced by the "Best Buy" alternative plans were calculated for each alternative. The results of all the calculations and comparisons of costs and outputs provided a basis for addressing the decision question of whether the additional outputs are worth the additional costs incurred to achieve them.

The incremental cost analysis examined how the costs of additional units of environmental output increase as the level of environmental output increases. For this analysis, the environmental outputs are measured in average annual habitat units. The plan is to improve environmental conditions in the study area, which includes restoring the natural flow and salinity levels. The project construction costs of each alternative were compared with the environmental benefits, within the framework of an incremental cost analysis, to identify the most cost effective Alternatives. This analysis identified the "Best Buy" plans for decision makers to consider. Table 9 displays the incremental cost of all plans relative to No Action.

Table 9 - Incremental Cost Compared to NAA - FY 18 Price Level

	Alternative	AAC	Plan Outputs (AAHU)	Incremental Cost Compared to NAA	Incremental Output Compared to NAA	Incremental Cost/ Unit Output
	NAA	0	0	0	0	N/A
1	Close Noyes	$157,722	493	$157,722	493	$320
6	Close Dynamite Cut and ORR	$170,227	1330	$170,227	1330	$128
7	Close Noyes, Dynamite Cut and ORR	$290,537	1780	$290,537	1780	$163

Table 9 shows that Alternative 6 has the lowest incremental cost per unit output at $128 dollars. As such, plans that produce less output than Alternative 6 are eliminated from further consideration.

Step 6 - Recalculate incremental costs: This step uses iterative incremental cost analysis to identify plans where there is a significant change in incremental costs and identify the potential NER plans. The first step in this process looks at the incremental costs and outputs for plans larger than the first "Best Buy" plan. Plans larger (i.e. providing more output) than the last "Best Buy" plan are iteratively considered with the incremental costs and outputs relative to that last plan.

Table 10 - Incremental Cost Analysis - FY18 Price Level

Alternative	Alternative Description	Incremental AAC (FY18 Price Level)	Incremental Plan Outputs (AAHU)	Incremental Cost/ Unit Output
6	Close Dynamite Cut and ORR	$170,227	1330	$128
7	Close Noyes, Dynamite Cut and ORR	$120,311	450	$267

As is indicated in Table 10, Alternative 7 delivers an additional 450 average annual habitat units at an incremental cost of $267 per habitat unit as the second “Best Buy” plan. Although it does not result in the least costly plan per additional AAHU, it does provide the maximum amount of ecosystem benefits (1780 AAHUs) which is 34 percent more in outputs than the next smaller plan. However, Alternative 6 results in the most incrementally cost-effective plan that maximizes ecosystem restoration benefits as compared to costs.

Step 7 - Tabulate and graph incremental costs: This is the last step that displays a summarized table (Figure 14) of the pertinent incremental cost and output information associated with the increasing size (in terms of output) of the “Best Buy” plans.

National Ecosystem Restoration (NER) Plan:
The identified NER plan would be the ecosystem restoration plan of the desired scale that maximizes the monetary and non-monetary beneficial effects/outputs (AAHU) as compared to the monetary and nonmonetary costs. The CE/ICA does not provide a discrete decision criterion for plan selection; however, the incremental cost analysis does provide for the explicit comparison of the relevant changes in costs and outputs on which such decisions may be based. The question that decision makers must ask themselves at each increment of output: “Is it worth it?”. They must decide whether the additional gain in environmental benefit is worth the additional cost. To help with this process, the PDT determined that the alternative plan that would be selected as the NER plan would be based on the following criteria:

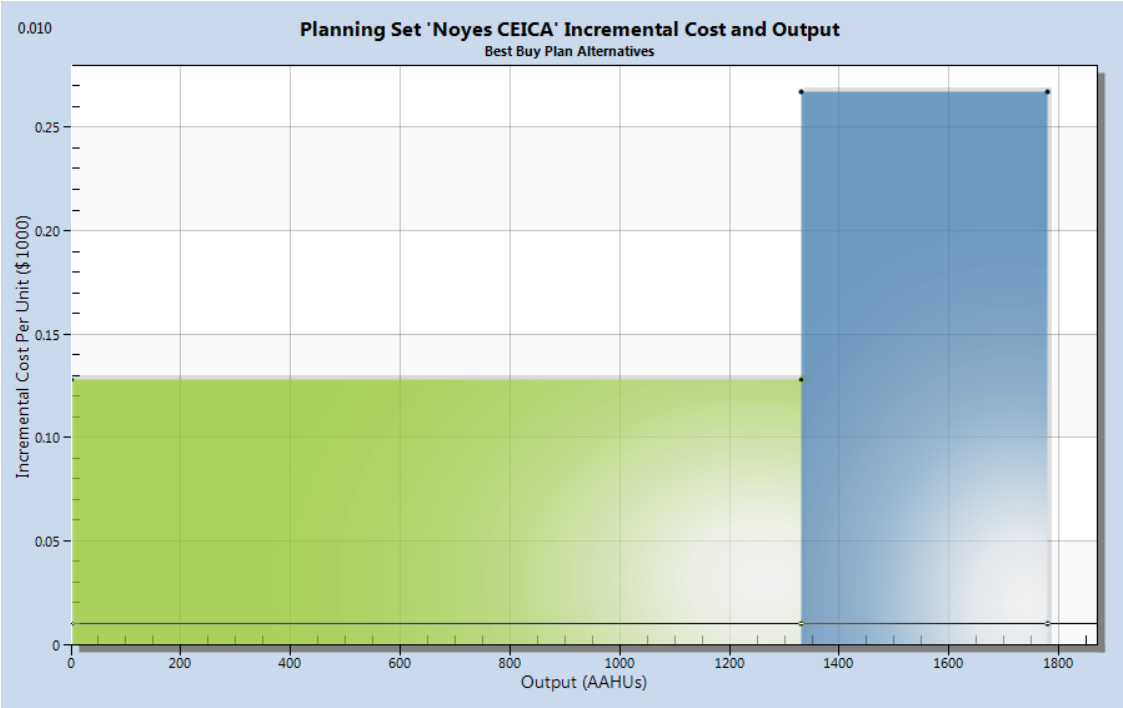

Figure 14 - Incremental Cost Analysis of Best Buy Plans

- Results of the cost-effectiveness and incremental cost analyses;
- Significance of ecosystem outputs produced by the project;
- Improvement in quantity and/or quality of desired ecosystem resources;
- Significance of ecosystem outputs produced by the project in terms of institutional, public, and technical recognition;
- Acceptability, completeness, effectiveness, and efficiency of the plan; and,
- Risk and uncertainty associated with the costs and outputs of the alternative restoration plans.

3.4.1 Additional Habitat Lift from Salinity Gradient Improvements

Within the West Tributary of Dover Creek, Alternative 7 (Close Noyes Cut, Dynamite Cut, and ORR) provides a more suitable salinity gradient (demonstrated by Figure 15) than Alternative 6 (Close Dynamite Cut and ORR) for migratory fish seeking cues to find upstream freshwater spawning habitat.

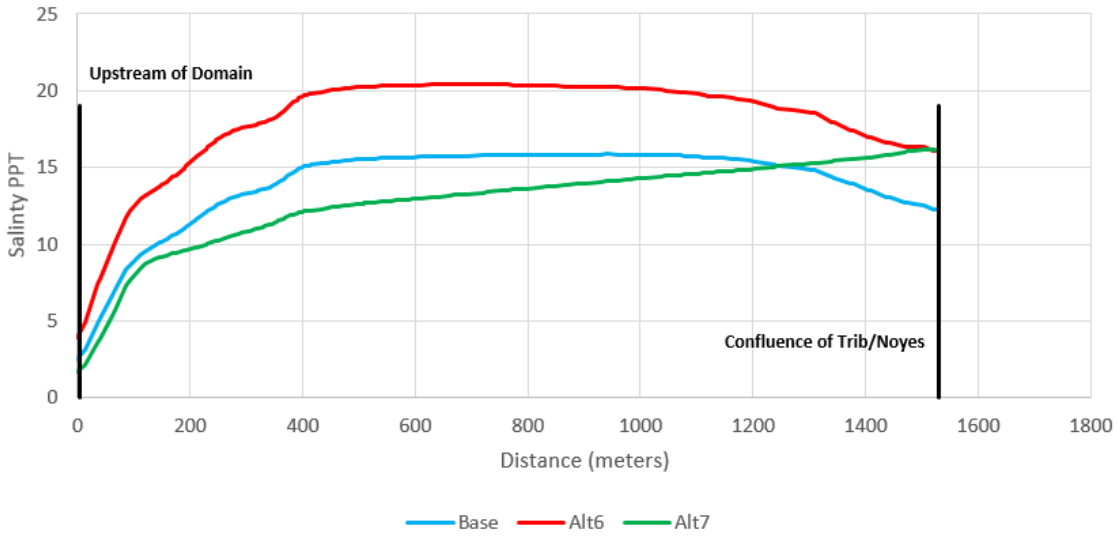

Figure 15 - West Tributary: Graph Starts at Upstream End of Tributary

As illustrated by Figure 15, the base condition and Alternative 6 have a salinity peak that is upstream of the confluence of the west tributary (Figure 3) and Noyes Cut. This increase in salinity levels as migratory fish start to swim upstream toward freshwater discourages fish seeking freshwater from continuing upstream towards spawning habitat. With Alternative 7, there would be a steady reduction in salinity as migratory fish progress upstream towards spawning habitat - without any areas where salinity increases on the way. Alternative 7 provides a significantly improved gradient.

Alternative 7 also provides more freshwater spawning habitat than Alternative 6. The improved salinity gradients would improve habitat for the migratory fish and shellfish listed in Table 2. In addition, Alternative 7 provides more improvements to habitat for the Federally protected manatee due to the increase in freshwater upstream and improved access to this freshwater.

These benefits from an improved salinity gradient would be additional benefits to those calculated in the CE/ICA because the habitat unit calculations did not include salinity analysis.

3.4.2 Costs

Federal and non-Federal cost-share apportionments are based on the fully-funded total project cost to implement the Tentatively Selected Plan (TSP). Those costs differ slightly from those used in the CE/ICA, which was based on the first cost. The fully-funded costs are the current estimate of the costs at current price levels and inflated through the estimated mid-point of construction.

Implementation responsibilities:
The non-Federal sponsor would be responsible for the following actions:

- Provide during period of construction, a cash contribution equal to 25% of the total construction costs. All construction costs identified and quantified in Table 11.

- Provide all OMRR&R costs at their own expense, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any other specific directions prescribed by the Federal Government or OMRR&R Manual.

- Provide all real estate interests that may be required for implementation of the TSP. To date, there have not been any real estate requirements identified in this study.

- Obtain an intra agency agreement for the staging and laydown area located at the GPA Brunswick terminal.

Table 11 quantifies the Federal and non-Federal sponsor cost responsibilities.

Table 11 - Implementation Responsibilities

Item	Non-Federal Cost (25%)	Federal Cost (75%)	Total Cost (rounded)
Design	$ 454,750	$1,364,250	$1,819,000
Construction	$1,407,500	$4,222,500	$5,630,000
Construction Management (S&A)	$ 39,000	$ 117,000	$156,000
Total	**$1,901,250**	**$5,703,750**	**$7,605,000**
OMRR&R[1]	$10,000 (annual)	None	$10,000 (annual)

[1] OMRR&R costs are 100 percent non-Federal.

Implementation timelines for project phases:

Table 12 - Implementation timelines

Phase	Timeline
Decision Document Approval by SAD/Deauthorization of Noyes Cut	April 2018
Design	7 months
Construction	71 days
Monitoring	1 event pre-construction 1 event 1 year after construction 1 event 3 years after construction 1 event 5 years after construction
Adaptive Management	If needed, would occur post construction
OMRR&R	Begins 1 year after construction and re-occurs every year of project life

3.5 Real Estate

Construction of all of the closures would use barges to avoid impacts to surrounding wetlands. All of the tidal creeks and wetlands in the construction area are owned by the State of Georgia and the U.S. Government. Rock for construction of the closure structures will be sent by rail to Brunswick GPA, which will be the staging area. Use of the staging area at GPA would not incur any additional cost. Since the staging area and the entire area of construction is owned by the State of Georgia and U.S. Government, no other real estate actions would be required. More detail regarding real estate issues may be found in Appendix F.

4 Evaluation of Alternatives/ Environmental Impacts*

4.1 Hydrology and Floodplains

Future Conditions with No Action Alternative:

Selection of the NAA would not have impacts on the floodplains within the project area. Selection of the NAA would not be expected to have further adverse impacts to the hydrologic malfunctions that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe (Figure 16).

Figure 16 - Entrance of Noyes Cut from Dover Creek facing south

Future Conditions with Action Alternatives 1, 6, and 7:

The Savannah District does not anticipate any significant adverse impacts to the hydrology and floodplains within the Satilla River Basin from the action alternatives, since the alternatives would only involve restoration of historic tidal circulation patterns and would not significantly alter the floodplain hydrology. By restoring flows to the upper portions of Dover and Umbrella Creeks, there may be increased potential for flooding during some hurricane events. If this occurs, the potential for flooding would not be above the historic levels prior to the man-made cuts.

To achieve the study goals, this project will alter the hydrodynamic environment. Those alterations are designed to restore historic conditions of salinity gradients, reduce local sedimentation issues, and increase connectivity for local biota. The three action alternatives focus on closing a combination of ORR, Noyes Cut, and Dynamite Cut to alter tidal exchange within Dover and Umbrella Creeks. The closure structures would vegetate and become more resistant to tidal surges and sea level rise over time.

4.2 Aquatic Resources and Aquatic Habitat

Future Conditions with No Action Alternative:

Selection of the NAA would not be expected to have further adverse impacts in addition to the habitat degradations that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

Future Conditions with Alternative 7:

To achieve the study goals, this alternative will alter the hydrodynamic environment, which will consequently restore salinity gradients, reduce local sedimentation issues, and increase connectivity for local biota. This alternative would close a combination of ORR, Noyes Cut, and Dynamite Cut to alter tidal exchange in Dover and Umbrella Creeks. Closing cuts would restore historic conditions of salinity regimes and increase connectivity for local fauna.

Potential indirect long-term benefits of restoring depths and flows in the study area may include increased dissolved oxygen (DO) levels, decreased Total Suspended Solids (TSS), and improved nutrient exchange between the Satilla River, St. Andrews Sound, and the Atlantic Ocean. In addition to the intended ecosystem benefits, ancillary benefits would include the return of commercial fishing and crabbing and sport fishing in Dover and Umbrella Creeks. Residential deep water access would also be restored to residential developments adjacent to the estuary that currently have access only at high tide. Alternative 7 also provides significant improvements to habitat for the Federally protected manatee as detailed in Section 4.6.

The PDT quantified the habitat benefits from each alternative by calculating the amount of tidal exchange (exchange volume) in multiple locations throughout Dover and Umbrella Creeks. Exchange volume serves as an important surrogate for the

restoration of salinity gradients, which influence the wide variety of species occurring in the estuary. Additionally, exchange volumes may be used to assess the predictability of the salinity regime in the estuary and the degree to which it represents the unaltered condition needed for estuarine fauna (i.e., expected upstream-to-downstream, fresh-to-saline patterns). The habitat model calculated that this alternative would produce 1780 average annual habitat units. More detail on the habitat unit calculation may be found in Appendix A.

Aquatic species dependent on gradual salinity gradients would benefit more from this alternative. Many of the species in the project impact area (Table 2) require this more natural salinity gradient to navigate between saltwater, brackish, and freshwater environments to successfully complete their life cycles. This beneficial impact is discussed in more detail in Section 3.4.1 and is additional to the habitat model calculations of benefits. Alternative 7 also provides more spawning habitat than Alternatives 1 or 6 for those species that require freshwater for spawning.

Positive impacts of restoring higher flows to Dover and Umbrella Creeks (and a consequential increase in freshwater upstream) include benefits to crabs, shrimp, and striped bass (Montague 2017b). American shad, river herring, blueback herring, alewife, American eel, and striped bass would also benefit from greater depths and restored salinity gradient in Dover and Umbrella Creeks. Most of the species in Table 2 would be expected to be benefited by Alternative 7. There are many other species in Table 2 of major significance for commercial and recreational value that would be benefited more by Alternative 7 than the other alternatives. Many of these species are scarce and have been in a state of rapid decline in recent decades, as described in Section 2.3.2.

Future Conditions with Alternative 6:
Improvements to aquatic habitat from this alternative would be similar to Alternative 7 above. The main difference would be the quantity of benefits, which would be significantly lower (1330 habitat units) than Alternative 7, as described in Section 3.4.

Future Conditions with Alternative 1:
Improvements to aquatic habitat from this alternative would be similar to the alternatives above. The main difference would be the quantity of benefits, which would be significantly lower (480 HUs) than Alternative 7 or Alternative 6, as described in Section 3.4.

4.3 Essential Fish Habitat

Future Conditions with No Action Alternative:
Selection of the NAA would not be expected to have further adverse impacts in addition to the habitat degradations that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

Future Conditions with Action Alternatives 1, 6, and 7:

Potential indirect long-term benefits of restoring depths and flows in the study area may include increased dissolved oxygen (DO) levels, decreased Total Suspended Solids (TSS), and improved nutrient exchange between the Satilla River, St. Andrews Sound, and the Atlantic Ocean. In addition to the intended ecosystem benefits, ancillary benefits may include the return of commercial fishing and crabbing and sport fishing in Dover and Umbrella Creeks, for the aforementioned species.

To achieve the study goals, this project will alter the hydrodynamic environment, which will consequently restore salinity gradients, reduce local sedimentation issues, and increase connectivity for local biota. The alternatives focus on closing a combination of ORR, Noyes Cut, and Dynamite Cut to alter tidal exchange in Dover and Umbrella Creeks. Closing cuts would restore historic conditions of salinity regimes and increase connectivity for local fauna. Section 5.0 contains a quantitative comparison of the alternatives.

Future Conditions with Alternative 7

This alternative involves closure of man-made cuts that would result in an adverse impact to EFH from conversion of 1.08 acres of EFH (0.87 acres of open water and 0.21 acres of salt marsh) to non-EFH rock and sheet pile after construction of the closure structures. However, these adverse impacts would be expected to be nullified by the restoration of EFH (salt marsh habitat) within the three cuts. This restoration of tidal salt marsh would displace an equal amount of open water EFH, which is of lower value from a scarcity and ecological perspective. This conversion to tidal salt marsh would also restore the system closer to the original condition before the man-made cuts.

These cuts would also be expected to at least partially fill in with wetland habitat from natural processes of sedimentation and regeneration of wetland vegetation. An existing project, New Cut in Savannah Harbor, has completely filled in due partially to the deposition of fill material and partially due to the natural processes of sedimentation and regeneration of wetland vegetation.

The Figure 17 andFigure 18 illustrate the condition of New Cut shortly after construction.

Figure 17 - New Cut, Savannah River Estuary, February 19, 1992

Figure 18 - New Cut Post Construction, Savannah River Estuary, 1993 Google Earth Image

The latest aerial imagery (Figure 19) shows the cut completely filled with wetland habitat. New Cut has completely filled in due partially to the deposition of fill material and partially due to the natural processes of sedimentation and regeneration of wetland vegetation.

Figure 19 - Google Earth Aerial Imagery 2014

All three of the areas being closed in Alternative 7 would also be expected to at least partially fill in with wetland habitat from natural processes of sedimentation and regeneration of wetland vegetation.

This restored tidal salt marsh EFH would displace an equal amount of open water EFH, which is of lower value. Tidal marshes are some of the most ecologically productive ecosystems providing critical habitat for fish and shellfish of commercial and recreational importance.

Since this alternative involves restoring natural and historic circulation patterns by closing man-made cuts, overall impacts are expected to be beneficial on an individual project and cumulative effects basis. Restoring the natural circulation patterns may also restore historical salinity gradients allowing more efficient use of EFH by migratory fish species.

This alternative would increase flow to upstream areas of Dover and Umbrella Creeks and consequently, would be expected to convert brackish water to a more freshwater system. This conversion would result in a neutral impact to EFH.

Future Conditions with Alternative 6: Closure of Dynamite Cut and ORR
This alternative involves closure of Dynamite Cut that would result in an adverse impact to EFH from conversion of 0.33 acres of EFH (0.23 acres of open water and 0. 09 acres of salt marsh) to non-EFH rock and sheet pile after construction of the closure structures. However, this adverse impact is expected to be more than offset by the restoration of wetlands (tidal salt marsh habitat) within the cut (as discussed above).

This restoration of tidal salt marsh would displace an equal amount of open water EFH, which is of lower value from a scarcity and ecological perspective. This conversion to tidal salt marsh would also restore the system closer to the original condition before the man-made cuts.

This alternative is expected to convert brackish water to a more freshwater system in upstream areas of Dover and Umbrella Creeks. This conversion would result in a neutral impact to EFH.

Since this alternative involves restoring natural and historic circulation patterns by closing man-made cuts, overall impacts are expected to be beneficial on an individual project and cumulative effects basis. Restoring the natural circulation patterns may also restore historical salinity gradients, allowing more efficient use of EFH by migratory fish species.

Alternative 1: Closure of Noyes Cut
Construction of the closure in this cut would result in an adverse impact to EFH from conversion of 0.76 acres of EFH (0.64 acres of open water and 0.12 acres of salt marsh) to non-EFH rock and sheet pile after construction of the closure structures. However, this adverse impact is expected to be more than offset by the restoration of wetlands (tidal salt marsh habitat) within the cut (as discussed above). This restoration of tidal salt marsh would displace an equal amount of open water EFH, which is of lower value from a scarcity and ecological perspective. This conversion to tidal salt marsh would also restore the system closer to the original condition before the man-made cuts.

This alternative would increase flow to upstream areas of Dover and Umbrella Creeks and consequently, would be expected to convert brackish water to a more freshwater system in the upper reaches of these creeks. This conversion would result in a neutral impact to EFH.

Since this alternative involves restoring natural and historic circulation patterns by closing man-made cuts, overall impacts are expected to be beneficial on an individual project and cumulative effects basis. Restoring the natural circulation patterns may also restore historical salinity gradients, allowing more efficient use of EFH by migratory fish species.

4.4 Wetlands

Future Conditions with No Action Alternative:
Selection of the NAA is not be expected to have impacts to this resource.

Future Conditions with Action Alternatives 1, 6, and 7:
All action alternatives involve closure of man-made cuts that would result in adverse impacts to minor amounts of tidal salt marsh from construction of the closure structures within man-made cuts.

Alternative 7: Construction of the closures in Noyes Cut, Dynamite Cut, and ORR would result in the loss of a total of 0.87 acres of jurisdictional waters of the U.S.; and the loss of a total of 0.21 acres of jurisdictional wetlands (Spartina salt marsh). However, this adverse impact is expected to be more than offset by the restoration of wetlands (tidal salt marsh habitat) within the cuts.

This restored tidal salt marsh would displace an equal amount of open water (Jurisdictional Waters of the U.S.), which is of lower value from a scarcity and ecological perspective. As illustrated by the photographs of New Cut (Figure 17, Figure 18, and Figure 19), these man-made cuts are also expected to at least partially fill in with wetland habitat from natural processes of sedimentation and regeneration of wetland vegetation. Construction of the closures would use barges to avoid impacts to surrounding wetlands.

Alternative 6: Closure of Dynamite Cut and ORR
Construction of the closure in this cut would result in the loss of a total of 0.23 acres of jurisdictional waters of the U.S.; and the loss of a total of 0.10 acres of jurisdictional wetlands (Spartina salt marsh). However, this adverse impact is expected to be more than offset by the restoration of wetlands (tidal salt marsh habitat) within the cuts. This tidal salt marsh would displace an equal amount of open water (Jurisdictional Waters of the U.S.), which is of lower value from a scarcity and ecological perspective. This conversion to tidal salt marsh would also restore the system closer to the original condition before the man-made cuts.

Alternative 1: Closure of Noyes Cut
Construction of the closure in this cut would result in the loss of a total of 0.64 acres of jurisdictional waters of the U.S.; and the loss of a total of 0.12 acres of jurisdictional wetlands (Spartina salt marsh). However, this adverse impact is expected to be more than offset by the restoration of wetlands (tidal salt marsh habitat) within the cuts. This tidal salt marsh would displace an equal amount of open water (Jurisdictional Waters of the U.S.), which is of lower value from a scarcity and ecological perspective. This conversion to tidal salt marsh would also restore the system closer to the original condition before the man-made cuts.

4.5 Terrestrial Resources and Wildlife

Future Conditions with No Action Alternative:
Selection of the NAA is not be expected to have further adverse impacts in addition to the adverse impacts resulting from habitat degradations that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

Future Conditions with Project Action Alternatives 1, 6, and 7:
In general, there will positive impacts to local terrestrial fauna in the project vicinity from restoring higher flows to Dover and Umbrella Creeks (and a consequential increase in freshwater upstream). These indirect beneficial impacts would include numerous species of wildlife that feed on fish and shellfish from the restored aquatic ecosystem

(Table 2) (Montague 2017b/c). Higher flows throughout the year would provide a healthier freshwater marsh plant community. All of these benefits to the ecosystem previously discussed may indirectly provide higher quality habitat for terrestrial wildlife.

4.6 Threatened, Endangered, and Protected Species

Future Conditions with No Action Alternative:

Selection of the NAA is not be expected to have further adverse impacts in addition to the adverse impacts resulting from habitat degradations that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

Future Conditions with Alternative 7:

Section 7(a)(2) of the Endangered Species Act (16 U.S. Code 1531 et seq.) requires every Federal agency, in consultation with and with the assistance of the USFWS and the NMFS, to ensure that any action it authorizes, funds, or carries out in the United States or upon the high seas, is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat.

In general, there will positive impacts to local flora and fauna in the project vicinity from restoring higher flows to Dover and Umbrella Creeks (and a consequential increase in freshwater upstream). These beneficial impacts would include numerous species of fish and shellfish (Table 2) (Montague 2017a). More freshwater conditions throughout the year would provide a healthier freshwater marsh plant community. All of the benefits to the ecosystem previously discussed would directly and indirectly combine to provide higher quality habitat for all of the protected species in Table 4.

West Indian Manatee (*Trichechus manatus)* **Federal Status**: Threatened

Manatees may move through the study area in the summer months. The potential for adverse impacts to manatees would be limited to short term impacts during construction activities associated with the closure structures. The USFWS requires standard construction procedures if construction activities are performed outside winter months of (December to February) designed to protect the manatee. These construction procedures for mitigation of potential impacts to manatees will be part of the contractor specifications and must be implemented on the project site by the contractors at all times. Construction contractor specifications will include the standard manatee construction limitations provided by the USFWS. This project “may affect but is not likely to adversely affect” because there is an expected benefit to this species in the long term.

Shortnose Sturgeon (*Acipenser brevirostrum*) **Federal Status**: Endangered
Atlantic Sturgeon (*Acipenser oxyrinchus*) **Federal Status**: Endangered

Impacts from Alternative 7 to these two species of sturgeon would likely to be positive due to the increase in freshwater feeding/spawning habitat; connectivity to this habitat in the upper reaches of the estuary (less shoaling); and the improvement to salinity gradients facilitating successful navigation to these potential spawning grounds. Freshwater habitat is required for sturgeon to spawn; however, sturgeon tend to require deeper water than what the proposed restoration is likely to provide.

The potential for adverse impacts to these species would be limited to temporary impacts from construction of the closure structures. Best Management Practices (BMPs) established by NMFS would be implemented to mitigate potential impacts. Per correspondence GADNR-WRD "does not anticipate any adverse impacts to sturgeon from this project or any need for any kind of mitigation during construction" (GADNR-WRD 2017). This project "may affect but is not likely to adversely affect" because there is an expected benefit to these species in the long term. There will be "no affect" to Atlantic Sturgeon critical habitat.

Wood Stork (*Acipenser oxyrinchus*) **Federal Status**: Endangered
As discussed in previous sections, the overall improvements to the ecosystem are expected to improve wood stork habitat by improving fishery habitat. This project "may affect but is not likely to adversely affect" because there is an expected benefit to this species in the long term. Critical habitat for this species has not been designated.

In addition to the Federally protected species, the following State Endangered/Threatened species may inhabit the study area and consequently may be beneficially impacted by the restoration of aquatic habitat (GADNR-CRD 2017).

- Bald eagle (*Haliaeetus leucocephalus*)
  Habitat: Edges of lakes and large rivers; seacoasts

- Round tailed muskrat (*Neofiber alleni*)
  Habitat: Freshwater marshes; bogs

Future Conditions with Alternative 6:
Improvements to habitat for this species from this alternative would be similar to Alternative 7 above. The main difference would be the quantity of benefits, which would be lower than Alternative 7, as described in Section 3.4. Adverse Impacts to protected species would be the same as for Alternative 7.

Future Conditions with Alternative 1:
Improvements to habitat for protected species from this alternative would be similar to the alternatives above. The main difference would be the quantity of benefits, which would be lower than both Alternative 7 and Alternative 6, as described in Section 3.4. Adverse Impacts to protected species would be the same as for Alternatives 7 and 6.

4.7 Air Quality

Future Conditions with No Action Alternative:

Selection of the NAA would not be expected to have impacts on air quality.

Future Conditions with Action Alternatives 1, 6, and 7:
There would be no long term impacts to air quality from any of the alternatives. There would be some short term negligible impacts from air emissions during construction of the closure structures. The project area is currently in attainment for the NAAQS for all criteria pollutants. Therefore, implementation of any of the alternatives is not expected to contribute to a change in this designation.

4.8 Water Quality

Future Conditions with No Action Alternative: Selection of the NAA is not expected to have further impacts in addition to the shoaling in portions of the estuary that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

Future Conditions with Project Action Alternatives 1, 6, and 7:
A benefit of closing the man-made cuts would be restoring the natural tidal flows that typically occurs in along the length of unaltered tidal creeks. This distribution should redistribute the sediments, creating a sandier, deeper creek bottom, and restoring gradual salinity gradients from the headwaters to the mouth. Salinity gradients serve as important cues for orienting migratory fish and shellfish.

The estuarine species (Table 2) historically found in Dover and Umbrella Creeks include shrimp (white and brown), herring, shad, blue crab, eastern oyster, and striped bass. All of these species may benefit from the restoration of tidal exchange, water depths, and salinity gradients in the area. Shad, herring, and striped bass require freshwater for spawning, while blue crabs, oysters, and shrimp require brackish water for successful reproduction. The amount of freshwater upstream would increase under the action alternatives.

Additional benefits of restoring depths and flows in the study area would include increased dissolved oxygen (DO) levels, decreased TSS, and improved nutrient exchange between the Satilla River, St. Andrews Sound, and the Atlantic Ocean.

All of the action alternatives will result in these same benefits but in varying degrees. Alternative 7 would result in the largest increase in these benefits based on the H&H modeling and habitat valuation analysis detailed in Section 3.4 (See Section 5.0 for comparative benefits between alternatives).

4.9 Cultural Resources

Future Conditions with No Action Alternative:
The No Action Alternative will have no effects on cultural resources. This alternative would allow processes that are currently in place to continue. Shoaling that would continue in the estuary would not expose or erode archaeological sites that are recorded near Umbrella Creek.

Future Conditions with Action Alternatives 1, 6, and 7:
Implementation of any of the action alternatives would have no effect on cultural resources. A cultural resources survey of the cuts and ORR determined that there are no significant cultural resources located within the areas where the plug features will be placed or within the cuts. One anomaly was identified in Dover Creek, just southwest of the identified plug location for Dynamite Cut. The anomaly will not be impacted by placement of the closure plug or the created wetland habitat.

No historic architectural resources would be affected, nor would the constructed closure structures have an adverse visual effect. The closure structures would help create wetland habitat which is compatible with the viewshed.

Recorded archaeological sites located along the marsh near Umbrella Creek would not be affected by the implementation of this alternative as the sites would not be subjected to increased periods of exposure or longer durations of saturation.

4.10 Socioeconomic Resources

4.10.1 Demographics and Economic Conditions

Future Conditions with No Action Alternative:

Selection of the NAA would have no effects on demographics and economic conditions in the project area.

Future Conditions with Action Alternatives 1, 6, and 7:

In addition to the intended ecosystem benefits, ancillary benefits may include the return of commercial fishing and crabbing in Dover and Umbrella Creeks closer to historic levels. Indirect benefits from improvements to commercial fishing could be more jobs in the community and improvements in supply to local fish markets.

4.10.2 Noise

Future Conditions with No Action Alternative:

Selection of the NAA would have no effects on noise within the project area.

Future Conditions with Action Alternatives 1, 6, and 7:

Implementation of any of the three alternatives being evaluated would not have any direct long term impacts to noise within the project area. There would be some minor short term impacts during construction activities associated with installing closure structures. However, this impact is expected to be negligible due to the very sparse population in the project area.

4.10.3 Recreation

Future Conditions with No Action Alternative:
Selection of the NAA is not likely to adversely impact recreation within the project area. Without cut closure(s) and the elimination of the sedimentation nodes; low tide access at Dover Bluff, Piney Bluff, and River Marsh Landing is expected to continue to deter boating activities in the future. Habitat for game fish would also be expected to continue to be limited within the study area as described in Section 4.2. Therefore, no additional impacts to recreational boating and fishing are expected from this alternative.

Future Conditions with Action Alternatives 1, 6, and 7:
Recreational activities include boating and fishing for residents of local communities (i. e. Dover Bluff, Piney Bluff, and River Marsh Landing). Piney Bluff and River Marsh Landing are more recent developments, the residents of which have had more limited access to Satilla River due to the extensive sedimentation that has occurred in the area over the decades since Noyes Cut was constructed (Montague 2017c). Access for Piney Bluff Community and River Marsh Landing has been restricted to high tide access in skiffs or larger boats that draw less than 2 feet (Montague 2017c). With the closure of ORR and man-made cuts and the subsequent elimination of the sedimentation nodes; low tide access at Piney Bluff and River Marsh Landing is expected to improve over time, and should not continue to deteriorate.

With implementation of the cut closures and the subsequent elimination of the sedimentation nodes; low tide boat access at Dover Bluff, Piney Bluff, and River Marsh Landing are expected to improve. Alternative involving closure of Dynamite Cut (Alternatives 6 and 7) may restrict some access to the Satilla River for residents of the Piney Bluff and Dover Bluff communities. Alternatives involving man-made cuts would increase travel time 8 minutes (from 12 to 20 minutes) to access Satilla River for the residents of Dover Bluff Community (Voigt 2017). The closure structures would include signage on both sides to warn boat traffic of the danger associated with the closures.

Fishing: Implementation of any of the closures is expected to improve recreational fishing in the project vicinity. The past habitat degradations have adversely impacted recreational fishing for game species and the restoration of historical circulation patterns to the estuary is expected to improve the habitat for all of these game species (Table 2). The action alternatives are not expected to have any further adverse impacts in addition to the adverse impacts that have occurred to recreational fishing resulting from the

habitat degradations that have occurred since the opening of all of the 8 man-made cuts in the study area in the 1900 to 1939 timeframe.

4.10.4 Aesthetics

Future Conditions with No Action Alternative:

With the no action alterative, aesthetics are not expected to change from the current condition.

Future Conditions with Action Alternatives 1, 6, and 7:

Aesthetics are expected to improve from any of the action alternatives due to the restoration of aquatic habitat and the improvements to sedimentation and shoaling within portions of the estuary. In addition, closure structures within man-made cuts would help restore wetland habitat, which is compatible with the viewshed. Vegetation would establish on the closure structures to provide a natural look.

Residential deep water access would also be restored to some residential developments adjacent to the estuary that currently have water at their docks only at high tide.

4.10.5 Water Supply

There would be no impacts to water supply from any of the alternatives evaluated during this study.

4.10.6 Environmental Justice

Future Conditions with No Action Alternative:

Selection of the NAA would have no effects on Environmental Justice.

Future Conditions with Action Alternatives 1, 6, and 7:
Implementation of Alternative 1 would beneficially impact a portion of the Satilla River estuary that primarily includes Noyes Cut, Dover Creek, and Umbrella Creek and adjacent tidal marsh. The high ground adjacent to the Satilla River estuary does not support disproportionate concentrations of minority or low-income communities. Minority or low-income populations do not recreate in this portion of the estuary in disproportionate numbers. As a result, this alternative would not result in disproportionately high and adverse human health or environmental impacts on minority or low-income populations. Therefore, these alternatives comply with Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations”.

4.11 Hazardous Toxic and Radioactive Waste (HTRW)

Future Conditions with No Action Alternative:
Selection of the NAA is not expected to have any impacts related to this issue.

Future Conditions with Action Alternatives 1, 6, and 7:
Fill material requirements for the project's closure of man-made cuts would come from sources that are free of any contamination (e.g. rock and sheet pile). Pollutants from existing sediments being disturbed during construction activities is not expected and historical land use does not warrant any sediment testing for contaminants. The probability of encountering new HTRW contamination is very low for all of the action alternatives. If a new environmental condition is identified prior to the construction phase at the site of the closures, USACE will take the necessary measures to avoid that recognized environmental condition so that the probability of encountering or disturbing HTRW would continue to be low.

4.12 Cumulative Impacts

Council on Environmental Quality regulations (40 CFR 150.7) require an analysis of the cumulative impacts resulting from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes these other actions. Cumulative impacts can result from individually minor, but collectively significant, actions. This cumulative impacts section addresses the cumulative effects arising from considering the alternatives in combination with other historic, ongoing, or proposed actions within the Satilla River Basin.

NAA: The NAA is not expected to result in additional impacts to the ecosystem. However, the past degradations caused by the unnatural circulation patterns created by the existing man-made cuts would continue and would not be offset by any of the improvements from the alternative actions.

Future Conditions with Action Alternatives 1, 6, and 7:
The Satilla River estuary contains a complex network of tidal channels. From 1900 to 1939, eight man-made cuts were made between natural channels to increase the accessibility of the tidal creeks for the timber industry (Figure 2). These cuts changed the circulation patterns in the estuary and (1) altered local patterns of tidal exchange; (2) disrupted gradual salinity gradients from the headwaters to the mouth of the creeks; and (3) reduced access to headwaters for estuarine species due to channel sedimentation.

Currently, salinity gradients are altered by a large volume of Satilla River brackish water entering through the short pathway of Noyes Cut. This large volume of brackish water overwhelms the freshwater that enters the headwater area and causes the salinity to be nearly constant throughout most of Dover Creek. Additionally, tidal flows through multiple creeks and cuts causes a tidal node where sediment deposition clogs channels.

By closing man-made cuts, the project is expected to improve the aquatic ecosystem by restoring the historical hydrologic regime. These improvements would offset much of the historic adverse impacts to the ecosystem from the eight man-made cuts since 1900. Since the action alternatives involve restoring natural and historic circulation patterns by closing man-made cuts, overall impacts are expected to be beneficial on an individual project and cumulative effects basis. Restoring the natural circulation patterns may also restore historical salinity gradients allowing more efficient use of the ecosystem by migratory fish species.

These three action alternatives focus on closing a combination of ORR, Noyes Cut, and Dynamite Cut to alter tidal exchange within Dover and Umbrella Creeks. The closure structures would vegetate and become more resistant to tidal surges and sea level rise over time. For the study area, sea level is predicted to rise 9 inches over the 50-year period of analysis. The tidal marsh in the study area would be very adaptable to increases in sea level rise due to the large tidal range, available sediment supply, and the ability of the existing marsh to create its own sediment from detritus (NOAA 2011). Actions to mitigate for potential adverse impacts to closure structures from sea level rise are addressed in Section 10.2 (Adaptive Management Plan).

Reasonably foreseeable future actions by others in the basin: In future decades, foreseeable developments in the area appear limited to a slow increase in houses on the north bank of the estuary (Hazzards Neck), and a possible spaceport on the eastern end of the southern bank (Floyds Neck), 5 miles south of the project impact area. The spaceport may also stimulate residential and economic development nearby.

Hazzards Neck is currently rural, with less than 100 houses now along the five adjacent east-west miles closest to this project. The densest development along that stretch is within the confines of the private Dover Bluff Club at the eastern end. Residents of Dover Bluff Club have little desire for intense future development (Montague 2017d).

The industrially zoned eastern end of Floyds Neck is also the site proposed for the small spaceport (known as Spaceport Camden, and consisting of one launch pad, one vertical landing pad, and a few support buildings, with a maximum of 12 liquid-fueled launches per year). The proposed spaceport must be licensed by the Federal Aviation Administration (FAA), a process now ongoing. An EIS for Spaceport Camden is currently in preparation by FAA consultants. Spaceport activities would not be anticipated to negatively impact fish and shellfish habitat in the estuary (Montague 2017d),

The potential for future development is low compared to more urban basins in Georgia and northern Florida. The upland areas immediately adjacent to the estuary is similarly rural. No economic centers or towns are near the proposed restoration area. Woodbine, a town of about 1,300, is near the headwaters of the estuary 15 miles upriver (10 miles west of Noyes Cut).

Across the estuary to the South, Floyds Neck has even less development adjacent to the Satilla River estuary. Its eastern end is zoned by Camden County for heavy industry, however, no active industry or residences are now present. Two large tracts there are owned by Union Carbide and Bayer Crop Science. For half a century, pesticides and rocket fuels were manufactured there, but all such operations ceased circa 2012. An unlined "legacy" landfill is managed by Union Carbide under a Resource Conservation and Recovery Act (RCRA) permit.

Union Carbide's legacy landfill is close to Todd Creek, a tributary of the estuary that intersects the AIWW adjacent to the eastern end of Floyds Neck (several miles south of the study area). If case either groundwater or bank erosion reach identified trigger points over the coming decades, Union Carbide has proposed plans to stabilize bank erosion in Todd Creek.

The project impact area, which consists of tidal wetlands and creeks, is Federally protected as jurisdictional waters of the U.S. There are no current dredging activities in the vicinity. The AIWW has very little funding and is only rarely dredged to maintain authorized depths. There have not been any other known past, present, or future plans to alter or modify this estuary identified in this study.

4.13 P&G Screening Alterative for Plan Selection

4.13.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to obtaining the expected benefits to the objective.

A complete alternative is one that is well thought out. All the necessary implementation actions have been accounted for in the planning process. Once plan effects have been identified, it is important to scrutinize the plan to ensure that it includes all that is necessary to realize the plan effects. This means considering those things beyond the planners' control, as well as those things that may be beyond the scope of the USACE program or the sponsors' commitment.

Since this study accounted for all project purposes, study objectives, necessary investments, implementation actions, and multiple levels of review, the NAA and each of the three action alternatives meet the above conditions of completeness.

4.13.2 Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. An effective plan is responsive to the wants and needs of the country. An effective plan makes a significant contribution to the solution of some problems and achieves some opportunities. It contributes to the

attainment of the planning objectives. In the screening process, it is often possible to identify alternatives that make little or no contribution to the planning objectives. When this happens, these alternatives would be rejected because they are relatively ineffective.

The alternatives were formulated to meet the project criteria and were evaluated based on their effectiveness in restoring historic hydrodynamic conditions to the study area. Based on the H&H models and the habitat valuation method, all action alternatives would be effective in varying degrees in restoring the hydrology and ecosystem. These models also indicate that Alternative 7 would be the most effective since it provides the most and best habitat restoration to the area.

4.13.3 Efficiency

Efficiency is the extent to which an alternative plan cost effectively alleviates the specified problems and realizes the specified opportunities, consistent with protecting the Nation's environment.

Efficiency refers to the allocation of resources. Are the resources used efficiently in the construction of a project or the implementation of a plan? Are the outputs produced by the plan produced in an efficient manner? Are the resources that are going to be significantly affected by the plan still going to be available for efficient use by society? A criterion of efficiency is cost effectiveness. Have we identified the lowest cost of implementation?

Efficiency must be considered in light of all opportunity costs, not just monetary costs. This makes the efficiency criterion considerably more difficult for planning for the Corps' environmental mission because planners may have to trade-off increased implementation costs against less environmental losses.

Cost Effectiveness Incremental Cost Analysis (CE/ICA) was used to identify the most efficient alternative. Based on the CE/ICA, Alternatives 6 and 7 are both Best Buy Plans that would provide the most additional benefits to the ecosystem for the additional cost. The CE/ICA determined that Alternative 6 was more cost efficient than Alternative 7. However, Alternative 7 provides a non-captured benefit to the ecosystem by providing strong salinity cues to migratory fish and larval invertebrates, as detailed in other sections (Sections 3.4.1 and 6.0).

In addition, Alternative 7 also provides more ancillary benefits from improvements to recreational boating and fishing; and commercial fishing. Therefore, Alternative 7 would provide the most overall value to the ecosystem.

4.13.4 Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing

laws, regulations, and public policies. Acceptability does not equate with the non-Federal sponsor's willingness to sign a Project Cooperation Agreement. Also, if the plan has opposition from the public, that doesn't make it unacceptable.

There are two primary dimensions to acceptability: implementability and satisfaction. Implementability means is it feasible in the technical, environmental, economic, and social senses. To be acceptable to state and local entities as well as the public, a plan has to be feasible. There are many factors that can render a plan infeasible. These factors can generally be categorized as technical, economic, financial, environmental, social, political, legal, and institutional. If a plan cannot be done for legitimate reasons, it is not feasible.

Acceptability can also be defined as the extent to which a plan is welcome or satisfactory to the public. The goal is to have high acceptability, which means that the alternatives are generally acceptable to all in both an implementable and satisfactory sense. These dimensions of acceptability have been considered in this study. The alternatives satisfy the requirements of all agencies and users and are implementable.

This study has received support from the non-Federal sponsor, stakeholders; and the regulatory agencies that have been involved in the study including GADNR, USFWS, and NMFS. As of March 2017, most local residents and commercial fishermen (crabbing) have been supportive of alternatives involving closure of man-made cuts in the vicinity during recent inquiries by stakeholders (Montague 2017a). The USFWS has indicated a preference for the plan that would provide the greatest increase in fisheries and related aquatic habitat values (FWCAR 2017), which would be Alternative 7.

4.13.5 Risk and Uncertainty

The fundamental purpose of the study was to identify the best method of restoring the hydrodynamic environment of the study area. Restoring the hydrodynamic environment would consequently restore the ecosystem from the degradations that have occurred since the 8 man-made cuts were implemented in the early 1900's.

To achieve the project objectives, the alternatives were assessed and compared to determine the most effective at restoring the hydrodynamic environment. Based on changes in tidal exchange from the alternatives predicted in H&H models, this study determined which alternative was the most cost effective solution for restoring this ecosystem. The degree of accuracy of H&H models limits the confidence in subsequent predictions of the degree of ecosystem restoration.

Since the USACE Civil Works Program explicitly deals with risk and uncertainty, the goal is to construct an approach that explains the risk and uncertainty in a uniform manner. Risk and uncertainty analysis is about intended to improve information and, ultimately, the decisions based upon that information. The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) of March 10, 1983, states:

> "The planner's primary role in dealing with risk and uncertainty is to identify the areas of sensitivity and describe them clearly so that decisions can be made with knowledge of the degree of reliability of available information."

The PDT evaluated the consequences of all known risks and uncertainties and delineated them in the development of a risk register. A detailed description of risks is captured in the study's Risk Register. After careful consideration, the PDT developed recommendations on how to manage the risks and uncertainties. The alternative selected by the PDT eliminates or minimizes as many adverse effects as possible.

There is some associated risk with selecting Alternative 7 over Alternative 6, since 6 was determined to be the most cost effective in the CE/ICA analysis (Section 3.4). However, this risk is minimal since additional habitat improvements (outside of CE/ICA analysis) were identified with Alternative 7 from the H&H salinity modeling. This additional habitat value is based on providing a more suitable salinity gradient (demonstrated by Figure 9 in Section 3.4.1) than Alternative 6 for migratory fish seeking cues to find upstream freshwater spawning habitat. More detail on the derivation of this additional habitat value is in Section 3.4.1.

5 Comparison of Alternatives (Quantitative and Qualitative Effects Matrix)

Table 13 shows a ranking of alternatives based on impacts to important resources in the study area. More detail can be found in Section 4.0.

Table 13 - Ranking of Alternatives Based on Impacts

	NAA	Alt 7	Alt 6	Alt 1
Hydrology	1	4	3	2
Aquatic Resources/Habitat	1	4	3	2
EFH	1	4	3	2
Wetlands/Jurisdictional Waters	--	--	--	--
Terrestrial Resources	--	--	--	--
Threatened/Endangered Species	1	4	3	2
Air Quality	--	--	--	--
Water Quality	1	4	3	2
Cultural Resources	--	--	--	--
Socioeconomics	1	4	3	2
HTRW	--	--	--	--
Cumulative Impacts	1	4	3	2
Average	**1**	**4**	**3**	**2**
Rankings – 1 through 4; 4 being the greatest benefit **-- indicates no significant relative difference between alternatives** **U - Undetermined - to be determined after Phase I surveys**				

Conclusion

Based on this analysis, Alternative 7 has the least adverse impacts and the most beneficial impacts among alternatives. Alternative 7 has the highest ranking of the four final alternatives considered in detail.

6 Selection of Tentatively Selected Plan (TSP)

The level 4 cost estimate (First Cost) to implement Alternative 6 is estimated to be $4,235,636, which would be shared 75% Federal and 25% non-Federal. The level 4 cost estimate (First Cost) to implement Alternative 7 is estimated to be $7,483,680, which would be shared 75% Federal and 25% non-Federal.

In addition to the NAA, the study team evaluated three alternatives in detail. Alternatives 6 and 7 would produce more benefits at a substantially lower cost per habitat unit than Alternative 1. Therefore, Alternative 1 is less cost-effective and was dropped from consideration as the TSP.

The cost effectiveness of Alternatives 6 and 7 can be compared starting with the less expensive plan - Alternative 6. Its output is 1,330 AAHUs, which results in an incremental cost of $128 per AAHU. Alternative 7 has a higher level of output at 1,780 AAHU, which means that an additional 450 AAHUs could be produced for an additional incremental cost of $267 per AAHU. If the additional 450 AAHUs are worth $267 apiece, then Alternative 7 would be selected as the TSP.

As detailed in Section 3.4.1, Alternative 7 provides an additional benefit to the ecosystem by providing strong salinity cues to migratory fish and larval invertebrates. Those additional benefits were not measured or included into the CE/ICA calculations (Section 3.4). The ecological and commercial significance of these additional ecosystem outputs were discussed in Section 2.2. The impact analysis in Sections 4.0 and 5.0 also support selection of Alternative 7 as the TSP by detailing the amount and significance of the additional benefits to the ecosystem. Therefore, based on all of the above summaries of Sections 2.2, 3.4, 3.4.1, 4.0, and 5.0, Alternative 7 is identified as the TSP.

7 Planned Public Involvement*

The Integrated Feasibility Report (including Appendices) will be available to the public for a 30 day review. The non-Federal sponsor, stakeholders; and the regulatory agencies that have been involved in the study will be consulted regarding the selection of the TSP. This includes the GADNR, USFWS, and NMFS.

As of March 2017, most local residents and commercial fishermen (crabbing) have been supportive of alternatives involving closure of man-made cuts in the vicinity during recent inquiries by stakeholders (Montague 2017a). The Satilla Riverkeeper has been coordinating with local fisherman, boaters, and other organizations in the area regarding the potential construction of this project.

8 Coordination and Regulatory Compliance*

Preparation of this report is being coordinated with appropriate Congressional, Federal, state, and local interests, as well as environmental groups, interested Federally recognized tribes, and other interested parties. A list of the Federal and state agencies, interested Federally recognized tribes, and Non-Government Organizations (NGO) that will be contacted during the evaluation or that will receive a copy of the report for review follows:

USFWS
EPA
NMFS
Georgia DNR
Georgia DNR-CRD
Georgia DNR-WRD
Georgia DNR-EPD
Georgia DNR - Historic Preservation Division (HPD)
Seminole Nation of Oklahoma

Consultation with Georgia HPD and the Seminole Nation of Oklahoma in accordance with Section 106 of the National Historic Preservation Act compliance requirements is ongoing. The draft report will be submitted for review and consultation will be complete upon concurrence with the findings of the survey and acceptance of the final report.

The draft report will be submitted for review and consultation will be complete upon concurrence with the findings of the survey and acceptance of the final report. Consultation regarding protected species in the study area is on-going with the USFWS and the GADNR. Recommendations of the USFWS in accordance with the Fish and Wildlife Coordination Act (FWCAR) are included in Appendix D. GADNR-CRD has also been consulted regarding compliance requirements with the Coastal Zone Management (CZM) Consistency Act (GADNR-CRD 2017). GADNR-WRD has been consulted regarding state protected species.

NMFS has been consulted regarding the fish and shellfish in the study area protected by the Magnuson-Stevenson Fishery Conservation and Management Act. EFH areas

have been identified and USACE will continue coordination of the project with this agency.

The EPA will review the Draft Feasibility Report pursuant to Section 309 of the Clean Air Act.

The following individuals/agencies listed were consulted during this study:

Name	Organization/Role in Study
Ms. Cynthia Cooksey	NMFS EFH POC for Savannah District
Ms. Kelie Moore	Georgia DNR-CRD Federal Consistency Coordinator & Non-Federal Sponsor
Rachael Thompson	Satilla Riverkeeper
Ms. Gail Martinez	USFWS US FWCAR Preparer
Dr. Clay Montague	Stakeholder Former Satilla Riverkeeper Associate Professor Emeritus Department of Environmental Engineering Sciences. University of Florida
Mr. Fred Voigt	Stakeholder and Resident of Dover Bluff Community
Mr. Bill Post	Diadromous Fish Coordinator S.C. Department of Natural Resources
Doug Peterson	University of Georgia
Dr. Kyle McKay	US Army Engineer Research and Development Center (ERDC) engineer/scientist Development of Habitat Valuation Method
Dr. Bruce Pruitt	ERDC engineer/scientist Development of Habitat Valuation Method
Mr. John Hickey	CEIWR-HEC-WRS Development of Habitat Valuation Method
Mr. Tim Barrett	Georgia DNR-WRD Fisheries Regional Supervisor Provided research on sturgeon presence in area
Mr. Don Harrison	Georgia DNR-WRD Fisheries Biologist III
Ms. Debbie Scerno	USACE South Atlantic Division Planning Division
Mr. Christopher M. Wallen and Staff	Dynamic Solutions Knoxville Tennessee Prime Contractor for H&H model development
Mr. Trap Puckette	RPS Evans-Hamilton H&H Sub Contractor Charleston South Carolina Field data collection
Dr. Clark Alexander	Professor Skidaway Institute of Oceanography Provided local knowledge and available data
Mr. Gaurav Savant	ERDC and consultant for Dynamic Solutions

Mr. Gary Brown	ERDC and consultant for Dynamic Solutions

9 Mitigation*

The appropriate application of mitigation is to formulate an alternative that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. Compensatory mitigation is not warranted for the TSP, since the proposed action would result in substantial positive environmental effects. Some temporary adverse impacts may result from construction of the closure structures; however, standard BMPs would be implemented to mitigate these effects.

The TSP avoids adverse impacts by:

1) Limiting construction activities to periods when protected species are less likely to be in vicinity [consultation on-going with USFWS].

2) Construction of the closures would utilize barges to avoid impacts to surrounding wetlands. Barges and rocks would not be placed within marshes outside of closure area.

3) Closures are designed with sheet pile tying into the marsh (not across the entire structure) on both ends to minimize environmental impacts in the marsh.

10 Monitoring and Adaptive Management Plans

10.1 Monitoring Plan

All action alternatives include pre- and post-construction monitoring of the 14 data points (Appendix A) used in the hydraulic modeling for the project. Use of the same data points allow a direct comparison of the observed results to those predicted during the feasibility study. The monitoring would assess changes in flow, salinity, and sedimentation.

1) Monitor post-construction changes in Flux at 10 locations (existing data points 4 through 13).

   1 pre-construction monitoring event; 3 post-construction monitoring events (years 1, 3, and 5). Pre-construction monitoring costs are part of PED costs. Monitoring of flux will be performed during mid-tide and average lunar tidal conditions (incoming or outgoing tide will be chosen).

The goal is for the change in flux at 10 locations to trend in the same direction as the modeled results.

- Performed by USGS. Use a doppler profiler to collect the flow data. 1 day per creek ~2 weeks total. 2 days for travel. 3-man crew. Post-processing, admin, and escalation. **$**40,000/year X 4 years = $**160,000 Total Flux Costs**

2) Monitor post-construction changes in the salinity profile along Umbrella and Dover Creeks. The monitoring would extend to the upper end of each of these two major tidal creeks.

- Performed by EN-H. Profiles with USACE Boston Whaler. ~1 day per creek, ~ 2 days. 2 person crew, 1.5 days post processing. ~$8000/year X 4 years **= $32,000 Total Salinity Costs**

1 pre-construction monitoring event; 3 post-construction events (years 1, 3, and 5). Pre-construction monitoring costs are part of PED costs. Monitoring will be performed during a maximum spring tide.

The goal for this monitoring is for the data to show a continually decreasing trend from high to low salinity as one progresses up the tidal creek, as shown in Figure 9 for Alternative 7.

3) Channel surveys (bathymetry) of domain of the hydraulic model within Dover and Umbrella Creeks, and the Alternate AIWW to measure the amounts of scouring/sedimentation.

Goal is for bathymetry trends to be in the direction (increasing or decreasing sedimentation) predicted in the model.

- Performed by OP-N. ~3 weeks, Admin and escalation. $12,000/year X 4 years = $48,000
- EN labor for volume calculations and/or shoaling maps. $5000/year X 4 years = $20,000.

Total Bathymetry Costs: $68,000

1 monitoring event pre-construction; 3 events post construction (years 1, 3, and 5). Pre-construction monitoring costs are part of PED costs.

Total Costs $260,000
$15,000 - EN-H labor ($5000 per year) coordinate with USGS on flux sampling, provide data to PD
$75,000 - PD labor (4 Summary Reports; coordinating with agencies/SAD)

Grand Total $350,000*

***Portion of Monitoring Costs Occurring in PED Phase: $65,000**

10.2 Adaptive Management Plan

Adaptive management is a tool to manage risk and uncertainty. The risk of this project failing to obtain the study objectives is considered to be low. If failure occurs, possible adaptive management strategies could include:

- Dredging to improve flows and salinity gradients
- Closure of other existing cuts
- Preventing tidal surges from circumventing constructed closures by:
    - creating wetlands in cuts behind closures to prevent flows going around the closure
    - extending sheet pile wall further into wetlands
    - adding 2 foot of height (additional rock) to closure structures to compensate for settling under the closure structure

Based on limited geotechnical data, the most likely area of project failure is from tidal surges circumventing the sheet pile wall. The estimated cost for installing a 40-foot length of sheet pile to the end of one structure is $717,000.

11 Compliance with Law and Regulations*

Table 14 summarizes compliance of TSP with applicable Federal/State laws.

Table 14 - Relationship of Project to Environmental Requirements

Federal Statutes	Level of Compliance*
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	Full
Coastal Zone Management Act	Partial
Comprehensive Environmental Response, Compensation and Liability Act	Full

Endangered Species Act	Partial
Estuary Protection Act	Full
Farmland Protection Policy Act	N/A
Federal Water Project Recreation Act	N/A
Fish and Wildlife Coordination Act	Full
Flood Control Act of 1944	Full
Land and Water Conservation Fund Act	Full
Magnuson Fishery Conservation and Management Act	Full
Marine Mammal Protection Act	Full
National Environmental Policy Act	Full
National Historic Preservation Act	Partial
North American Wetlands Conservation Act	Full
Resource Conservation and Recovery Act	N/A
Rivers and Harbors Act	Full
Water Resources Development Acts of 1976, 1986, 1990, and 1992	Full
Water Resources Planning Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic Rivers Act	Full
Executive Orders (EO), Memoranda, etc.	
Migratory Bird (E.O. 13186)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Federal Statutes	Level of Compliance*
Protection and Enhancement of Cultural Environment (E.O. 11593)	Partial
Exotic Organisms (E.O. 11987)	Full
Floodplain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full

Relating to Protection and Enhancement of Environmental Quality (E.O. 11991)	Full
Environmental Justice in Minority and Low-Income Populations (E.O. 12898)	Full
Invasive Species (E.O. 13112)	Full
Protection of Children from Health Risks and Safety Risks (E.O. 13045)	N/A
Prime and Unique Farmlands (CEQ Memorandum, 11 August 1980)	N/A

*Level of Compliance:
Full Compliance (Full): Having met all requirements of the statute, E.O., or other environmental requirements.
Partial Compliance (Partial): Not having met some of the requirements at current stage of planning. Compliance with these requirements is ongoing.
Non-Compliance (NC): Violation of a requirement of the statute, E.O., or other environmental requirement.
Not Applicable (NA): No requirements for the statute, E.O, or other environmental requirement for the

Environmental compliance for the TSP would be achieved upon:

- Coordination of this draft report with appropriate agencies, organizations, and individuals for their review and comments.

- U.S. Fish and Wildlife Service (USFWS) and NMFS confirmation that the TSP would not likely adversely affect any endangered or threatened species or their critical habitat. The specific Federally protected species include manatees, Atlantic sturgeon, shortnose sturgeon, and wood stork.

- Obtaining Section 401 Water Quality Certification from the State of Georgia.

- Concurrence by the Georgia State Historic Preservation Officer with USACE's determination of effect on cultural resources and resolution of adverse effects should any be required.

- Receipt and acceptance or resolution of all USFWS Fish and Wildlife Coordination Act recommendations.

The Draft FONSI will not be finalized and signed until the TSP achieves environmental compliance with applicable laws and regulations, as described above.

12 Recommendations

The non-Federal sponsors, GADNR and the Satilla Riverkeeper, in collaboration with Dover Bluff residents, requested that the Savannah District investigate the best method to restore the Satilla River estuary system under the Section 1135 authority. The purpose of the project is to restore aquatic habitat (wetlands and tidal creeks) degraded by the AIWW in the vicinity of Umbrella and Dover Creeks of the Satilla River estuary and improve salinity gradients that improve directional cues for migratory fish, shrimp, and crabs. The project is needed because past actions for the AIWW altered salinity gradients by allowing a large volume of Satilla River water to enter upriver portions of tidal creeks through the short pathway of Noyes and Dynamite Cuts.

To achieve the project objectives, the Tentatively Selected Plan (Alternative 7) would alter the hydrodynamic environment by closing ORR, Noyes Cut, and Dynamite Cut. All three closure structures would consist of a combination of sheet pile walls, rip rap, and bedding stone. Implementation of the TSP would include pre- and post-construction monitoring. The monitoring would assess changes in flow, salinity, and sedimentation to determine if the goals of the study were obtained. There would be one pre-construction monitoring event and three post-construction monitoring events. The three post-construction events would occur in alternate years (i.e. years 1, 3, and 5) following construction.

Implementation of Alternative 7 (TSP) requires deauthorization of Noyes Cut, as a portion of the Federally authorized AIWW project. I recommend that deauthorization, which would occur after approval of this restoration project. Even though Noyes Cut has been obsolete since 1939, it is still technically part of the Federal AIWW navigation project.

It is anticipated that GADNR will be the non-Federal sponsor for the construction phase. The total estimated cost is $7,605,000. Of that amount, the Federal portion would be $5,703,750 and the non-Federal portion would be $1,901,250. The non-federal sponsor that enters into the Project Partnership Agreement with USACE will be responsible for all of the cost-shared activities that are included in that agreement.

I recommend implementation of Alternative 7 for the restoration of aquatic habitat within the study area.

DRAFT

Date

Marvin L. Griffin, P.E.
Colonel, U.S. Army
Commanding

13 References

Alber, M., Alexander, C, Blanton, J., Chalmers, A. and Gates, K. (2003). *The Satilla River Estuarine System: The Current State Of Knowledge*. A report submitted to The Georgia Sea Grant College Program and The South Carolina Sea Grant Consortium.

Atlantic States Marine Fisheries Commission (ASMFC). http://www.asmfc.org/fisheries-management/program-overview . Research regarding historic decline of American shad populations on east coast. 2016.

Cooksey, Cindy. NMFS EFH POC for Savannah District. 843-762-8610. Teleconference on February 1, 2017.

DeVoe, M. R. and D. S. Baughman (1986). *South Carolina coastal wetland impoundments: ecological characterization, management, status, and use*. III. Technical appendix. South Carolina Sea Grant Consortium. SC-SG-TR-86-2.

EPA. Research on my waterway website at https://watersgeo.epa.gov/mywaterway/map.html . October 4, 2017.

Fish and Wildlife Coordination Act Report (FWCAR). USFWS Georgia Ecological Services. Townsend, GA. July, 2017.

GADNR-CRD. Kelie Moore, Federal Consistency Coordinator. Telephone conversation regarding exemption from CZM Determination. May 24, 2017

GADNR-EPD. Satilla River Basin Management Plan. 2002.

GADNR-WRD. Tim Barrett, Fisheries Regional Supervisor. Telephone conversation and email correspondence regarding project impacts on sturgeon. July 11, 2017

Garrott, R.A., B.B. Ackerman, J.R. Cary, D.M. Heisey, J.E. Reynolds, III, and J.R. Wilcox. 1995. Assessment of trends in sizes of manatee populations at several Florida aggregation sites. Pages 34-35 *in* T.J. O'Shea, B.B. Ackerman, and H.F. Percival (eds.). Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.

Georgia Senate Resolution. Senate Resolution 267 of the 2013 Legislative Session. March 21, 2013:

Georgia Southern University (GSU), *A Holistic Assessment of Noyes Cut on the Satilla River Estuary*, Dr. Jessica Reichmuth. 2016.

Georgia Water Coalition. Dirty Dozen Report. Nov 2012

Harrison, Donald. Fisheries Biologist III, GAEPD-WRD Fisheries Management. Email correspondence regarding project impacts on sturgeon. (912) 285-6483. July 11, 2017

Hill, Amanda. USFWS Charleston Office. Personal communication regarding Federally protected species in the vicinity. November 3, 2010 and December 8, 2010.

McMahon, George F. Chief, Coastal and Waterways Engineering Station. Hydrodynamic Analysis from Man-made Cuts, Dover Bluff, Satilla River Basin, Camden County, Georgia. September 1983.

Montague, Clay. Resident Dover Bluff Community, former Satilla Riverkeeper, and Associate Professor Emeritus, Department of Environmental Engineering Sciences. University of Florida, Gainesville. PDT meeting with sponsor and stakeholders on March 19, 2017a.

Montague, Clay. Resident Dover Bluff Community. Email correspondence regarding socioeconomic impacts in vicinity on March 28, 2017b.

Montague, Clay. Resident Dover Bluff Community. Email correspondence regarding socioeconomic impacts in vicinity on April 13, 2017c.

Montague, Clay. Resident Dover Bluff Community. Email correspondence regarding cumulative impacts in vicinity on September 28, 2017d.

NMFS. 1998. *Final Recovery Plan for the Shortnose Sturgeon Acipenser brevirostrum*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

NMFS. *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies.* South Atlantic Region. St. Petersburg, FL. September 2010.

NOAA. National Estuarine Research Reserve Association (NERRA). *Rising to the Challenge: Will Tidal Marshes Survive Rising Seas?* January 2011.

Seabrook, Charles. "Tidal Marshes." New Georgia Encyclopedia. 21 April 2017. Web. 05 July 2017.

South Atlantic Division (SAD) U.S. Army Corps of Engineers, Planning Division. IPR meeting December 18, 2015.

SAD U.S. Army Corps of Engineers, Planning Division. IPR meeting June 12, 2017.

Teal, John. *Energy Flow in the Salt Marsh Ecosystem of Georgia*. Woods Hole Oceanographic Institution. October 1962.

USACE. Chief of Engineers Annual Report. 1940.

USACE. Savannah District. Meeting with non-Federal sponsor and stakeholders. March 19, 2017a.

USACE. Savannah District. Table developed through collaboration with the USFWS, NMFS, Dr. Clay Montague, USACE biologists. 2017b.

USFWS, Georgia Ecological Services. Townsend, GA. Email correspondence from Gail Martinez, May 16, 2017.

Voigt, Fred. Resident Dover Bluff Community. PDT meeting with sponsor and stakeholders on March 19, 2017.

Wiegert, R.G., and B.J. Freeman. 1990. Tidal Salt Marshes of the Southeast Atlantic Coast: A Community Profile. Biological Report 85(7.29). US Department of the Interior, Fish and Wildlife Service, Washington, DC, 70 pp.