US Army Corps
Of Engineers®
Charleston District

INTERIM FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

COASTAL STORM DAMAGE REDUCTION GENERAL INVESTIGATION STUDY

EDISTO BEACH, COLLETON COUNTY SOUTH CAROLINA

March 2014

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* denotes Sections which integrate both NEPA and Feasibility Report elements and requirements.

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EXECUTIVE SUMMARY

This Integrated Feasibility Report and Environmental Assessment presents the results of studies performed to examine the feasibility of federal coastal storm damage reduction for the Town of Edisto Beach, South Carolina. It describes baseline conditions, the formulation and evaluation of alternative plans and the identification of a Recommended Plan.

Edisto Island is a barrier island located at the mouth of the South Edisto River in Colleton County, South Carolina, approximately 45 miles southwest of Charleston, South Carolina and approximately 20 miles east-northeast of Beaufort, South Carolina. The study area is illustrated in Figure S.1. Edisto Beach encompasses approximately 6 miles of sand shoreline, all of which were included in the feasibility study.

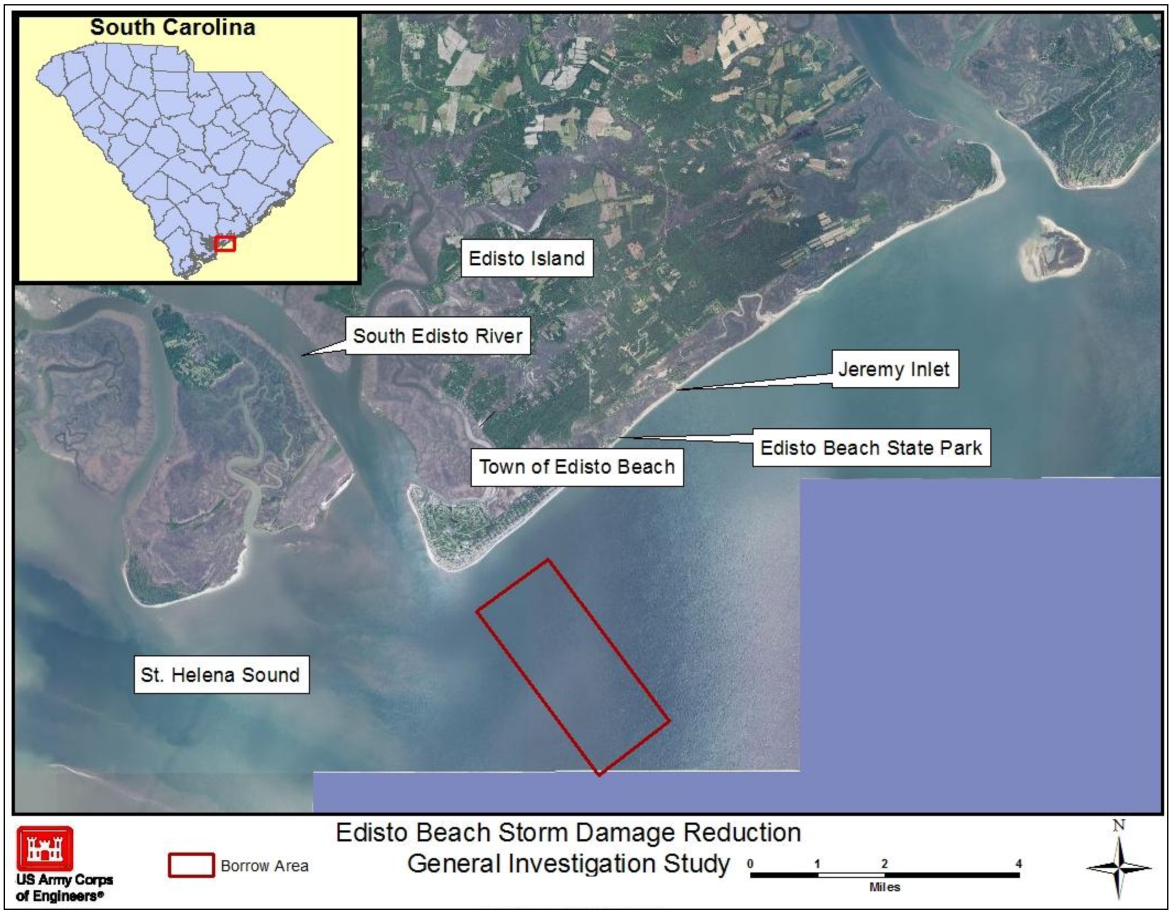

Figure S.1: Location of Edisto Beach study area.

The primary goal of the study is to reduce the adverse economic effects of coastal storms at Edisto Beach. Six action alternatives and the no action alternative were evaluated and compared in order select and recommend an alternative. The action alternatives included:

1. Mid-size dune and berm fill combined with 1,090 ft of groin lengthening
2. Minimum size dune and berm fill combined with 360 ft of groin lengthening
3. Maximum size dune and berm fill combined with 1,970 ft of groin lengthening
4. Mid-size dune and berm fill combined with 1,130 ft of groin lengthening
5. Dune sand fencing on some reaches with dune and berm fill on other reaches
6. Non-Structural/Demolition (over limited reaches)

The mid-size dune and berm fill combined with 1,130 ft of groin lengthening alternative (number 4 above) generated the highest net economic benefits and was selected as the recommended plan. The primary features of the plan are illustrated in Figure S-2 and summarized in the text, below.

The primary features of the Recommended Plan include:

- A 15-foot high, 15-foot wide dune beginning at the northern end of the project and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would taper to a 50-foot width over the remaining length of the berm. The width of each end of the berm would taper to match the existing beach profile

- Beginning at the southern end of the 15-foot high dune, the dune would transition to a 14-foot high, 15-foot wide dune and extend around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm

- Approximately 1,130 ft of groin lengthening across 23 of the existing groins.

- 16-year renourishment interval

It is worth noting that the Edisto Beach State Park was initially a part of the study area. However, it was not included in the Recommended Plan because of a lack of existing infrastructure needed to generate enough benefits to justify the cost to protect that portion of beach.

Figure S.2: Primary Features of Recommended Plan

Based on 2014 price levels, the initial construction cost of the project is $21,129,000, and the renourishment cost that is expected to occur every 16 years is $10,914,000, with the present value totaling $16,030,800. The interest during construction is approximately $106,800 and operations and maintenance approximately $83,000. The project related costs, including the total average annual cost for the Recommended Plan are summarized in Table S.1, below.

Table 1: Recommended Plan Cost Summary

Initial Construction	$	21,129,000
1st Renourishment	$	6,294,200
2nd Renourishment	$	3,629,900
3 Renourishment	$	2,093,400
Total First Cost	$	33,146,400
Interest During Construction	$	106,800
Total Project Cost	$	33,252,800
Average Annual First Cost	$	1,418,000
O&M	$	83,000
Total Average Annual Cost	**$**	**1,501,000**

The total expected average annual coastal storm damage reduction benefits (at 3.5% interest rate) for the Recommended Plan are estimated to be $2,849,000. The average annual recreation benefits are $573,200. The benefits associated with the Recommended Plan, as well as the Benefit-to-cost ratio are summarized in Table S.2, below.

Table S.2: Recommended Plan Benefits Summary

Average Annual CSDR Benefits	$2,894,000
Average Annual Recreation Benefits	$ 573,200
Total Average Annual Benefits	$3,467,200
Total Average Annual Cost	$1,501,000
Benefit-to-Cost Ratio	2.3
Net Average Annual Benefits	$1,966,200

The Environmental Assessment and Finding of No Significant Impact were distributed in August 2013 for a 30 day comment and review period. The Final Environmental Assessment addresses the comments received during this review period. The findings demonstrate that the proposed project will not significantly adversely affect environmental resources or human health, the preparation of an Environmental Impact Statement is not warranted.

FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

COASTAL STORM DAMAGE REDUCTION

EDISTO BEACH, COLLETON COUNTY

SOUTH CAROLINA

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1. STUDY OVERVIEW*

This Interim Integrated Feasibility Report and Environmental Assessment presents the results of studies to examine the feasibility of federal coastal storm damage reduction for the Town of Edisto Beach, South Carolina. As an integrated report, it includes all elements that are required for a U.S. Army Corps of Engineers (USACE) Feasibility Report, as well as an Environmental Assessment (EA) per the National Environmental Policy Act (NEPA). Sections which integrate both NEPA and Feasibility Report elements and requirements are denoted with a "*" at the end of the section title.

1.1 Study Authority

The Edisto Beach Coastal Storm Damage Reduction General Investigation (GI) Feasibility Study is being conducted in response to a resolution adopted on April 22, 1988 by the Committee on Environment and Public Works of the United States Senate:

> "*Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army in accordance with the provisions of Section 110 of the River and Harbor Act of 1962, is hereby authorized to study, in cooperation with the State of South Carolina, its political subdivisions and agencies and instrumentalities thereof, the entire Coast of South Carolina in the interests of beach erosion control, hurricane protection and related purposes. Included in this study will be the development of a comprehensive body of knowledge, information, and data on coastal area changes and processes for such entire coast.*"

1.2 Non-Federal Sponsor

The non-Federal sponsor for this project is the Town of Edisto Beach, South Carolina. The study was cost shared 50/50 per a feasibility cost sharing agreement that was signed September 29, 2006.

1.3 Location of Study Area

Edisto Island is a barrier island located at the mouth of the South Edisto River in Colleton County, South Carolina, approximately 45 miles southwest of Charleston, South Carolina and approximately 20 miles east-northeast of Beaufort, South Carolina (Figure 1.1). The incorporated Town of Edisto Beach is located on the island, as is Edisto Beach State Park. Edisto Beach encompasses approximately 6 miles of sand shoreline, all of which are included as part of the current feasibility study. The Town of Edisto Beach and Edisto Beach State Park are part of Edisto Island. They are separated from the main body of Edisto Island by Big Bay Creek, Scott Creek and the associated salt marsh to the northwest and Jeremy Inlet to the northeast. The Town of Edisto Beach and Edisto Beach State Park are also bounded by the South Edisto River and St. Helena Sound to the southwest and the Atlantic Ocean to the southeast. The maximum width at the southern end of this portion of Edisto Island is approximately 1.5 miles, while the northern end is much narrower. The Town of Edisto Beach occupies the central and southern portions of the island and is separated from Edisto Beach State Park by SC Hwy 174, which provides the only access to and from the island. The Town's beachfront extends approximately 4.5 miles between SC Hwy 174 and the South Edisto River/St. Helena Sound. The town has been developed as a permanent and seasonal residential area with limited commercial development. Edisto Beach State Park occupies approximately 1,255 acres of the island and is structured around a dense live oak and maritime forest. It offers ocean and marsh side camping sites, as well as cabins, picnic areas and nature and hiking trails. The park is one of the most heavily visited of the South Carolina state parks, with approximately 254,400 recorded visitors in 2009. Its beachfront extends approximately 1.5 miles between Jeremy Inlet and SC Hwy 174. Additionally, the project is adjacent to the Ashepoo, Combahee and Edisto (ACE) Basin. This area represents one of the largest undeveloped estuaries on the east coast of the United States and consists of approximately 1.1 million acres of diverse habitats. The study area also includes an offshore borrow site study area located approximately 1 to 5 miles offshore of Edisto Beach. Material from the area has been used previously for a locally funded project and is known to contain beach compatible sand.

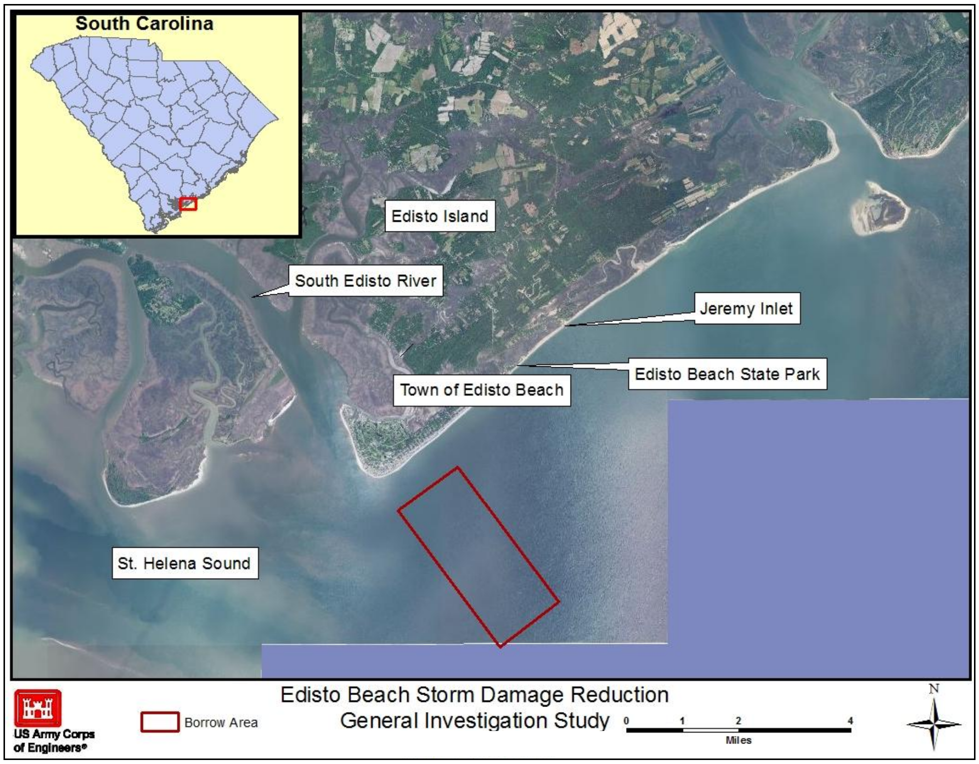

Figure 1.1: Location of Edisto Beach and offshore borrow area.

1.4 Scope of Study

This study consists of the analysis of measures and alternative plans for reducing coastal storm damages in the study area. This study, and others like it, identify the plan with the highest net National Economic Development (NED) benefits, a locally preferred plan (LPP), if applicable, or determine that no plan of improvement is justified under current planning criteria and policies.

1.5 Study Process

USACE studies for water and related land resources follow detailed guidance provided in the *Planning Guidance Notebook* (Engineer Regulation 1105-2-100). This guidance is based on the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* that were developed pursuant to section 103 of the Water Resources Planning Act (P.L. 89-80) and Executive Order 11747, which were approved by the U.S. Water Resources Council in 1982 and by the President in 1983. A defined six-step planning process is used to identify and respond to problems and opportunities associated with the federal objective and specific state and local concerns. The process involves an orderly and systematic approach to making evaluations and decisions at each step so that the public and the decision makers can be informed of basic assumptions made, the data and information analyzed, risk and uncertainty, the reasons and rationales used and the significant implications of each alternative plan. The process concludes with the selection of a recommended plan. The six steps are:

Step 1- Identifying problems and opportunities
Step 2- Inventorying and forecasting conditions
Step 3- Formulating alternative plans
Step 4- Evaluating alternative plans
Step 5- Comparing alternative plans
Step 6- Selecting a plan

Specific aspects of the process are described in more detail in subsequent chapters of this report.

1.6 Prior Studies and Reports

The following studies have been previously conducted at Edisto Beach:

- In 1952, a report on beach erosion at Pawleys Island and Folly, Edisto and Hunting Island Beaches, South Carolina, was prepared by the Charleston District in cooperation with the State of South Carolina under the authority of Section 2 of the Rivers and Harbors Act approved 3 July 1930, as amended. The purpose of the investigation was to determine the best method of preventing further erosion and of stabilizing and improving the beaches. In that report, it was concluded that the best method of protection for Edisto Beach would require a system of groins and subsequent maintenance by artificial placement of beach material.

- An Interim Hurricane Survey Report entitled "Edisto and Hunting Island Beaches, South Carolina" was prepared by the Charleston District, submitted to the Chief of Engineers and printed on 5 April 1967 as House Document No. 100 of the 90th Congress, 1st Session. The report concluded that no economically justified method of protecting against potential damages at Edisto Island Beach had been found and that local interests had not expressed any desire for hurricane protection works. The report recommended that no improvement for hurricane protection be undertaken at Edisto Beach.

- A National Shoreline Study Report printed on 29 June 1973 as House Document 93-121 of the 93rd Congress, 1st Session was prepared by the USACE to appraise the erosion problems along the coasts of the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, Puerto Rico and the Virgin Islands. The report describes that erosion through the reach including Botany Bay Island, Edingsville Beach and Edisto Beach had been most severe at the northern end of the reach with a decreasing rate to the south. The report documents that the north end of Edisto Beach, at the State Park, had eroded approximately 700 feet between 1856 and 1954, while one mile up from the southern end of Edisto Beach there had been virtually no change in the shoreline position. The report also documents that the southern end of Edisto Beach had accreted significantly. At a point 0.4 mile northeast from the southern tip of Edisto Beach, the shoreline had advanced 1,600 feet between 1856 and 1933 and then had receded 150 feet between 1933 and 1954, resulting in a net gain of 1,450 feet.

- A Detailed Project Report on beach erosion control for Edisto Beach was submitted to the Chief of Engineers on 2 July 1970. The report concluded that the best plan of improvement of several alternatives considered was periodic beach nourishment to provide an artificial feeder beach that would arrest erosion and stabilize the beach fronting Edisto Beach State Park. Since the alternatives for improvement were determined to be economically unjustified, the report recommended no Federal participation in a project at that time.

- A Reconnaissance 905(b) report on beach erosion entitled "Edisto Beach, Charleston County, South Carolina" was completed in July 1973 by the Charleston District under the authority of Section 103 of the Rivers and Harbors Act of 1962 (Title I, P.L. 87-874), as amended. The purpose of the reconnaissance study was to consolidate readily available data on beach erosion at Edisto Beach, including Edisto Beach State Park and to make a preliminary evaluation of the data to determine whether further study was warranted. The report concluded that there was little justification for a Federally-supported shore protection project at the south end of Edisto Beach, due to recently constructed groins and allowing the groins a period of time to demonstrate their effectiveness. The report also concluded that, for Edisto Beach State Park, it was impossible to justify Federal participation in the cost of shore protection measures for that length of the beach. The report recommended that a detailed study of Edisto Beach not be undertaken at that time.

- A Reconnaissance 905(b) report for storm damage reduction entitled "Edisto Beach, South Carolina" was completed by Charleston District in July 1990 under authority of Section 103 of the Rivers and Harbors Act of 1962, as amended. The purpose of the reconnaissance study was to determine the extent of problems experienced and to evaluate preliminary alternative plans for controlling beach erosion of Edisto Beach. The report concluded that there was sufficient justification for continued Federal investigation to perform detailed analysis of storm damage reduction alternatives and focuses on a recommended plan to nourish approximately 1.5 miles of shoreline near the center of Edisto Island using an offshore borrow source located offshore of the southern end of the island. The report recommended that further Federal participation to alleviate storm damages at Edisto Beach was warranted and that a detailed, cost-shared project study be initiated. Upon completion of the reconnaissance phase, the sponsor opted to pursue another course of action for beach erosion control at Edisto Beach.

- Because of the time that had passed since the first 905(b) report, a second 905(b) report for coastal storm damage reduction entitled "Edisto Island, SC" was completed in August 2004 by the Charleston District. This report recommended the current feasibility study. The reconnaissance phase was completed in September 2006.

- Numerous other reports covering the study area have been developed by others. These include:

    - Preliminary Groin Field Assessment, Cubit Engineering, May 1987

    - Town of Edisto Beach: A Beachfront Management Plan, Planning Services Group, 1990

- Erosion Assessment and Beach Restoration Alternatives for Edisto Beach State Park, Coastal Science and Engineering, Sept 1990
- Edisto Beach Nourishment Project, Engineering Report, Geotechnical Studies, Coastal Science and Engineering, Dec 1992
- Edisto Beach Groin Study, Coastal Science and Engineering, June 1993
- Coastal Management at Edisto Beach SC - A Geologic Perspective, Pilkey and Young, April 1994
- Department of Army (DOA) Permit Public Notice, Town of Edisto, 1995
- Survey Report Number 3, Edisto Beach SC, Coastal Science and Engineering - Baird, 1997
- Survey Report Number 5, Edisto Beach SC, Coastal Science and Engineering, 2001
- Beach Restoration Plan, Draft Summary Report, Coastal Science and Engineering, 2002
- Town of Edisto Beach Comprehensive Plan, Planning Department, Low Country Council of Governments, 2003
- SC Annual State of the Beaches Report, South Carolina Department of Health and Envioronmental Control – Ocean and Coastal Resource and Management (SCDHEC–OCRM), March 2003
- Groin Conditions and Repair Recommendations, Edisto Beach, SC, Coastal Science and Engineering, Nov 2003
- Edisto Beach: A Beach Access Management Plan, Clemson University, January 2004

1.7 Existing Federal and Non-Federal Projects

There are no Federal navigation or coastal storm damage reduction projects in the study area. There was a non-Federal project to renourish Edisto Beach in 2006. This project is discussed in more detail in Section 3.1.1 of this report.

2. PROBLEMS, OPPORTUNITIES, OBJECTIVES AND CONSTRAINTS*

The first step in the plan formulation process is to identify the primary problems and opportunities the study will focus on. Appropriate study objectives are then be developed based on these problems and opportunities. Specific constraints, which limit the formulation process, are also identified at this stage.

2.1 Problems and Opportunities

The Town of Edisto Beach has indicated that the most significant problem facing the study area in the near future is the threat to buildings and infrastructure from coastal storms, particularly along the northern portions of the shoreline. Figure 2.1 shows the eroded beach at the town pier, located at the northern end of the island adjacent to the state park. The threat to structures is exacerbated by high levels of long-term beachfront erosion. The loss of the beachfront threatens not only the local economy and tourism in the small coastal community, but also has National Economic Development impacts when resources that could be used elsewhere are devoted to storm recovery and rebuilding efforts that could have been prevented. Additionally, there is a lack of local resources, both natural and financial, available to address coastal storm damage problems. In addition to the infrasturcture related problems, ongoing erosion could adversely affect sea turtle nesting success as well as shorebird nesting and foraging habitat.

Figure 2.1: Eroding berm at north end of Edisto Beach, adjacent to state park. (November 2011)

However, there are opportunities to address the identified problems. There are both structural and non-structural coastal storm damage reduction measures that could reduce future coastal storm damages to buildings and infrastructure. A discussion of potential measures is provided in Chapter 5 of this report.

2.2 Goals and Objectives

2.2.1 Federal Objective

The Federal objective, as stated in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, is to contribute to NED, consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the study area and the rest of the nation.

2.2.2 Study Goals and Objectives

The overall goal of the study is to reduce the adverse economic effects of coastal storms at Edisto Beach, South Carolina. Identifying and considering the problems, needs and opportunities of the study area in the context of Federal objective defined in the previous section resulted in the establishment of the following study specific objectives:

Objectives: Over a 50-year period of analysis and while minimizing or avoiding adverse impacts to natural resources:

1. Provide coastal storm damage reduction (as measured by increases in NED net benefits) to approximately 4.5 miles of the Edisto Beach shoreline.

2. Reduce the risk of damages to SC Hwy 174, which is the only emergency evacuation route for the community.

3. Preserve sea turtle nesting habitat and protect shorebird nesting habitat, foraging areas and roosting areas.

Achieving these objectives would likely yield increased benefits to recreation. However, those benefits are considered incidental to the primary goal of providing coastal storm damage reduction benefits to the study area and are not specifically formulated for.

2.3 Constraints

The formulation of alternatives to address the study goals and objectives is limited by planning constraints. Specific to this project, the formulation of alternative plans is potentially constrained by:

a. The limited amount of space on the island that is available for implementing certain alternatives.

b. The South Carolina Coastal Zone Management Program (CZMP) currently bans the building of certain types of hard structures along the state's coast.

c. The project alternatives cannot adversely impact down drift beaches, or the ACE Basin.

3. EXISTING CONDITIONS*

The second step of the planning process is to inventory and forecast conditions. This chapter describes the relevant environmental, physical and economic conditions as they currently exist within the study area. The existing conditions are used as the baseline for the forecast of future without project conditions, which are discussed in Chapter 4.

3.1 Physical Conditions and Processes

3.1.1 Historical Shoreline Conditions

Historical erosion of Edisto Beach has lead to a long history of shoreline management activities, including the construction of a series of groins, leading to the current existing condition of the shoreline. Construction of groins began in 1948 at the north end and continued southward until 1975. By that time, a total of 34 groins had been constructed along the Edisto Beach shoreline. Figures 3.1 and 3.2 provide the locations and an example groin, respectively.

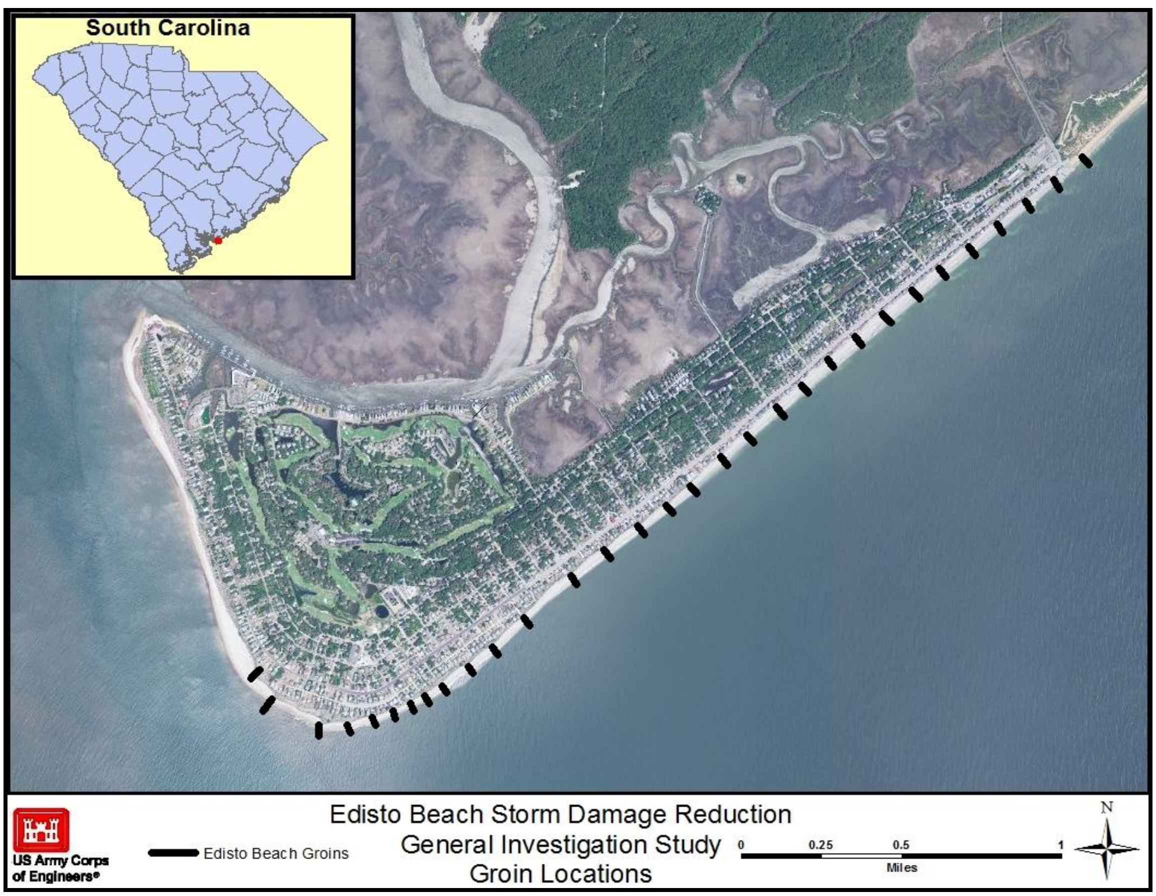

Figure 3.1: Location of functioning groins built on Edisto Island. Although 34 groins were originally built, 3 of those have subsequently become buried.

Figure 3.2: Example of one of the 34 groins built on Edisto Island.

Despite the construction of groins, erosion continued to threaten certain areas of the shoreline. As a result, in 1954 the South Carolina Highway Department (now SC Department of Transportation) undertook the first nourishment of Edisto Beach. Approximately 830,000 cubic yards (cy) of material consisting of sand, shells and mud was dredged from the marsh behind the island and placed between groins 1 and 12 at the northern end of the town. Unfortunately, much of the material was not suitable for beach fill and the fine portions washed away quickly. The next beach nourishment took place in 1995 when approximately 155,000 cy of fill was placed between groins 1 to 17 (Pavilion to Chancellor Street) and groins 24 to 28 (Laroche Street to Billow Street). This beach fill project was accompanied by major improvements to the groins in those areas. Despite the groin improvement and beach fill project in 1995, the Edisto Beach shoreline continued to be vulnerable to erosion. Therefore, another non-Federal beach nourishment project was constructed in 2006. This most recent beach nourishment project added approximately 850,000 cy (192,100 cy in the Edisto Beach State Park area) of beach compatible material along 18,258 feet (3,200 feet in the state park) of shoreline from Edisto Beach State Park to groin 27.

South Carolina's 2008 Annual State of the Beaches Report states that Edisto Island has a low long-term erosion rate, but an extreme lack of sand. The report does not quantify the long-term erosion rate, but does indicate that the low erosion rate is due to the presence of the extensive groin field. According to the report, the southern half of the developed portion of Edisto Beach has the widest oceanfront beach on the island, while the northern half was one of the most critically eroded sections of beach anywhere in the state prior to the 2006 renourishment. The northern half of Edisto Island is critically eroding because the supply of sediment to this area, from the north, has been diminishing and is expected to continue to diminish as the barrier islands to the north are reduced in elevation due to natural processes. As these barrier islands lose elevation, the amount of littoral material that is removed from the active littoral system by increased barrier island overwash processes increases, which further reduces updrift sediment supply to the northern portion of Edisto Island. The erosion rates tend to decrease to the south because of a reduction in net longshore sand transport rate gradients due to the presence of the groin field. Along the inlet-facing shoreline, the beach is stable to slightly accretive because of the change in shoreline orientation and because this area receives sediment eroded from the Atlantic-facing shoreline. It has a substantial berm but not a substantial dune. Pictures of the existing shoreline along the north and south ends of the island are shown in Figures 3.3 and 3.4, respectively.

Figure 3.3: Example of narrow berm at northern end of Edisto Beach. Photo dated November, 2011.


Figure 3.4: Example of a wider berm at the southern end of Edisto Beach. Photo dated November, 2011.

3.1.2 Coastal Storm Climatology

Coastal processes at Edisto Beach are driven by high energy waves and water levels generated by both tropical and extratropical storms. Significant tropical storm events (defined here as storms that generated at least 1.0 ft of storm surge) impacted the Edisto Beach shoreline approximately once every 4 years over the past 100 years (Scheffner et al 1994). These tropical storms normally occur between June and November with more than 65 percent of them occurring in the months of August and September. Extratropical storms, on the other hand, are a frequently occurring storm type that impacts Edisto Beach annually with significant events occurring about once every year and a half. Extratropical storms typically occur in the fall (September and October) and again in the winter (January through March) with most occurring in February. Tropical storm events are typically fast moving storms associated with elevated water levels and large waves whereas extratropical storms are slower moving storms with comparatively lower water level elevations and large wave conditions. Both storm types can produce extensive beach erosion and morphological changes as well as coastal inundation. The most recent storm to affect Edisto Island was Hurricane Irene, in August 2011. Irene caused minimal property damage, but caused extensive erosion of the beach berm in several areas. The last hurricane that caused substantial economic damage on the island was Hurricane Gracie, a Category 3 (out of a potential 5 rating) storm which made landfall on the southern edge of the island in September, 1959. About 80 houses on the island were severely damaged or destroyed during that storm.

3.1.3 Sediment Transport

Net longshore sand transport along Edisto Beach is from north to south and the magnitude of the longshore sand transport rate tends to increase moving from north to south. Intra-annual reversals in the longshore transport direction at Edisto Beach can be significant and are readily observed by shoreline position changes within groin compartments. These intra-annual transport direction reversals are driven by seasonal changes in the incident wave direction. Generally, during the more stormy late Fall/Winter/early-Spring seasons, net transport direction is to the south, whereas during the milder weather in the late-Spring and Summer season the net transport direction is often directed to the north (CSE, 1993).

Gross longshore sand transport rates in the vicinity of Edisto Beach have been estimated at approximately 210,000 cy/year, about 44,000 cy/year directed to the north and about 167,000 cy/year directed to the south. The current net longshore sand transport rate is about 123,000 cy/year, directed to the south (CSE, 1993).

3.1.4 Geomorphology

Edisto Beach is at the southern end of what was once a classical prograding drumstick shaped barrier island common in South Carolina. Over time, erosion in the central portion of the larger barrier island system due to a net longshore transport divergence has resulted in opening of new tidal inlets (Frampton Inlet, Jeremy Inlet and an un-named inlet north of Frampton Inlet) and loss of littoral sediments to developing shoal features at those inlets. Continued erosion has reduced the central barriers to little more than swash shoals that allow littoral material to wash over the barriers and become trapped in the coastal marshes. As a consequence, the Edisto Beach barrier island is transitioning to a landward migrating transgressive barrier island.

The geomorphology of Edisto Beach is unique among South Carolina beaches in that the sediment composition of the beach is coarser grained than most South Carolina beaches with a median grain size of approximately 0.4 mm (CSE, 2006) and significant shell content. The relatively coarse sediment grain size results in comparatively steep foreshore slopes. Within the oceanfront groin compartments, the foreshore slope is approximately 1 on 10. Within Edisto Beach State Park, the foreshore slope is slightly milder at 1 on 15. The foreshore slope along inlet shoreline is milder still at approximately 1 on 25. These steep foreshores slopes, together with a fairly high tidal range (average spring tide range is 6.3 ft), reduce the beach area between the low-tide terrace and the foredunes compared to other South Carolina beaches. Due to these geomorphic conditions, wave energy associated with storm conditions is not significantly dissipated before it reaches the relatively low foredunes.

3.1.5 Existing Beach Profile

For the purposes of coastal storm damage modeling, the existing beach profile was characterized across 23 reaches covering the length of the beach. Figure 3.5 shows the locations of these reaches. In each of these reaches, an “idealized” beach profile was characterized based on surveys performed in August 2004, November 2005, July 2007 and July 2008. An idealized profile is a simplified representation of the shoreline that is used for modeling purposes. The process of determining the idealized profiles is detailed in Appendix A (Coastal Engineering Appendix).

Figure 3.5: Location of modeling reaches.

Figure 3.6 depicts a generic idealized profile cross-section. Table 3.1, below, shows the idealized dune and berm heights and widths across these reaches.

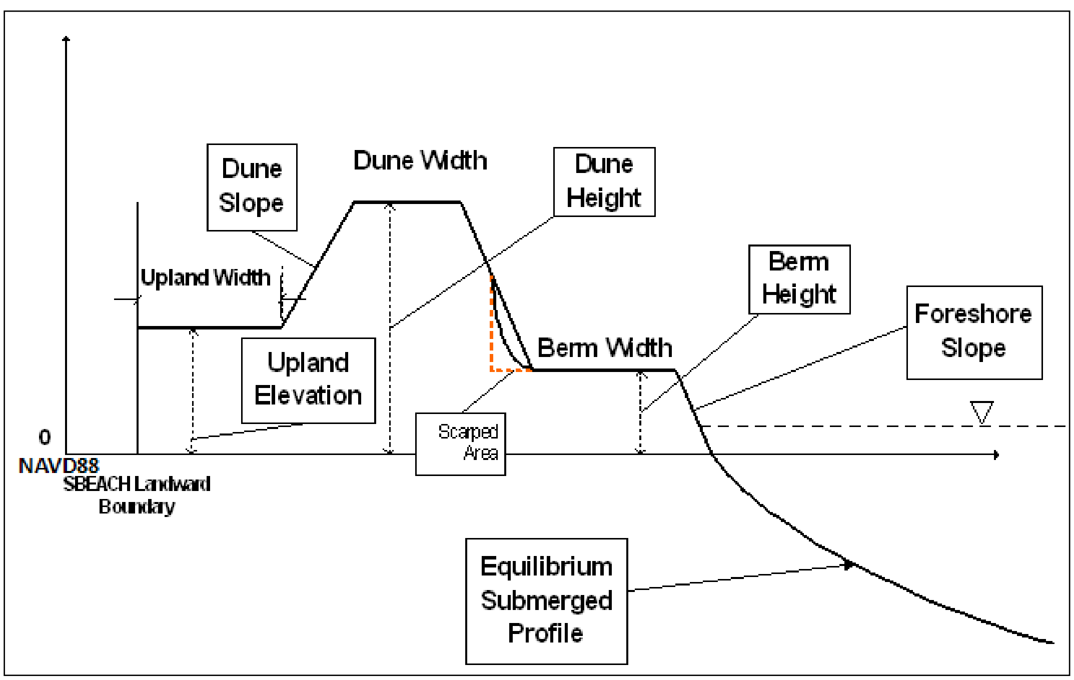

Figure 3.6: Features of an idealized shore profile cross-section.

Table 3.1: Idealized shoreline dimensions across the project study area.

Reach	Upland Elevation (ft)	Upland Width (ft)	Dune Slope (X:1)	Dune Elevation (ft)	Dune Width (ft)	Berm Elevation (ft)	Berm Width (ft)	Foreshore Slope (X:1)
I1	7	775	11	8.5	0	6	20	28
I2	7	425	6	10	5	6	20	32
I3	7	500	6	10	5	6	20	32
I4	7	700	6	10	5	6	20	32
P1	7	650	6	9.5	15	7	60	13
P2	7	475	7	10.5	10	7	30	10
E1	8	500	4	11.5	10	7	40	10
E2	8	550	4	12	10	7	45	11
E3	8	525	4	12	10	7	45	11
E4	8	375	6	12	5	7	70	10
E5	8	300	6	12	5	7	70	10
E6	7	275	6	12	10	7	60	11
E7	7	200	3	10.5	25	7	90	10
E8	7	250	3	10	15	7	85	12
E9	7	200	3	11	15	7	105	10
E10	7.5	175	7	11.5	10	7	85	11
E11	7.5	150	7	11	10	7	70	11
E12	8	150	7	12	10	7	40	12
E13	8	200	3	11	10	7	55	10
E14	8	250	5	12	15	7	35	11
E15	8	250	7	11	5	7	35	11
SP1	8	350	5	11.5	5	7	75	13
SP2	4	450	12	8.5	5	7	0	20

The beach contains a relatively short and flat dune (Figure 3.7). The berm is generally narrower and the shoreline is closer to homes at the northern end of the island. (see Figures 3.3 and 3.4 Section 3.1.1)

Figure 3.7: Example of one of the “taller” dunes at Edisto Beach, around reach E12.

3.1.6 Characterization of Beach Material

Table 3.2 lists the average sediment composition of the existing beach material, in terms of percent silt and shell. The composition determination is based on beach samples collected at 34 stations along Edisto Beach and reflects conditions after the 2006 renourishment. Each station included four grab samples – one each from the toe of the dune, berm, beach face and low tide swash zone. Additional details are contained in Appendix D (Geotechnical Engineering).

Table 3.2: Average sediment composition of native beach material and borrow area.

	MEAN (phi)	STD DEV (phi)	% PASSING #5	%PASSING #10	% PASSING #200*	% PASSING #230	% VISUAL SHELL
Edisto Native Beach	1.31	1.33	97.8	93.5	0.1	0.0	26.9
Borrow Area	1.73	1.31	94.7	90.0	0.4	0.2	18.8

*The % passing the #200 sieve is considered the % silt and clay.

3.1.7 Offshore Borrow Area

The sand borrow area being proposed for the project is an approximately 1 square mile portion of the ebb tide delta located about 2 miles offshore of the west side of the island (Figure 3.8). It contains approximately 7.2 million cubic yards of beach quality material. The average sediment composition of the borrow area, as compared to the composition of the native beach, is shown in Table 3.2. The curves in the northern and eastern corners of the borrow area are due to cultural resource avoidance areas (see Section 7.16). The proposed borrow area was narrowed down from a larger area containing about 30 million cubic yards of material. The larger area was evaluated and characterized based on 77 cores taken at approximately 1,000 ft spacing throughout the site. Additional details on how the borrow area was narrowed down, as well as the sampling methodology and material composition of the borrow site, are contained in Appendix D (Geotechnical Engineering Appendix). Other potential offshore borrow areas were also identified based on previous experience and limited historical data in the vicinity of Edisto Beach to 3 miles offshore. However, no subsurface investigation was performed in these areas due to the high cost of the sampling and analysis. These potential borrow areas were removed from further consideration because there is an adequate quantity of beach quality material to nourish Edisto Beach over a 50 year period in the primary borrow site. Additionally, the material offshore is believed to be finer than the ebb tide delta material and therefore not as compatible with the native beach and the site has been successfully used before by the Town of Edisto Beach to nourish the beach.

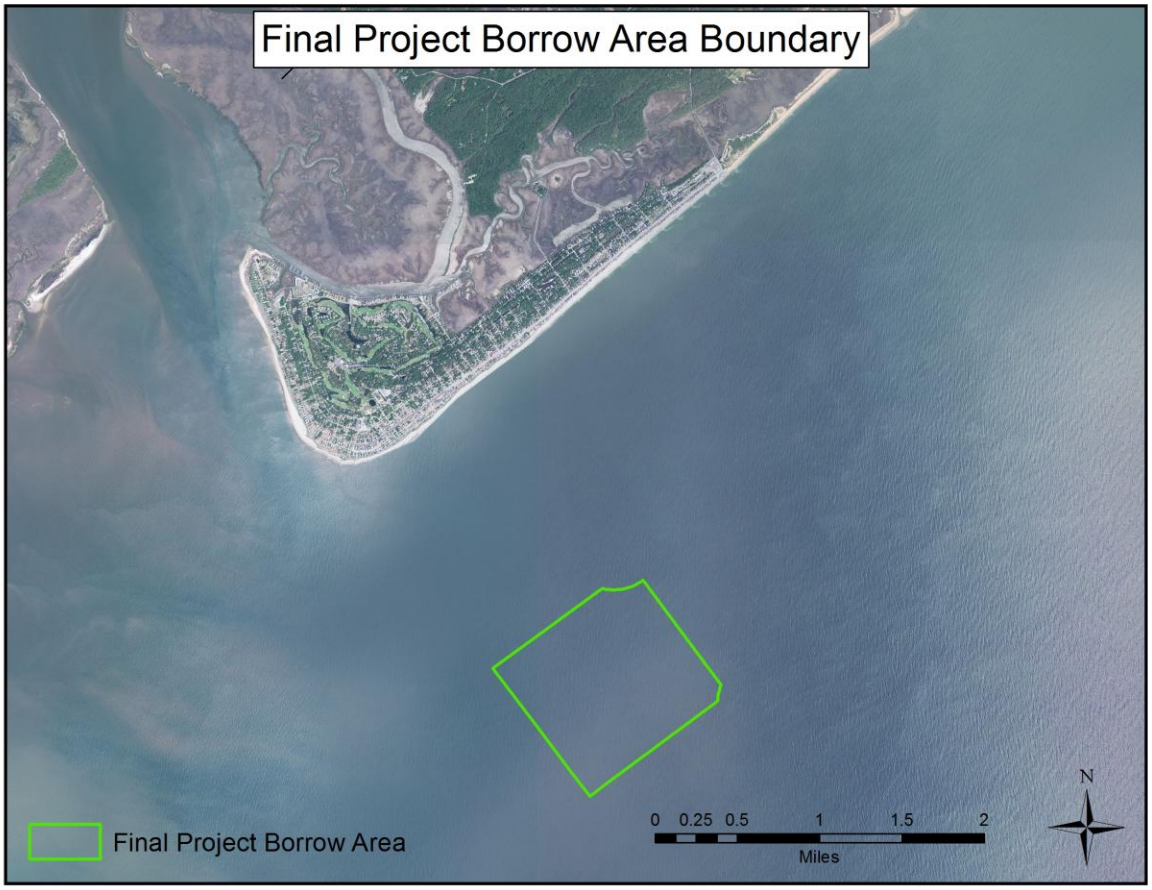

Figure 3.8: Location of proposed borrow area for the Edisto Beach project.

3.2 Environmental and Cultural Resources

3.2.1 Wetlands

Wetlands are transitional habitats between water and dry land. The coastal wetlands that are prevalent at Edisto Island consist primarily of salt marshes. In contrast to surrounding states, South Carolina does not have adequate habitat for submerged aquatic vegetation and coastal areas consist predominantly of intertidal emergent habitat (http://portal.ncdenr.org/c/document_library/get_file?uuid=6edc629c-628d-48fb-a8bf-dbbfbca94a2c&groupId=38337). Other wetlands in the project area include bottomland hardwood swamps and fresh marshes. Marsh communities have been well documented in terms of productivity, animal diversity and importance to the marine system (and to people). In fact, they are among the most productive ecosystems on Earth (Stedman and Dahl 2008).

Tidal marshes serve many important functions and are prevalent on the backside of Edisto Beach (Figure 3.9). The basis of the importance of these marsh communities involves the basic high productivity of the marsh itself and its ability to capture and retain nutrients. The dense plant growth in the marsh also provides excellent cover for many species of birds, aquatic and semi-aquatic mammals, reptiles and amphibians and typically provides spawning grounds, nurseries, shelter and food for many species of finfish, shellfish, birds and other types of wildlife. Besides the water quality and habitat benefits, marshes also serve to buffer storm waves and slow shoreline erosion.

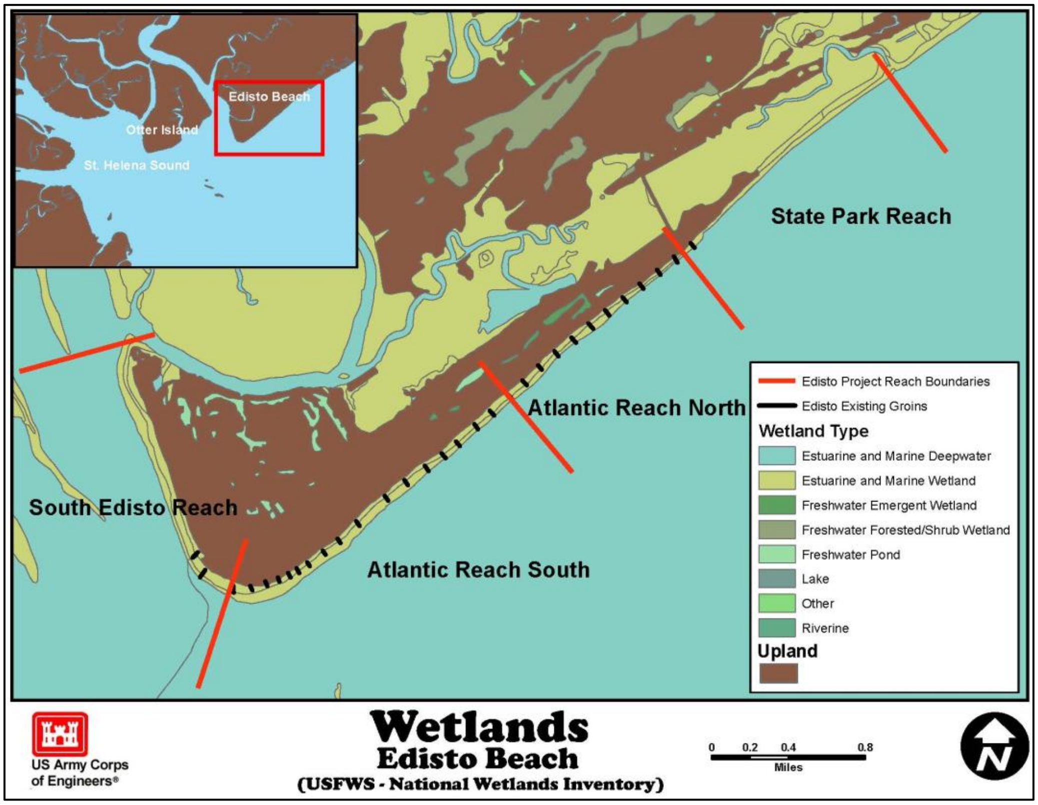

Figure 3.9: Location of wetlands within the project area.

Substrates in these communities are inhabited by a myriad of foraminiferans, nematodes, annelids, arthropods, mollusks such as the salt marsh snail (*Melampus bidentatus*), marsh periwinkle (*Littorina littorea*), ribbed muscle (*Modiolus demissus*) and eastern oyster (*Crassostrea virginica*) and crustaceans such as the penaeid shrimps (*Penaeidae*), sand fiddler (*Uca pugilator*), mud fiddler (*U. pugnax*) and blue crabs (*Callinectes sapidus*). The marsh community provides a nursery ground for the principal commercial marine organisms of the state - white (*Litopenaeus setiferus*) and brown shrimp (*Farfantepenaeus*) and blue crabs.

Marshes also serve as spawning and nursery grounds for many commercial and sport fishes and shellfishes, in addition to being valuable shellfish growing areas. Numerous shorebirds, waterfowl, gulls, herons and egrets can be found throughout these marsh communities. Birds such as the clapper rail (*Rallus longirostris*), plovers (*Charadrius sp*. and *Pluvialis sp*.), dowitchers (*Limnodromus sp.*) and sandpipers (many species) thrive on the benthic invertebrate population around the shoreline and on open flats. In the open water bordering these communities, waterfowl feed on vegetation or small marine fishes and free-swimming invertebrates. The herons and egrets feed on fish, invertebrates, reptiles, amphibians and small mammals. They also are found nesting and roosting during the summer months. Many gulls utilize these communities for resting and scavenging year-around. Other birds such as the red-winged blackbird (*Agelaius* *phoeniceus*), common and boat-tailed grackles (*Quiscalus sp.*), sparrows and warblers can be found nesting and feeding on insects and grains. Birds of prey such as the osprey (*Pandion haliaetus*) and marsh hawk (*Circus cyaneus*) also utilize these communities to some degree. Mammals of the marshes typically include the raccoon (*Procyon lotor*), otter (*Lutra canadensis*), marsh rice rat (*Oryzomys palustris*), opossum, (*Didelphis virginiana*), marsh rabbit (*Sylvilagus palustris*) and American mink (*Mustela vison*).

3.2.2 Sand and Mud Flats

Sand and mud flats are found in the project area, predominantly near Jeremy Inlet and the South Edisto River Inlet area. In most areas they lie below the mean high water line and are alternately covered and exposed by wind-driven or lunar tides and are typically devoid of vascular plants, but are frequently inhabited by numerous species of diatoms, bacteria, oysters, and infaunal invertebrates. These flats are usually fringed with stands of vigorously growing and highly productive smooth cordgrass and open water or beach and open water. Tidal action provides a constant influx of particulate organic matter to these habitats creating a rich nutrient supply for filter feeding benthic invertebrates. When the tidal flats are covered by water, these animals and nutrients constitute an important food source for a variety of fish species. When the flats are exposed, numerous wading birds and shorebirds feed upon the benthic animals.

3.2.3 Nearshore Ocean

Nearshore fisheries are monitored by the Southeast Area Monitoring and Assessment Program – South Atlantic (SEAMAP-SA) Coastal Survey, which has been conducted by SCDNR since 1986. The survey provides long-term, fishery-independent data on seasonal abundance and biomass of all finfish, elasmobranchs, decapod and stomatopod crustaceans, sea turtles, horseshoe crabs, and cephalopods that are accessible by high-rise trawls.

Phytoplankton and zooplankton serve as food for benthic fauna and for some juvenile fishes along beachfronts and structures (Hay and Sutherland 1988). Zooplankton communities are composed of holoplankton, such as copepods, and the larvae of benthic fauna and infauna, or meroplankton. These populations experience large fluctuations in density and species composition throughout the year (Hay and Sutherland 1988).

A majority of the South Atlantic Bight is inhospitable habitat for seaweeds because of the amount of unconsolidated sediments. Blue-green algae grow in the highest density in the intertidal zone, while the most abundant subtidal seaweed on nearshore structures is the brown alga, *Sargassum*. Other prevalent species are the brown alga, *Padina*, *Dictyota*, *Ectocarpus*, *Punctaria*, and *Petaloni*a; the green alga, *Bryopsis*; the red alga, *Chondria*, *Callithanmion*, *Champia*, *Dasya*, *Hypoglossum*, *Calonitophyllum*, and *Grinnellia*.

3.2.4 Maritime Shrub Thickets

These thickets normally occur landward of the dune where it is protected from ocean spray and waves. These habitats are rare and sporadic along the beachfront of Edisto Island, occurring on the marsh side of the island and at the Edisto Beach State Park area. Dominant shrubs and trees in this community are wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), red cedar (*Juniperus virginica*), live oak (*Quercus virginiana*), and loblolly pine (*Pinus taeda*). Vines are also common with greenbriar (*Smilax bona-nox*), pepper-vine (*Ampelopsis arborea*) and grape (*Vitus rotundifolia*) being particularly abundant. This community offers cover for a variety of songbirds. Other important species that may be found in the thickets include the seaside sparrow, painted bunting, saltmarsh sharp-tailed sparrow, Nelson's sharp-tailed sparrow, and marsh and sedge wrens.

3.2.5 Beach and Dune

Intensive development along the front beach has altered the natural areas and vegetation of the island. Vegetation on inland areas consists of maritime forest complex with slash (*Pinus elliottii*) and loblolly (*Pinus taeda*) pine, live oak (*Quercus virginiana*), magnolia (*Magnolia* sp.), cabbage palm (*Sabal palmetto*), dwarf palmetto (*Sabal minor*) and red bay (*Persea borbonia*). The high marsh behind the island is composed of a mixture of cordgrass (*Spartina* sp.), needlerush (*Juncus roemerianus*), yaupon (*Ilex vomitoria*) and sea myrtle (*Baccharis halimifolia*). The low marsh complex consists primarily of smooth cordgrass (*Spartina alterniflora*). The beach and dunes are the only biotic communities that would be affected by direct beach nourishment. Primary grasses on the dunes include sea oats (*Uniola paniculata*) and panic grass (*Panicum amarum*) interspersed with sedges and sandburs (*Cenchrus* sp.).

Beach vitex is a widespread plant found from Japan and China south to Malaysia, India, Sri Lanka, and Australia (Wagner et al. 1999). Since it is a prostrate, spreading woody shrub, it is considered an excellent beach stabilizing plant. Additional properties include its salt tolerance and rapid growth (Dirr 1998). Beach vitex was introduced in the mid-1980's as an ornamental and dune stabilization plant (Westbrooks and Madson 2006). While these were good intentions, it has become a serious threat to natural plant and animal communities along the coast of the Carolinas (Westbrooks and Madson 2006). The dense, woody mats can be a barrier to native vegetation and to sea turtles attempting to use those dunes as nesting sites. Yearly surveys have found Beach vitex as far south as Folly Beach in SC (www. beachvitex.org). As of 2006, the South Carolina Beach Vitex Task Force had documented 125 sites planted with Beach vitex in coastal communities of Horry, Georgetown, and Charleston counties. It is expected that the plants' range could extend throughout the southeastern US from Virginia to Florida (Westbrooks and Madson 2006). Because of this threat, the introduction of Beach vitex is a concern on Edisto Island, as the island is a heavily used site for sea turtle nesting. A local ordinance prohibiting the planting of Beach vitex was passed by a number of coastal communities, including the Town of Edisto Beach.

3.2.6 Surf Zone Fishes

Several species of fish are commonly observed in the surf zone along the project area, many of which are of importance to the sport and commercial fisheries of the state. The most abundant nekton in these waters are the estuarine dependent species, which inhabitat the estuary as larvae and the ocean as juveniles and adults. Important fishes in inshore waters include spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogon undulatus*), flounder (*Paralichthys sp.*), spotted seatrout (*Cynoscion nebulous*), sheepshead (*Archosargus probatocephalus*), bluefish (*Pomatomus saltatrix*), kingfish (*Menticirrhus sp.*), black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus)*, the Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), Florida pompano (*Trachinotus carolinus*), striped mullet (*Mugil cephalus*), rough silverside (*Membras *martinica*), striped killifish (*Fundulus majalis*), striped anchovy (*Anchoa hepsetus*), permit (*Trachinotus goodei*), and planehead filefish (*Monacanthus hispidus*).

3.2.7 Anadromous Fishes

Anadromous fish spend most of their lives in either estuaries or oceans. They typically swim upstream to freshwater rivers in order to spawn. South Carolina is home to a variety of anadromous fish, including blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*) , white perch (*Morone americana*), striped bass (*Morone saxatilis*), shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus*). The blueback herring and American shad are most numerous.

3.2.8 Benthic Resources

3.2.8.1 Beach Zone

The area where beach nourishment placement would occur at Edisto Beach is considered beach community. The beach community is comprised of a dry berm zone located beyond the high tide line, an intertidal zone that is alternately covered and exposed by tidal action, and a subtidal zone that occurs below the low tide line and extends seaward, merging with the ocean surf. In general, beaches are gently sloping communities that serve as transitional areas between open water and upland terrestrial communities. These communities experience almost continuous changes as they are exposed to erosion and deposition by winds, waves and currents. Sediments are unstable and vegetation is absent. Wave action, longshore currents, shifting sands, tidal rise and fall, heavy predation, and extreme temperature and salinity fluctuations combine to create a rigorous environment for macro-invertebrates. Macro-invertebrates are the predominant faunal organisms inhabiting the beach region and most live beneath the sand surface where salinities and temperatures are most constant. Relatively few species inhabit sandy beaches, but those present frequently occur in large numbers. Consequently, high-energy beaches are far from being biological deserts, and together with the associated fauna they act as extensive food-filtering systems. Typical beach inhabitants are beach fleas (*Orchestia sp*.) and ghost crabs (*Ocypode quadrata*) in the beach berm. Coquinas (*Donax variabilis*), mole crabs (*Emerita talpoida)* and various burrowing worms inhabit the beach intertidal zone and blue-crabs (*Callinectes sapidus*), horseshoe crabs (*Limulus polyphemus*), sand dollars (*Echinarachnius parma*) and numerous clams and gastropod mollusks inhabit the beach subtidal areas.

3.2.8.2 Nearshore Ocean

Sessile invertebrates in the intertidal zone consist largely of barnacles, oysters, and mussels (Hay and Sutherland, 1988). Several mobile organisms exist in this intertidal zone, including the large invasive isopod *Lygia exotica*, and the Atlantic oyster drill.

3.2.9 Hard bottom Resources

Hard bottoms are defined as localized areas not covered by unconsolidated sediments, where the ocean floor consists of hard substrate. Hard bottoms are also considered “live-bottoms” because they support a rich diversity of invertebrates such as corals, anemones, and sponges, which are refuges and food sources for fish and other marine life. When substrate has been cleared or new structure is constructed, recolonization in these hardbottom areas is restored within about a year (Hay and Sutherland, 1988). There is no suspected hardbottom habitat within the nearshore environment of Edisto Beach. The presence of hard bottom resources within the currently identified offshore borrow area was investigated as part of a hardbottom and cultural resources survey. No hardbottom habitat was found in the borrow area or within a quarter mile buffer surrounding the area. A more detailed description of the findings can be found in Appendix J (Hardbottom and Cultural Research Survey Final Report).

3.2.10 Essential Fish Habitat

The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) set forth new 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 Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of federally managed fisheries.

EFH is defined in the Magnuson-Stevens Fishery Conservation and Management Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802(10)." The definition for EFH may include habitat for an individual species or an assemblage of species, whichever is appropriate within each Fisheries Management Plan (FMP). Estuarine and inshore EFH within the vicinity of the project consists of the estuarine water column and wide expanses of salt marsh. EFH within the boundaries of the project reaches can be seen in Table 3.3 below. A detailed description of the EFH in the project area is contained in Appendix G (Essential Fish Habitat Assessment).

Table 3.3: Essential Fish Habitat types and presence within the project area.

Essential Fish Habitat List and Study Area Occurrence		
Habitat Type	**Habitat Name**	**Project Area**
Estuarine	Estuarine Emergent Wetland (tidal marsh)	Yes
Estuarine	Estuarine Scrub/shurb mangroves	No
Estuarine	Sea grass	No
Estuarine	Oyster reefs and shell banks	Yes
Estuarine	Intertidal flats	Yes
Estuarine	Palustrine emergent and forested wetland	No
Estuarine	Aquatic beds	No
Estuarine	Estuarine Water Column	Yes
Estuarine	Unconsolidated Bottom	Yes
Marine	Live/Hard bottoms	No
Marine	Coral and coral reefs	No
Marine	Artificial/manmade reefs	No
Marine	Sargassum	No
Marine	Marine water column	Yes
Marine	Surf zone	Yes

3.2.11 Avian Species

3.2.11.1 Shorebirds

The beach zone is also utilized by many species of shorebirds for nesting and feeding. Species commonly observed are the American oystercatcher (*Haematopus palliatus*), plovers (*Charadrius sp.*), willet (*Catoptrophorus semipalmatus*), sandpipers (*Scolopacidae*), lesser/greater yellow-legs (*Tringa flavipes/T. melanoleuca*), and gulls/terns (*Laridae*). Shorebirds typically feed by foraging for invertebrates in mud flats and sandy beaches. Plovers are medium sized birds with short, thick bills. They run to feed on vulnerable invertebrates. Avocets are larger shorebirds with long recurved bills that feed by using both tactile and visual methods. Foraging activity is usually focused around periods of low tide, where they feed in the intertidal zone. During high tides, shorebirds roost in flocks on the high beach, marsh, and sometimes on docks (Sanders and Murphy 2009).

3.2.11.2 Seabirds

Seabirds nest on small coastal islands in mixed colonies. The three common families of seabirds are Pelecaniae (pelicans), Pynchopidae (skimmers), and Laridae (gulls and terns). Seabirds that frequent the South Carolina coast are the Sandwich Tern (Thalasseus sandvicensis), Least Tern (Sterna albigrons), Royal Tern (Thalasseus maximus), Common Tern (Sterna hirundo), Eastern Brown Pelican (Pelecanus occidentalis), Forster's Tern (Sterna forsteri), Gull-billed Tern (Gelochelidon nilotica), Black Skimmer (Rynchops nigra), Willet (Cataoptrophorus semipalmatus), and Wilson's Plover (Charadrius wilsonia). The Least Tern is listed as state threatened due to a loss of nesting habitat (Thompson et al 1997 in Murphy et al 2009). All of the birds are subject to loss of suitable nesting habitat (Murphy et al 2009). Seabirds usually nest on isolated coastal islands that are high enough to prevent over-washing, yet small enough to not support mammalian predators (Murphy et al 2009). They are picivorous and feed in nearshore and estuarine waters. During the nesting season, foraging occurs within 10 to 15 miles of their nesting sites.

3.2.11.3 Migratory birds

Migratory birds in South Carolina represent three families: Scolopacidae (sandpipers), Charadriidae (plovers), and Recurvirostridae (avocets). Migrations can span across continents. Migratory shorebirds in South Carolina may be transient on northbound flights in the spring, southbound in the fall, or even wintering birds. Surveys of migrant shorebirds over the last three decades indicate that populations are on the decline (Manomet 2004); however, piping plovers are the only listed species.

3.2.12 Coastal Barrier Resources

Coastal barriers along the Atlantic and Gulf coasts provide quality habitat for migratory birds and other wildlife. This habitat is essential for spawning, nursery, nesting, and feeding for a variety of commercially and recreationally important species of finfish and shellfish. Recognizing this and the fact that barrier islands contain recreational and cultural resources, serve as natural protective buffers from storms, Congress passed the Coastal Barrier Resources Act in 1982. In this Act, Congress declared that the purpose of the act is to minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources by restricting future Federal expenditures and financial assistance that could potentially encourage development of barrier islands (16 U.S.C. 3501 et seq.). There are three important goals of the Coastal Barrier Resources Act, which include: (1) minimize loss of human life by discouraging development in high risk areas; (2) reduce wasteful expenditure of Federal resources; and (3) protect the natural resources associated with coastal barriers.

The Town of Edisto Beach lies between two Coastal Barrier Resources Systems (CBRS) units, the Edisto Complex Unit (M09 and M09P) and the Otter Island Unit (M10) (Figure 3.10). Unit M09P is an "Otherwise Protected Area" (OPA) and is not a part of the CBRS. Because it is an OPA, any measures that occur within Edisto Beach State Park (M09P) would be consistent with the intent of the Coastal Barrier Resources Act. The Edisto Unit is composed of three small marsh islands, Botany Bay Island, Edingsville Beach, part of Jeremy Inlet, and Deveaux Bank. The Otter Island Unit includes the southwestern half of the South Edisto River, Pine Island, Otter Island, and the southeastern tips of Fenwick Island and Hutchinson Island. Through coordination with the USFWS it has been determined that the proposed borrow site that would be used for a nourishment project is not located in the CBRS (Appendix I, USFWS, letter dated Jan 27, 2010).

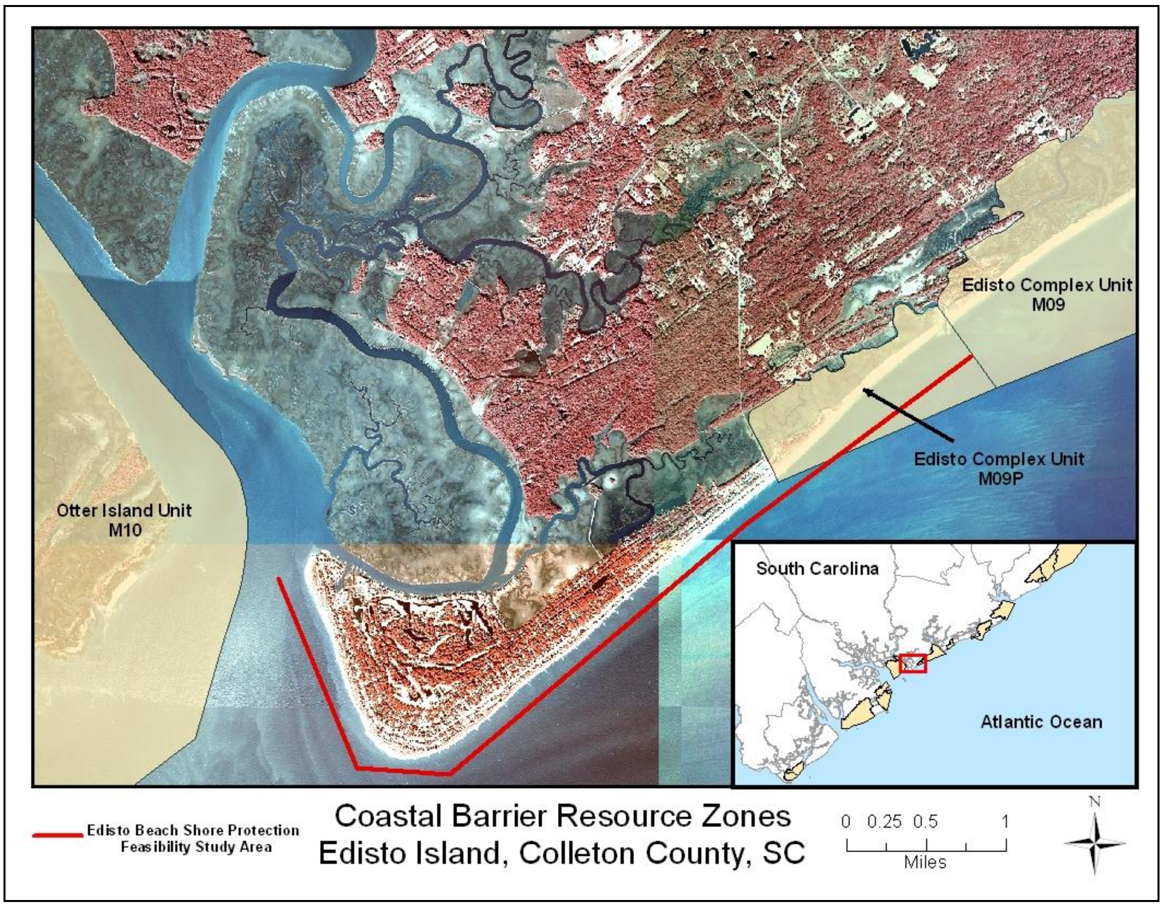

Figure 3.10: Location of Coastal Barrier Resource Zones in the vicinity of the project area.

3.2.13 Threatened and Endangered Species

Table 3.4 contains a list of threatened and endangered species in South Carolina under the jurisdiction of NMFS. Table 3.5 contains a list of federally threatened and endangered species that have been listed by the USFWS as occurring or possibly occurring in Colleton County.

3.2.13.1 Sea Turtles

There are four species of sea turtles that inhabit waters off of South Carolina, including the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green (*Chelonia mydas*) sea turtles. Although hawksbill (Eretmochelys imbricate) turtles have been stranded in Georgia and North Carolina, there have been no records of this species in South Carolina over the past two decades (Griffin et al., 2007).

The loggerhead sea turtle is the most likely sea turtle species to be affected by the proposed project. Loggerheads are Federally listed as a threatened species.

Table 3.4: NMFS listed threatened and endangered species found in South Carolina.

Common Name	Scientific Name	Status	Date Listed
Marine Mammals			
Blue whale	*Balaenoptera musculus*	E	12/2/1970
Finback whale	*Balaenoptera physalus*	E	12/2/1970
Humpback whale	*Megaptera movaeangliae*	E	12/2/1970
North Atlantic right whale	*Eubalaena glacialis*	E	12/2/1970
Sei whale	*Balaenoptera borealis*	E	12/2/1970
Sperm whale	*Physeter macrocephalus*	E	12/2/1970
Turtles			
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	12/2/1970
Leatherback sea turtle	*Dermochelys coriacea*	E	6/2/1970
Loggerhead sea turtle	*Caretta caretta*	T	7/28/1978
Green sea turtle	*Chelonia mydas*	T	7/28/1978
Hawksbill sea turtle	*Eretmochelys imbricata*	E	6/2/1970
Fish			
Atlantic sturgeon	*Acipenser Oxyrinchus*	E	2/6/2012
Shortnose sturgeon	*Acipenser brevirostrum*	E	3/11/1967
E - Federally endangered		*T - Federally threatened*	

There are four nesting subpopulations of loggerheads in the western Atlantic. The Northern Subpopulation extends from North Carolina to Northeast Florida and produces approximately 6,200 nests/year. South Carolina nesting produces more than 30% of the nesting of the Northern Subpopulation. Recent surveys of South Carolina nesting beaches indicate a downward trend. Information obtained from NMFS suggests that the numbers of nesting female loggerhead sea turtles may be declining in South Carolina and Georgia. Since loggerheads require 20 to 30 years to mature, the effects of a decline may not be evident on nesting beaches for many years. Edisto Beach has a significant number of true nests and nesting attempts each year. Edisto Beach State Park, as reported by park personnel (SCDNR, personal communication) has the highest density of nesting sea turtles on a populated beach in the state.

Critical habitat is not currently designated in the continental U.S. for the five species of sea turtles identified to occur within the proposed project vicinity. However, USFWS and NMFS have proposed listing critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of the loggerhead sea turtle. Critical habitat has been proposed for Edisto Beach and all surrounding beaches and the nearshore waters (i.e., from the mean highwater line seaward 1.6 km) off these beaches.

Table 3.5: USFWS listed threatened and endangered species occurring or possibly occurring in Colleton County, SC.

COLLETON COUNTY T&E Species			
Common Name	**Scientific Name**	**Status**	**Occurrence**
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	Known
Wood stork	*Mycteria americana*	E	Known
Red-cockaded woodpecker	*Picoides borealis*	E	Known
Piping plover	*Charadrius melodus*	T, CH	Known
Kemp's ridley sea turtle	*Lepidochelys kempii**	E	Known
Leatherback sea turtle	*Dermochelys coriacea**	E	Known
Loggerhead sea turtle	*Caretta caretta*	T, CH*	Known
Green sea turtle	*Chelonia mydas**	T	Known
Shortnose sturgeon	*Acipenser brevirostrum**	E	Known
Atlantic sturgeon	*Acipenser oxyrinchus**	E	Known
Pondberry	*Lindera melissifolia*	E	Possible
Canby's dropwort	*Oxypolis canbyi*	E	Known
Southern dusky salamander	*Desmognathus auriculatus*	SC	Possible
Angiosperm (no common name)	*Elytraria caroliniensis*	SC	Known
Godfrey's privet	*Forestiera godfreyi*	SC	Known
Pondspice	*Litsea aestivalis*	SC	Known
Boykin's lobelia	*Lobelia boykinii*	SC	Known
Carolina bird-in-a-nest	*Macbridea caroliniana*	SC	Known
Crested fringed orchid	*Pteroglossaspis ecristata*	SC	Known
Bachman's sparrow	*Aimophila aestivalis*	SC	Possible
Kirtland's warbler	*Dendroica kirtlandii*	E	
Henslow's sparrow	*Ammodramus henslowii*	SC	Possible
Rufa Red knot	*Calidris canutus rufa*	P	Possible
Black-throated green warbler	*Dendroica virens*	SC	Possible
Swallow-tailed kite	*Elanoides forficatus forficatus*	SC	Known
American kestrel	*Falco sparverius*	SC	Possible
American oystercatcher	*Haematopus palliatus*	SC	Known
Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
Black rail	*Laterallus jamaicensis*	SC	Possible
Painted bunting	*Passerina ciris ciris*	SC	Possible
Gull-billed tern	*Sterna nilotica*	SC	Known
Bluebarred pygmy sunfish	*Elassoma okatie*	SC	Known
Southern hognose snake	*Heterodon simus*	SC	Possible
Island glass lizard	*Ophisaurus compressus*	SC	Known
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC	Known

E - Federally endangered *Federally threatened* *P - Proposed*
BGEPA - Bald and Golden Eagle Protection Act *CH - Critical Habitat Designated* *CH* - proposed*
SC - State Species of Concern. These species are rare or limited in distribution but are not currently legally

SCDNR has indicated that the waters offshore of Edisto are very active with sea turtles, particularly loggerheads and leatherbacks. They are frequently seen in higher numbers near the project area during airplane surveys than in any other area of the state (SCDNR, personal communication).

At Edisto Beach State Park in 2003, 87 nests were laid, of which 62 had to be relocated. Since 1994, a total of 679 nests have been laid. Of these, 229 (34 percent) had to be relocated and 694 false crawls were made. A total of 72,622 eggs have been laid. The nesting success averaged 89 percent with a hatching success of 72 percent. Data from 2008 thru 2012 shows that Edisto Beach had the third highest number of sea turtle nests in the State (Figure 3.11). However, Edisto Beach also had the fifth lowest hatch success rate. These data indicate that while Edisto Beach is heavily used by nesting turtles, the current conditions on the beach are not particularly favorable to hatch success rates. Data from the past 5 nesting seasons (i.e., 2008 thru 2012) shows that Edisto Beach had the third highest number of sea turtle nests in the State (Figure 3.11).

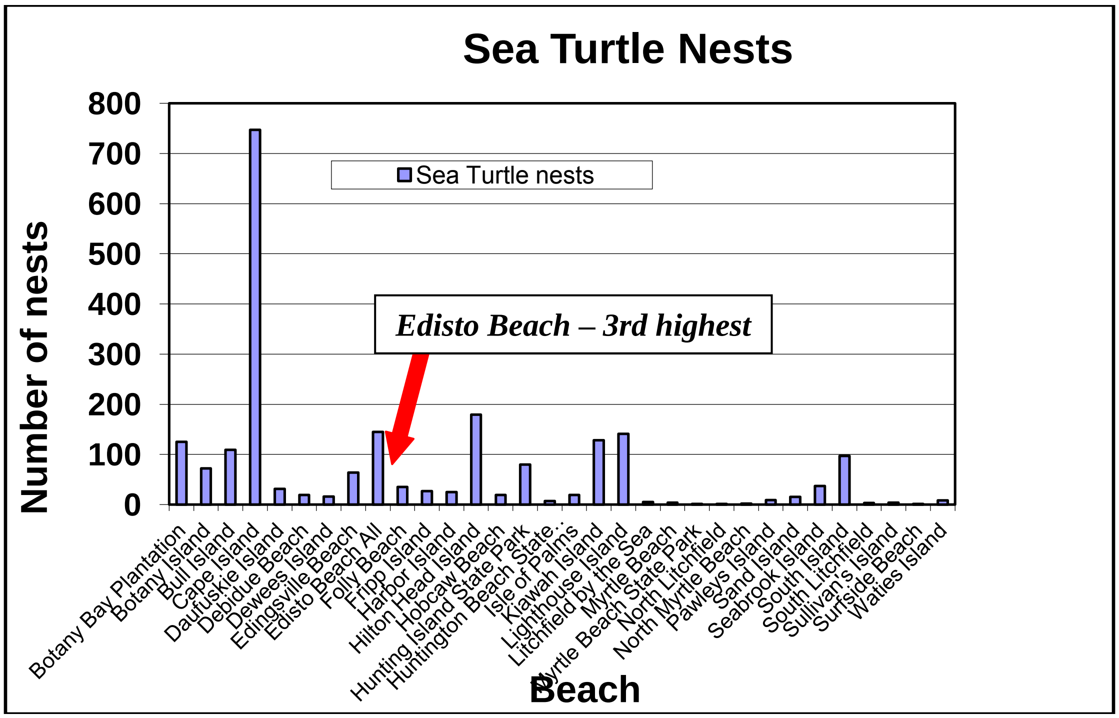

Figure 3.11: 2008-2012 count of sea turtle nests at South Carolina beaches.

3.2.13.2 Piping Plover

The piping plover (*Charadrius melodus*) is Federally classified as threatened with critical habitat in South Carolina, where it winters. Critical habitat for the piping plover is found north of the project area at Deveaux Bank and south of the project area at the southern rim of Otter Island (Figure 3.12). This species prefers expansive sand and mud flats for feeding which are in close proximity to a sandy beach for roosting. These birds tend to prefer isolated areas and may generally be found at accreting ends of barrier islands, on sandy peninsulas and near coastal inlets. The area near the proposed project, particularly the northern end of Edisto Beach State Park, may provide suitable habitat for these birds, since this area tends to be more isolated with fewer park visitors and is closer to Deveaux Bank.

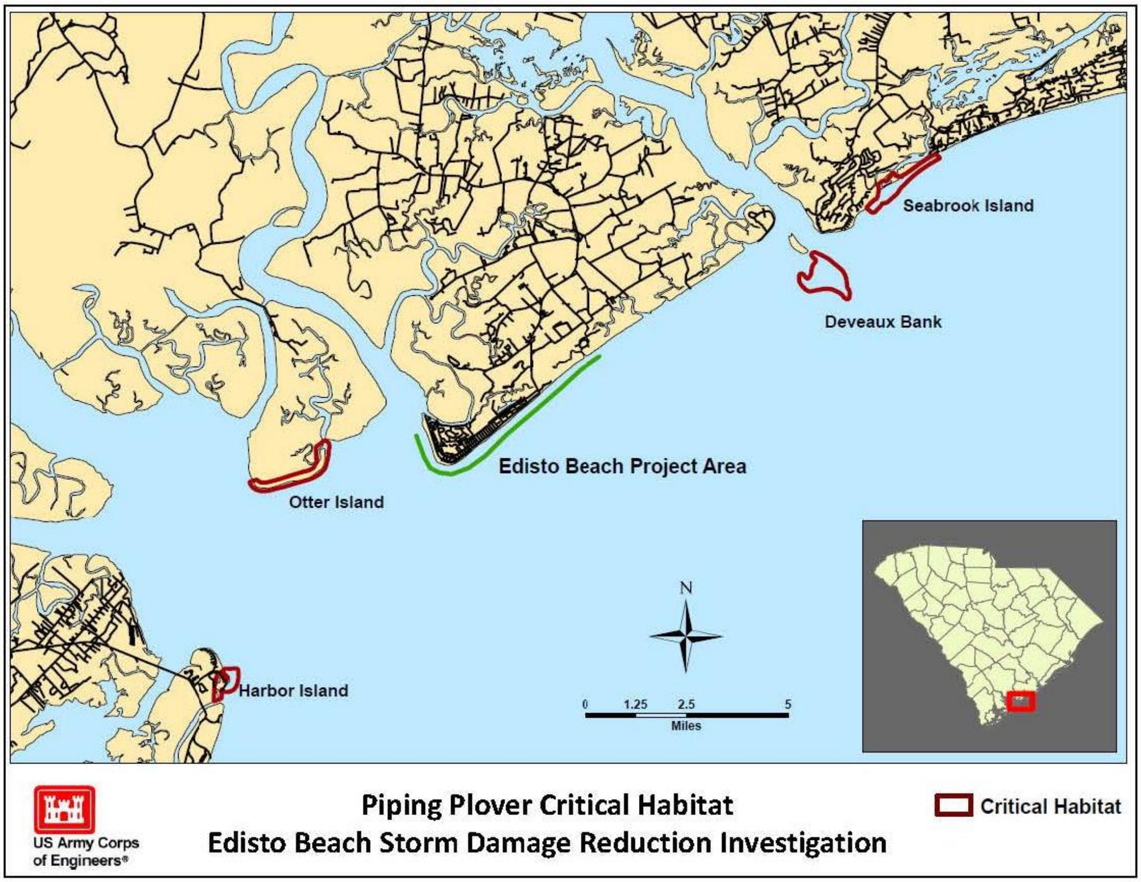

Figure 3.12: Location of piping plover critical habitat in the vicinity of the project area.

3.2.13.3 Rufa Red Knot

Rufa red knots (*Calidris canutus rufa*) are medium-sized shorebirds approximately 9 to 11 inches long. Each year red knots make one of the longest distance migrations known in the animal kingdom, traveling up to 19,000 mi annually. This migration occurs between the red knot's breeding grounds in the Canadian Arctic and several wintering areas, including the Southeast United States, the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America ("Winter" is used to refer to the nonbreeding period of the red knot life cycle when the birds are not undertaking migratory movements.). During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed. Red knots are a specialized molluscivore, eating hard-shelled mollusks, sometimes supplemented with easily accessed softer invertebrate prey, such as shrimp and crab-like organisms, marine worms, and horseshoe crab eggs. Red knots occupy all known wintering areas from December to February, but may be present in some wintering areas as early as September or as late as May. The primary threats to the red knot are loss of both breeding and non-breeding habitat; reduced prey availability throughout the non-breeding range; potential for disruption of natural predator cycles on the breeding grounds; and increasing frequency and severity of asynchronies (i.e., mismatches) in the timing of their annual migratory cycle relative to favorable food and weather conditions (USFWS, 2013b).

The red knot is a regular visitor along the South Carolina coast during both the spring and fall migrations. Flocks of over 1000 birds have been observed in the spring with lesser numbers being observed in the fall. The red knot also uses the South Carolina coast as a wintering area. The mud flats on Botany Bay Plantation get some red knot activity during migration (Sept/Oct and April/May); however, the red knot has not been sited on Edisto Island during either of the last two winter surveys. SCDNR indicates that red knots do not likely concentrate on Edisto Beach (Felicia Sanders, personal communication, 11/22/2013).

3.2.13.4 Sturgeon

The two types of sturgeon, indigenous to South Carolina, are the Atlantic sturgeon (*Acinpenser oxyrinchus*) and the Shortnose sturgeon (*Acipenser brevirostrum*). The Shornose sturgeon has been listed as "endangered" under the ESA since 1967. The American Fisheries Society deemed it "threatened" in 1989. It is much smaller than the Atlantic sturgeon, with adults reaching 1.2 m in length and maximum weight of around 18 kg. The body is shaped similar to a shark, and the body is protected by three rows of scutes (a protective armoring). They are benthic feeders and primarily prey on invertebrates. Their historical range is from the St. John River, Canada to the St. Johns River, Florida. In South Carolina, these species occur as distinct populations by river system, a characteristic typical for anadromous fishes. There are a minimum of five populations in South Carolina, one of which is located in the Ashepoo, Combahee, and Edisto (ACE) Basin. They move primarily from tidal estuarine into freshwater rivers to spawn. During fall and winter, sturgeon move seaward into estuarine waters to feed. Impediments to river flow (i.e., dams) are the major challenge that these species face. Other challenges include dredging and bridge construction that allows additional saltwater intrusion as well as the removal of prey from the benthos. Yet another challenge is from commercial and recreational fishing operations. By-catch from gill nets, trawls or trotlines may also cause increased mortality.

The Atlantic sturgeon was listed as "endangered" under the ESA on February 6, 2012. The Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish. They can grow up to 14 feet long and can weigh up to 800 pounds. They appear similar to the shortnose sturgeon but are larger, have a smaller mouth, different snout shape, and scutes. Adults spawn in freshwater in the spring and early summer and migrate into estuarine and marine waters where they spend most of their lives. This species faces threats due to by-catch, habitat degradation and loss from human activities such as dredging, dams, water withdrawals, and other development.

3.2.13.5 Whales

A variety of whale species are known to frequent South Carolina waters, including the blue whale, finback whale, humpback whale, North Atlantic right whale, sei whale, and sperm whale.

3.2.13.6 Manatees

The West Indian manatee (*Trichechus manatus*) was listed as endangered on March 11, 1967, under a law that preceded the Endangered Species Act of 1973, as amended (16 USC 1531 et seq.). Additional Federal protection is provided for this species under the

Marine Mammal Protection Act of 1972, as amended (16 USC 1461 et seq.). SCDNR indicates that manatees have been observed in SC since 1850. From 1850-2004 there have been 1117 records of manatees were documented in SC. These data suggest that manatees are infrequent visitors in SC (http://www.dnr.sc.gov/manatee/dist.html). However, in 2012, the SCDNR online reporting system noted that manatee sightings were reported beginning in April and lasting until October. Manatees have large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are grey in color and occasionally spotted with barnacles or colored by patches of green or red algae. The manatees' range is generally restricted to the southeastern United States; individuals occasionally range as far north as Massachusetts and as far west as Texas (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A007). There is no designation of critical habitat for the West Indian manatee in SC.

3.2.13.7 State Rare, Threatened, and Endangered Species

The State of South Carolina's Rare, Threatened and Endangered Species Inventory includes the loggerhead sea turtle, the Wilson's Plover (*Charadrius wilsonia*), and the Least tern (*Sterna antillarum*). All three species are listed on the State inventory as threatened. Least terns, willets, and Wilson's plovers have been observed nesting at the Edisto Beach State Park or present with young of the year (SCDEC, personal communication). American oystercatchers have also been observed utilizing the beach areas. Although American oystercatchers are not currently considered threatened or endangered, SCDNR has reported that the oystercatcher population is declining due to the continued loss of suitable habitat and increased beachfront development.

3.2.14 Cultural Resources

There are no known cultural resources on the beachfront at Edisto Beach. A comprehensive cultural resources review was conducted for the proposed offshore borrow area, including a quarter mile buffer around the area. Two potential sites of prehistoric interest were identified in the survey area. Discussion of these sites, as well as a detailed description of the paleo-environmental setting, the prehistoric context, and historic context of the study is contained in Appendix J of this report.

3.2.15 Water Quality

The proposed project would occur within the open ocean and on an adjacent beach. These waters are classified as Class SA waters by the SC Department of Health and Environmental Control (SCDHEC). SA waters are tidal saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption and uses listed in Class SB. They are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. Over the past few years Edisto Beach has had a few beach advisories due to high levels of bacteria after rain events.

The proposed project would occur in the open ocean and on an adjacent beach. SCDHEC issued a notice on 401 water quality certifications that stated that groin construction and beach nourishment have very few water quality impacts and have waived the requirement for 401 certifications for these projects.

Section 404 of the Clean Water Act (CWA) governs the discharge of dredged or fill material into waters of the U.S. Although the USACE does not process and issue permits for its own activities, the USACE authorizes its own discharges of dredged or fill material by applying all applicable substantive legal requirements, including public notice, opportunity for public hearing, NEPA, and application of the section 404(b)(1) guidelines. A 404(b)(1) evaluation has been completed for this project and is included as Appendix H to this report.

3.2.16 Air and Noise Pollution

The Clean Air Act requires the U.S Environmental Protection Agency (EPA) to establish health and science-based standards for air pollutants that have the highest levels of potential harm to human health or the environment. These National Ambient Air Quality Standards (NAAQS) are in place for six air pollutants, also referred to as criteria pollutants. The six criteria pollutants are Ozone, Sulfur Dioxide, Particulate Matter, Lead, Nitrogen Dioxide, and Carbon monoxide. Of the six current criteria pollutants, particle pollution and ozone have the most widespread health threats, but they all have the potential to cause damage to human health and the environment. Areas of the country which persistently exceed the NAAQS are designated as “nonattainment” areas and those which meet or exceed the standards are designated “attainment” areas. Colleton County is designated as an attainment area.

With regards to noise pollution, ambient noise levels along Edisto Beach are low to moderate and are typical of recreational environments and are not considered an issue or nuisance. The major noise producers include the breaking surf, residential areas, and traffic (vehicular and to a lesser extent, boat).

3.2.17 Hazardous, Toxic and Radioactive Wastes (HTRW)

There are currently no known hazardous, toxic or radioactive waste producers adjacent to the project site or any entity that discharges toxic effluents nearby.

3.3 Socio-Economic Resources

3.3.1 Demographics and Population

As of the census of 2010, there were 414 people in the Town of Edisto Beach. This is a decrease of 35.4% since the 2000 census which showed a population of 641 people. However, according to a Town of Edisto Beach representative, the 2010 population count of 414 has been challenged because the Town did not have a mail out census, just a door to door count during a season when many people are out of town. According to the sponsor, the voter registration is 704 people, a 10 percent increase from the 2000 census.

Based on the 2010 census, there are 2,181 housing units, with 10.6 percent being occupied and 89.4 percent being vacant housing units mainly for rent or seasonal use. There are 232 households out of which 3.4 percent had children under the age of 18 living with them; 62.9 percent are married couples living together; 1.7 percent have a female householder with no husband present and 35.3 percent are non-families. The average household size is 1.78 and the average family size is 2.13.

3.3.2 Income

In 2010, the per capita income was $51,628. The median income for a household in the town was $64,125, and the median income for a family was $96,250. About 2.9% of families were below the poverty line.

3.3.3 Education

According to the 2010 census, the education attainment in Edisto Beach for high school graduates is 20.8 percent. The population that attained an associate's degree is 6.5 percent, and the population percentage that received a bachelor's degree is 35.7, and 19 percent of the population has a graduate or professional degree.

3.3.4 Employment

In 2010, Edisto Beach had 261 people in the labor force. The occupations in Edisto Beach are as follows: management, business, science and arts (154 people), service occupation (22 people), sales and office (38 people), natural resources, construction and maintenance (12 people), and production, transportation and material moving (20 people). The unemployment rate is 5.7 percent.

3.3.5 Transportation and Utilities

The Town of Edisto Beach is accessible from Edisto Island and the mainland via SC Hwy 174. The William McKinley Jr. Bridge connects Edisto Island to the mainland. Major local roads on the island include Palmetto Boulevard (a section of SC Hwy 174 which runs parallel and close to the beach), Lybrand Street, Jungle Road, Dock Site Road and Myrtle Street. One company supplies well water to the Town of Edisto Beach. There is also one sewer plant for the Town.

3.3.6 Land Use and Development

Land use on Edisto Beach is primarily residential in the form of single and multiple family dwelling units. The west end of the island has been developed as a planned gated community. The Edisto Beach State Park occupies approximately one third of Edisto Beach at the northern end and offers numerous scheduled activities and educational opportunities. Edisto Beach has relatively few commercial units, and commercial development is limited. Approximately 34 acres, 2 percent, of the 1,531 acres on the beach is zoned for commercial use, excluding resort amenities within the gated section of Wyndham Resort. There are 4.67 miles of walking/biking trails that provide recreational activities to the public throughout the town. The town is already near full development capacity with less than 2 percent of developable lots vacant.

3.3.7 Historical Storms and Damages

Edisto Island has had a number of damaging storms and hurricanes affect its shores. Some of the major hurricane events to impact Edisto in recent history include:

- On August 11, 1940 a powerful (unnamed) hurricane directly hit Edisto Island at high tide, damaging nearly every house on the island and completely destroying more than half of the approximately two hundred beachfront homes at the time.

- The first named storm to hit Edisto was Able, which struck on August 31, 1952. The storm completely destroyed many beach cottages and damaged many others. Palmetto Boulevard (SC Hwy 174) also sustained heavy damage.

- Category 3 Hurricane Gracie made landfall on the southern edge of Edisto Island on September 29, 1959. The Pavilion's fishing pier was largely destroyed, 16 homes were wrenched from their foundation, and 63 other homes were severely damaged. If Gracie had not come ashore at low tide, the amount of damage would have undoubtedly been much worse.

- Hurricane Hugo in 1989 landed 40 miles to the north of Edisto Island. Only moderate property damage, largely from high winds, was incurred at Edisto as a result of the hurricane.

Since Hugo, Edisto Beach has not suffered major damages from a single event. However, long term erosion of the shoreline continues, making structures even more vulnerable to future storms.

3.3.8 Structure Inventory

Beach front development is predominantly single family dwellings, many of which are vacation rental properties. Figure 3.13 shows examples of some typical shoreline structures. A complete structure inventory was completed in 2010 of existing structures that based on location would most likely benefit from a storm damage reduction project. These are generally houses in the two rows closest to the shoreline. There are no public structures in the study area inventory, although public structures exist elsewhere on Edisto Island. The depreciated replacement cost for the structure values were also calculated in 2010 (see Appendix C, Structure Inventory Analysis). There are only about 8 developable lots in the inventory area that are currently vacant. A summary of the structure inventory is shown in Table 3.6.

Table 3.6: Edisto Beach structure inventory count

Edisto Beach Structure Inventory	
Damage Element	**Number**
Commercial	15
Single-Family	505
Multi-Family	16
Walkovers	80
Road	8
Utility	16

The ‘Road’ damage element is Palmetto Boulevard. It has been divided based on reaches and treated as a linear damage element. The ‘Utility’ damage element refers to the underground water pipes that run along the side of the road that have potential to be damaged. There are twice as many utilities as roads because the utilities run along both sides of the road.

Figure 3.13: Examples of some typical structures along the Edisto Beach shoreline.

3.3.9 Structure and Content Value

The value of structures in the study area required for economic analysis to determine NED benefits is expressed in terms of depreciated replacement costs. Staff from the USACE Savannah District prepared the Edisto Beach Structure Inventory Analysis that determined the depreciated replacement cost for the structures (Appendix C). Tax Assessor’s records on the current inventory were examined and studied. Variables relating to assessed value, date of construction, type of construction, number of floors, square footage, recent sales and selling prices, along with other information were analyzed. Content value was taken at 50 percent of the structure value. A web search of trade associations of homeowner casualty underwriters revealed that insurers generally use a content to structure ratio between 50 and 75 percent of replacement cost. For this analysis, the more conservative number of 50 percent was used. Based on this analysis, the total existing value of structures included in the inventory, is $126,007,000 and the content value is $62,531,000.

3.3.10 Beach Parking and Access

The Town of Edisto Beach provides widespread public access to their beach, particularly within the study area. There are 38 existing public access points within the Town (locations are detailed in Appendix B). Edisto Beach State Park also provides additional public access points at the northern end of the study area. Access points exist at a rate of one per each quarter mile in the northern end of the study area and are more frequent (about every 300 feet) at the southern end of the study area. These access points vary in size from walking paths to wooden walkovers. Signage for the access points is uniformly designed and is adequate for identification by the public of the location of the access points. There is no restricted public access/private beach within the study area.

Parking is provided at 11 of the public access points, some of which have lots that can accommodate up to 150 cars. In addition, there are 113 on-street parking spaces within the study area. Parking is also provided at a town-owned, 20-space parking lot at Jungle

Street on the northern end of the study area. Edisto Beach State Park is also available for parking and can accommodate an additional 400 vehicles. Informal observation of the parking situation during tourist season indicates that lack of parking during peak days has not historically been an issue on the island. A significant amount of beach-goers are overnight visitors and utilize the private parking associated with rental properties.

4. FUTURE WITHOUT PROJECT CONDITIONS*

The existing conditions described in the previous chapter form the basis on which the future without project conditions are developed. Although the future without project conditions discussion in this chapter touches on all major resource areas, it is generally only quantified for those areas that are directly related to the study objectives, which in this case is the reduction of coastal storm damages.

4.1 Assumptions

For the purposes of USACE planning, the future without project condition is defined as the most likely condition of the project area over a fifty year period of analysis, in the absence of a USACE coastal storm damage reduction project. Predictable or planned actions undertaken by others (including other federal agencies), as well as expected maintenance of existing USACE projects, are all included as part of the future without project condition. The discussion of the without project condition in the subsequent sections is based on the following assumptions: a) continued maintenance of the existing groin fields, b) no additional groin construction, c) due to a lack of dedicated funding, no additional planned beach nourishments by the local interests, d) smaller scale "emergency" nourishment activities would take place as areas become increasingly threatened, and e) SC Hwy 174 would be armored as it becomes increasingly threatened, since the road is the primary evacuation route off the island and is essential for public safety. These assumptions are derived from conversations with the Town of Edisto Beach regarding actions they would or would not take in the absence of a federal project and an assessment of previous actions that have been taken. An additional assumption being made for the future without project condition and the future with project condition is that the level and type of development in the study area will remain consistent with existing conditions.

4.2 Shoreline Rate of Change

The future without project average annual rates of change, as determined through Beach-*fx* simulations for each of the 23 project reaches (see section 3.1.5), are shown in Table 4.1. Beach-*fx* is a Monte-Carlo life-cycle simulation model for evaluating the physical performance and economic benefits of coastal storm damage reduction projects (Gravens et al, 2007). The predicted rate of change includes the effects of emergency nourishment actions that are considered part of the future without project condition. The method by which these rates were determined is detailed in Appendix A. As indicated in the table, the shoreline is largely erosional and a resultant decrease in beach width can be expected to occur in the future without project scenario.

4.3 Sea Level Rise

The historical rate of sea level rise for the study area, which is 3.19 mm/yr, is also being applied as the future without project sea level rise rate. The "Intermediate" rate of future sea level change was computed using modified NRC Curve 1 and equations 2 and 3 in EC-1165-2-212 Appendix B. The "High" rate of future sea level change was computed using modified NRC Curve III and equations 2 and 3 in EC-1165-2-212 Appendix B.

The relationships for future sea level change as outlined in EC-1165-2-212 are coded within Beach-fx and sea level change is internally computed continuously throughout the simulated project lifecycle.

Table 4.1: Expected future without project condition shoreline average annual rate of change (AARC) as estimated through Beach-*fx* simulations. A negative value indicates erosion, positive values indicate accretion.

Reach	AARC (ft/yr)	Reach	AARC (ft/yr)	Reach	AARC (ft/yr)
I1	1.37	**E3**	-1.09	**E11**	-2.07
I2	0.62	**E4**	-1.64	**E12**	-1.67
I3	0.38	**E5**	-1.83	**E13**	-1.80
I4	0.16	**E6**	-1.96	**E14**	-1.98
P1	0.22	**E7**	-2.44	**E15**	-1.99
P2	0.13	**E8**	-2.28	**SP1**	-4.38
E1	-0.17	**E9**	-2.50	**SP2**	-5.13
E2	-0.58	**E10**	-2.33		

4.4 Future Development

As the town is already nearly fully developed, a large increase in the number or type of structures in the future is not expected. There are a few developable vacant lots that will likely eventually be developed. However, for the purposes of being conservative in the project economics analysis, those lots are assumed to remain vacant. The analysis also assumes that houses that are damaged or destroyed will be rebuilt to the same level of construction as the existing structure, assuming there is sufficient room on the lot to allow for rebuilding.

4.5 Coastal Storm Damages

Average annual coastal storm damages occurring in the future without project condition were calculated using the Beach-*fx* software, as detailed in Appendix A and Appendix B (Economics Appendix). In order to account for local actions taken under the future without project condition, the following parameters were included as part of the analysis:

1) Armoring of SC Hwy 174 is triggered when the seaward edge of the berm gets within 20 feet of the road.

2) Emergency nourishment is triggered in a reach when dune height in that reach falls below 9 ft. During emergency nourishment, the dune is reconstructed with a target elevation of North American Vertical Datum 11 ft (if achievable) with a fill density 10 cy/ft.

Table 4.2 provides the expected average annual without project condition damages for each of the 23 defined reaches. The future without project average annual damages over the entire study area are estimated at $2,068,000.

Table 4.2: Summary of future without project structure and content damages. FY 2012 interest rate of 4.000%.

Reach	Average Structure Damage	Average Content Damage	Average Total Damages	Average Annual Total Damages
I-1	$6,317,733	$2,990,364	$9,308,097	$433,294
I-2	$3,062,552	$1,114,885	$4,177,437	$194,461
I-3	$718,326	$296,763	$1,015,089	$47,253
I-4	$1,042,894	$417,459	$1,460,353	$67,980
P-1	$369,642	$141,146	$510,788	$23,777
P-2	$636,016	$271,999	$908,015	$42,268
E-1	$252,774	$126,588	$379,362	$17,659
E-2	$702,507	$288,870	$991,377	$46,149
E-3	$848,403	$280,191	$1,128,594	$52,536
E-4	$1,419,165	$645,353	$2,064,518	$96,104
E-5	$1,047,363	$315,453	$1,362,816	$63,439
E-6	$335,689	$145,157	$480,845	$22,383
E-7	$123,200	$55,066	$178,266	$8,298
E-8	$1,310,857	$640,868	$1,951,725	$90,853
E-9	$1,444,122	$714,053	$2,158,175	$100,463
E-10	$2,151,029	$1,057,831	$3,208,860	$149,373
E-11	$2,196,338	$1,087,834	$3,284,172	$152,879
E-12	$388,255	$183,945	$572,199	$26,636
E-13	$1,112,656	$543,753	$1,656,409	$77,106
E-14	$3,637,260	$1,790,893	$5,428,153	$252,682
E-15	$1,481,667	$721,851	$2,203,518	$102,574
SP-1	$0	$0	$0	$0
SP-2	$0	$0	$0	$0
Total	**$30,598,447**	**$13,830,322**	**$44,428,769**	**$2,068,168**

In addition to the storm damages to structures and contents documented above, additional damages based on land loss are also incurred in a future without project condition. Table 4.3 contains the average annual land loss value for only the reaches where net erosion is occurring, but excluding the state park. The total land loss value is based on the annual erosion rates in table 4.1, and a near shore upland value of $19.76 per square foot (see Appendix C for details as to how the near shore land value was estimated).

Table 4.3: Summary of future without project damages resulting from land loss.

Reach	**Average Annual Land Loss Damages**
E1	$1,656
E2	$9,959
E3	$26,406
E4	$56,646
E5	$45,454
E6	$47,637
E7	$27,000
E8	$56,631
E9	$29,689
E10	$53,223
E11	$25,196
E12	$19,800
E13	$20,701
E14	$47,341
E15	$67,713
Total	**$535,054**

To summarize, the results of the future without-project scenario, as simulated with Beach-*fx*, indicate an unfavorable future within the project study area due to chronic long term erosion and damaging storms. The total average annual future without project damages are estimated at $2,603,000 per year (4.000% interest rate). In recent history, substantial damages have largely been avoided due to successful local nourishment projects that were constructed in 1995 and 2006. However, future local nourishment projects are not anticipated due to funding constraints. Therefore, significant damages and even complete losses to privately held developed properties could occur in the without project condition, although these losses might be somewhat mitigated by local emergency protection efforts. Indications are that Edisto State Park would be subject to extreme losses due to coastal erosion including the inability to support recreational camping within the park. Figures 4.1 to 4.3 depict the predicted future without project location of the shoreline from the inlet to the state park (reaches I1-E15) and Figure 4.4 shows recent landside inundation in Reach 15 due to high tides.

Figure 4.1: Predicted location of the shoreline between reaches I1 and E3 (purple line) after 50 years in the future without project scenario.

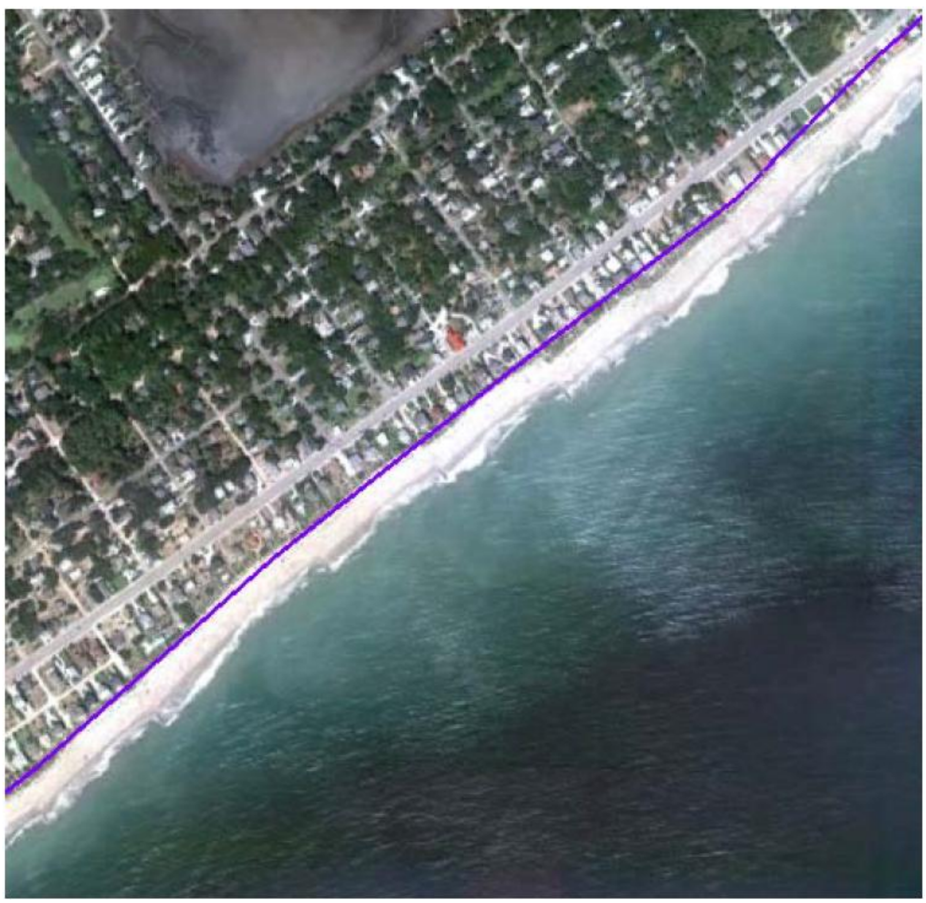

Figure 4.2: Predicted location of the shoreline between reaches E4-E7 (purple line) after 50 years in the future without project scenario.

Figure 4.3: Predicted location of the shoreline between reaches E8-E15 (purple line) after 50 years in the future without project scenario.

Figure 4.4: Recent photograph of high tide in Reach 15.

4.6 Environmental Resources

Overall, it is expected that sea turtle nesting habitat, shorebird habitat, quality beach and dune habitat would likely decrease in a future without project condition. A general listing of the impacts of a future without project condition (no action alternative) on environmental resources is provided in Table 5.6. However, the future without project condition of some environmental resources would vary along three distinct sections of the beach. These are the Inlet section, Atlantic Facing section, and Edisto Beach State Park section. These varying outcomes are discussed in the sections, below.

4.6.1 Edisto Beach State Park Section

The ongoing erosion that would continue to occur in this section in the future without project condition would reduce the shoreline area available for nesting sea turtles and potentially reduce the successful hatching rate of juvenile turtles as they are more vulnerable to overwash from waves. In the northern part of the island, this effect might be minimized because of the lack of development and the potential for the beach to migrate landward. Edisto Island has the third highest rate of nesting turtles in South Carolina, and quality habitat would be reduced if erosion were to continue. However, as there are adjacent beaches available for nesting, it is unknown whether this would result in more turtles nesting on those beaches rather than Edisto Beach.

The salt marsh that exists behind Edisto Beach State Park would likely be reduced in size as the mean high water line shifts landward in the future without project condition. As a result of a diminished area of salt marsh behind the beachfront, there would likely be a loss of Essential Fish Habitat. Shorebirds would thrive in the overwash fans created as a result of tidal and wave inundation. Recreational beach area would be diminished with future erosion, which could result in fewer visitors to the park. However, fewer visitors would be beneficial to wildlife species including birds as they would likely be disturbed less frequently.

4.6.2 Atlantic Facing Section

In the without project condition, it is assumed that a minimal measure of protection would be provided for beach front properties and SC Hwy 174 along the Atlantic facing reaches of Edisto Beach. This minimal measure of protection would not facilitate a healthy beach and dune system along these reaches. Beaches without coastal development could migrate landward without drastic consequences to the beach and dune system. In developed areas, roads and other infrastructure would act as an impediment to this landward migration. SC Hwy 174 would likely be protected by a revetment which would act as a sea wall and reduce the area of active beach above the MHW line. SCDHEC OCRM states about seawalls, bulkheads, and revetments that, "While these structures can protect coastal property and infrastructure from erosion, they do so at the expense of the long-term health of the beach/dune system and the public's access to this shared resource. The structures themselves can intensify erosion problems in their immediate vicinity; and as sea levels rise, eventually the dry sand and intertidal beach will be lost." (SCDHEC-OCRM 2010) In time, there would be minimal beach even at low tide. Without a healthy dune system, coastal properties are more vulnerable to storm damage.

Dune systems support a wide array of wildlife (discussed in section 3) which would lose habitat with continued erosion. Negative impacts to sea turtle hatching rates and habitat would be similar or greater than those that are experienced in the park section. In addition to potentially impacting sea turtles, an eroding beach would also result in a loss of shorebird nesting habitat, foraging area, and roosting area. Also, the diminishment of the intertidal area would negatively affect the various macroinvertebrate species that inhabit the intertidal beach. Presently, Edisto Beach does not see many water quality advisories in any given year. However, water quality impairments could increase in the without project condition if infrastructure such as water and sewer lines are compromised and not repaired properly.

4.6.3 Inlet Section

Based on current and predicted accretion rates, the mean high water line would advance seaward in this portion of the beach. The South Edisto River portion of the study area would continue to accrete and build a dune system similar to what is presently there. This dune system is diverse but has a very low profile due to the nature of the coarse sand at Edisto Beach. Being in a dynamic inlet area, the rate of accretion is subject to short and long term influences. The low profile dune system leaves this habitat vulnerable to periodic overwashing during storm events. Washover fans are valuable habitat to a variety of shorebirds (Section 3.2.11.1). The seaward advance of the MHW line would help enhance habitat for sea turtle nesting, which would be crucial to turtle nesting along Edisto Beach, especially due to the assumption that only short term small scale protection measures would be applied along the Atlantic facing shoreline of the Town. This would likely limit the availability of adequate nesting habitat. It is likely that sea turtle volunteers and various resource agencies would need to utilize this portion of beach to relocate nests. Beach and dune habitat as described in Section 3 of this report would be enhanced in the without project condition. Additionally, the small pockets of existing maritime forest may be able to grow larger in size due to additional protection from salt spray and inundation.

4.7 Socioeconomic Resources

In a future without project condition where the beach is allowed to erode, a large economic impact would likely be felt by the local community, which is largely reliant on tourism dollars. Absent the beach, revenue gained from tourism could be expected to decrease as recreational opportunities diminish. Additional discussion of the impact on socioeconomic resources in the future without project condition (no action alternative) is contained in Tables 5.5 and 5.6 later in this report.

5. PLAN FORMULATION*

This chapter describes the plan formulation process through the selection of a recommended plan. It includes a discussion of the general plan formulation and evaluation criteria being used, the identification and screening of measures, the creation of comprehensive alternative plans through the combination of measures and the evaluation and comparison of alternative plans. A number of measures/alternatives are usually identified early in the planning process and their number is reduced by screening and evaluation through an iterative sequence in increasing levels of detail to finally identify the recommended plan.

5.1 Formulation and Evaluation Criteria

Alternative plans are evaluated by applying numerous, rigorous criteria. Per the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, four general criteria are considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability. Those terms are defined, below.

<u>Completeness:</u> Completeness is the extent that an alternative provides and accounts for all investments and actions required to ensure the planned output is achieved. These criteria may require that an alternative consider the relationship of the plan to other public and private plans if those plans affect the outcome of the project. Completeness also includes consideration of real estate issues, operations and maintenance (O&M), monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties also have to be considered.

<u>Effectiveness:</u> Effectiveness is defined as the degree to which the plan would achieve the planning objective. The plan must make a significant contribution to the problem or opportunity being addressed.

<u>Efficiency:</u> The project must be a cost-effective means of addressing the problem or opportunity. The plan outputs cannot be produced more cost-effectively by another institution or agency.

<u>Acceptability:</u> A plan must be acceptable to Federal, state, and local government in terms of applicable laws, regulation, and public policy. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

There are also specific technical criteria related to engineering, economics, and the environment, which also need to be considered in evaluating alternatives. These are:

Engineering Criteria:

- The plan must represent a sound, acceptable, and safe engineering solution.

Economic Criteria:

- The plan must contribute benefits to NED.
- Tangible benefits of a plan must exceed economic costs.
- Each separable unit of improvement must provide benefits at least equal to costs.
- Recreation benefits may not be more than 50 percent of the total benefits required for economic justification.

Environmental Criteria:

- The plan would fully comply with all relevant environmental laws, regulations, policies, executive orders.
- The plan would represent an appropriate balance between economic benefits and environmental sustainability.
- The plan would be developed in a manner that is consistent with the USACE Environmental Operating Principles (EOPs).

Adverse impacts to the environment would be avoided to the extent practicable. In cases where adverse effects cannot be avoided, mitigation must be provided based on the guidance in ER 1105-2-100, paragraph C-3(d)(1), and Memorandum dated 31 August 2009 Implementation Guidance for Section 2036(a) of WRDA 2007-Mitigation for Fish and Wildlife and Wetland Losses, which states:

> "it is the policy of the Corps of Engineers Civil Works program to demonstrate that damages to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable and than any remaining unavoidable damages have been compensated to the extent possible per ER 1105-2-100, paragraph C-3(d)(3)(l)....in order to compensate for non-negligible impacts to aquatic and terrestrial resources to the extent incrementally justified and to ensure that the recommended project would not have more than negligible adverse impacts on ecological resources."

5.2 Environmental Operating Principles

The USACE Environmental Operating Principles were developed to ensure that USACE missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the Corps of Engineers role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation and, through the international reach of its support missions. More information on the Principles can be found here:
http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx

5.3 Identification of Measures

A variety of potential measures can be considered and combined when formulating alternative plans for reducing coastal storm damages. These measures generally are categorized as either structural or nonstructural. Structural measures are those that directly affect conditions that cause storm damage. The nonstructural measures are measures taken to reduce damages without directly affecting those conditions.

A wide variety of structural measures for addressing coastal storm damage reduction were initially considered for this study. These measures include "soft" stabilization activities such as beach nourishment, and "hard" stabilization structures such as breakwaters, seawalls, revetments, and groins. These measures are discussed in more detail below:

5.3.1 Hard Stabilization

S-1: Emergent Breakwaters

Breakwaters are generally shore-parallel structures that reduce the amount of wave energy reaching the protected area. They are similar to natural bars, reefs or nearshore islands and are designed to dissipate wave energy. The reduction in wave energy slows the littoral drift and results in sediment deposition in the sheltered area behind the breakwater. Some longshore sediment transport may continue along the coast behind the nearshore breakwater. Properly designed, breakwaters can be effective in reducing erosion and in building up the beaches locally using natural littoral drift. At the same time, they are also effective in holding nourished beach material (Burcharth and Hughes 2003).

S-2: Submerged Artificial Reefs

This management measure would use the perched beach concept to limit the amount of underwater fill and retain the dry beach for a longer period. This would be accomplished by placement of a submerged artificial reef in shallow water with beach fill material placed "perched" behind the reef structure. This measure may reduce initial fill quantities and offer environmental benefits by creating nearshore hardbottom habitat. The submerged artificial reef would be constructed out of large size rock, and/or ReefBalls® with a foundation material to avoid subsidence. The beach fill material would come from the identified borrow area at the ebb-tidal shoal at the south end of Edisto Island.

SCDNR manages an extensive array of artificial reefs that have been proven to be beneficial to wildlife habitat for benthic organisms and fish species. However, artificial reefs are not commonly used for coastal storm damage reduction purposes in South Carolina, and the amount of coastal storm damage reduction benefits they could provide is uncertain.

S-3: Groins

Groins are the oldest and most common shore-connected, beach stabilization structure. They are structures that extend, fingerlike, perpendicularly or at nearly right angles from the shore and are relatively short compared to navigation jetties at tidal inlets. Usually constructed in groups called groin fields, their primary purpose is to trap and retain sand, nourishing the beach compartments between them. Groins initially interrupt the longshore transport of sediment within the littoral drift. They are most effective where longshore transport is predominantly in one direction and where their action does not cause unacceptable downdrift erosion. When a well designed groin field fills to capacity, longshore transport continues at about the same rate as before the groins were built and a stable beach is maintained. However, if the groins fields are not filled, the overall effect is accretion on the updrift side and erosion on the downdrift side (Burcharth and Hughes 2003). Kraus (http://www.springerlink.com/content/p43lnl710912k6x3/fulltext.pdf) states that a long groin intercepts too much sand moving alongshore, which causes erosion of the downdrift beach by impounding or blocking sediment on the updrift side.

Modern coastal engineering practice is to combine beach nourishment with groin construction to permit sand to immediately begin to bypass the groin field system. At the end of the sediment cell, terminal groins may be used to anchor the beach and limit the movement of sand into a navigational channel or onto an ebb-tidal shoal at tidal inlets.

Groins have been constructed from a wide range of materials including armorstone, pre-cast concrete units or blocks, rock-filled timber cribs and gabions, steel sheet pile, timber sheet pile, and grout filled bags and tubes. There are also a variety of possible groin configurations.

In the state of South Carolina, new groins are only allowed in conjunction with a financial commitment to renourishment and on beaches that have high erosion rates, with erosion threatening existing development or public parks (SC Beachfront Management Act, R.30-15(G)).

Two groin related measures were initially considered:

S-3a: Adding New Groins

This measure would consist of creating new groins to supplement the existing groin field.

S-3b: Lengthen Existing Groins

This measure would lengthen the existing groins. As lengthening the groins would only be effective if additional sand was added to the beach, this measure would only be considered in conjunction with a beach fill measure (see S-6), and groins would only be lengthened to the extent necessary to support the added beach fill.

S-4: Seawalls

Seawalls are usually massive, vertical structures used to protect backshore areas from heavy wave action, and in lower wave energy environments, to separate land from water. They can be constructed using a range of materials; the most common being poured concrete, steel sheet pile, concrete blocks, gabions, and timber cribs. While erosion of the land seaward of the seawall might be reduced, erosion of the seabed immediately in front of the structure will be enhanced due to increased wave reflection caused by the seawall (Burcharth and Hughes 2003). Seawalls often exhibit some instability because of the erosion around the toe of the structure. Furthermore, they are not readily adaptable if sea level rise exceeds the original design level of the structure.

The SC Beachfront Management Act specifically prohibits the use of these types of structures seaward of the 40-year setback line.

S-5: Revetments

Revetments are a cover or facing of erosion resistant material placed directly on an existing slope, embankment or dike to protect the area from waves and strong currents. They are usually built to preserve the existing uses of the shoreline and to protect the slope. Like seawalls, revetments armor and protect the land behind them. They may be either watertight, covering the slope completely, or porous, to allow water to filter through after the wave energy has been dissipated.

Most revetments do not significantly interfere with transport of littoral drift. They do not redirect wave energy to vulnerable unprotected areas, although beaches in front of steep revetments can be prone to erosion. Materials eroded from the slope before construction of a revetment may have nourished a neighboring area, however. Accelerated erosion occurring after the revetment is built can be controlled with a beach-building or beach-protecting structure such as a groin or breakwater.

The SC Beachfront Management Act specifically prohibits the use of these types of structures seaward of the 40-year setback line.

5.3.2 Soft Stabilization

<u>S-6: Beach Fill</u>

Beach fill measures consist of placing sand in order to create or expand the beach berm (the flat 'shoreline' part of the beach) or dune (the more elevated portion of the beach landward of the berm). Beach fill measures are oftentimes considered preferable to hardened structures because they mimic the natural environment and can be shaped to maximize net storm damage reduction benefits. Additionally, a beach fill measure is naturally adaptable to sea level rise. However, the beach fill template would need to be periodically renourished throughout the life of the project.

The beach berm reduces coastal storm damages by increasing the distance between structures and the water, thus reducing the potential for erosion related damages, and dampening storm surge and wave heights. It is also the area of the beach that is generally recreated upon. The dune functions as sacrificial line of defense and an additional repository of sand, and can further protect structures from wave attack.

Three beach nourishment measures were considered:

S-6a: Dune Only Fill

This measure can consist of increasing the width and/or height of an existing dune, or creating a new dune if one does not already exits.

S-6b: Berm Only Fill

This measure consists of maintaining or increasing the width of the existing berm with no expansion to the existing dune dimensions. Berm widths that may initially be considered are 50, 75, and 100 foot berms. The height of the berm is generally kept at the natural berm elevation.

S-6c: Dune and Berm Fill

This measure is a combination of S-6a and S-6b.

<u>S-7: Dune Vegetation</u>

Proper vegetation on dunes increases erosion resistance by binding the sand together via extensive root masses penetrating into the sand. Such vegetation also promotes dune growth through sand trapping when wind transports substantial quantities of sand. Vegetation is an effective and inexpensive way to stabilize dunes. It also enhances the natural beauty of the landscape by providing a pleasing variety and contrast to the eye and attracting small animals to the food, nesting sites and the protective cover it affords.

However, vegetation does not protect against major storms and it is more fragile than other erosion control measures. As such, this measure, by itself, would not provide adequate coastal storm damage reduction and would need to be used in conjunction with a beach nourishment measure.

S-8: Dune Sand Fencing

Sand fences built along the seaward faces of dunes can trap windblown sand and naturally build up the dune feature. Their effectiveness is dependent on a variety of factors, such as the availability and composition of the sand.

5.3.3 Non-Structural Measures

N-1: Removal

One category of nonstructural measures involves moving beachfront structures away from the damage threat. There are three potential removal measures:

N-1a: Retreat

This measure consists of moving an existing structure away from the shoreline a short distance within the same property parcel.

N-1b: Relocation

This measure consists of moving an existing structure away from the shoreline a longer distance to a vacant property.

N-1c: Demolition

This measure consists of acquiring the property and demolishing the structure.

N-2: Floodproofing Structures

This measure consists of protective measures directly applied to the structure that would help protect it from water inundation. There are a variety of floodproofing techniques that could be considered.

N-3: Elevating Structures

This measure consists of raising the structure in place, thereby protecting it from a majority of damages if the water remains below the raised first floor elevation.

N-4: Regulations

Regulatory measures consist of things like coastal building codes, building construction setbacks, floodplain regulations and comprehensive evacuation planning. Many regulatory measures are already in place and considered part of the existing conditions. Recommendations to implement regulatory measures were considered during this project to further reduce risk. The associated recommendations are provided in Section 11.

5.4 Screening of Measures

The management measures initially identified underwent a preliminary screening process. The screening process used pertinent technical and policy/legal constraints, while also considering the measure's acceptability, efficiency, completeness and effectiveness (see section 5.1). Table 5.1 summarizes the screening process and provides information about which measures were carried forward for the formulation of alternative plans and the rationale for dropping some measures from consideration. Measures were screened out if there were technical or policy/legal constraints precluding implementation of the measure or if the measure was determined to be inefficient or ineffective, relative to other measures. Although acceptability of the measure was also considered, it was not used as the sole factor for ruling out a measure during preliminary screening.

In summary, the following measures were retained for further analysis:

Structural Measures

S-3b: Lengthen Groins
S-6a: Dune Only Fill (Reaches I1 to I4)
S-6b: Berm Only Fill
S-6c: Dune and Berm Fill
S-7: Dune Vegetation
S-8: Dune Sand Fencing (Reaches I1 to I4)

Non-Structural Measures

N-1c: Demolition

Table 5.1: Summary of Measures Screening Process

Measure	Description	Technical Constraints	Policy/Legal Constraints	Acceptability	Efficiency	Effectiveness	Completeness	Other	Retain?	Reason for screening out
Structural										
S-1	Emergent Breakwaters	The location of a breakwater would have to be carefully considered	None	Environmental Resource Agencies have expressed extreme concerns with the use of breakwaters	Breakwaters would likely not be a cost efficient method for reducing coastal storm damages	No historical proof of effectiveness for storm damage reduction, existing groins already providing some shoreline stability	Incomplete: Would require additional measures such as dune and/or berm fill over some portions of the project	None	No	Not relatively effective or efficient for reducing storm damages
S-2	Submerged Artificial Reefs	The location of the reefs offshore would have to be carefully considered. Reefs would likely also be used in areas with the highest erosion	None	Could cause navigational problems, act as an impediment to sea turtles	Not known at this time, but may not be cost effective depending on its location	May reduce some wave energy, but would need to be done in conjunction with a beach fill measure in order to provide any substantial benefits	Incomplete: Would require additional measures such as dune and/or berm fill over some portions of the project	This measure would likely provide ancillary environmental benefits. Local sponsor has no interest in this measure.	No	Effectiveness is unknown and would take additional modeling efforts to better quantify, no local sponsor interest
S-3a	Adding New Groins	The presence of 34 existing groins limits the locations where new groins could be added	None	Environmental resource agencies have expressed extreme concerns with the building of additional	Would likely not be cost efficient, due to the number of existing groins already in place	Would likely not be relatively effective, due to the number of existing groins already in place	Incomplete: Would likely require dune and/or berm fill measures to create a complete alternative	None	No	Technical constraints on location, and would likely not be efficient or effective
S-3b	Lengthen Existing Groins	None	None	Could cause some additional environmental impacts	Not known at this time, further analysis would be needed	Would need to be done in conjunction with a beach fill measure in order to provide any substantial benefits	Incomplete: Would likely require dune and/or berm fill measures to create a complete alternative	None	**Yes**	NA
S-4	Seawalls	None	Construction of seawall would violate SCBMA, and hence federal CZMA	Implementation of measure would not be acceptable due to violation of state and federal policy	Not known at this time, further analysis would be needed	Would likely be effective, however effectiveness would decrease with accelerated sea level rise	Complete: Primary storm damage reduction benefits would be achieved without additional measures	Measure would likely not provide ancillary environmental and recreation benefits, and is not readily adaptable to sea level rise	No	Would violate legal constraints, and not publicly acceptable for implementation
S-5	Revetments	None	Construction of revetment would violate SCBMA, and hence federal CZMA	Implementation of measure would not be acceptable due to violation of state and federal policy	Not known at this time, further analysis would be needed	Would likely be effective, however effectiveness would decrease with accelerated sea level rise	Complete: Primary storm damage reduction benefits would be achieved without additional measures	Measure would likely not provide ancillary environmental and recreation benefits, and is not readily adaptable to sea level rise.	No	Would violate legal constraints, and not publicly acceptable for implementation
S-6a	Dune Only Fill	On the north end of the island, there is not enough existing berm to build a dune on top of	None	No known issues	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Incomplete: Would likely require berm fill and groin modifications to create a complete alternative	Would only be considered on the southern end of the island	**Yes**	NA
S-6b	Berm Only Fill (no expansion of existing dune)	None	None	No known issues	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Incomplete: Would likely require berm fill and groin modifications to create a complete alternative	None	**Yes**	NA
S-6c	Dune and Berm Fill	None	None	No known issues	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Incomplete: Would likely require berm fill and groin modifications to create a complete alternative	None	**Yes**	NA
S-7	Dune Vegetation Planting	None	None	No known issues	Not known at this time, further analysis would be needed	Existing dunes are already heavily vegetated. Dune vegetation on its own is not an effective storm damage reduction measure	Incomplete: Would likely require a combination of other measures to create a complete alternative	Would only be done in association with building of a dune	**Yes**	NA
S-8	Dune Sand Fencing	None	None	None	Not known at this time, further analysis would be needed	Effectiveness is uncertain for the study area	Incomplete: Would likely require a combination of other measures to create a complete alternative	Analysis of measure will assume some percentage of effectiveness as compared to direct dune construction measures	**Yes**	NA
Non-Structural										
N-1a	Retreat	Most properties are constrained by the existing road, and there is not room to move the property back in the lot	None	No known issues	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Incomplete: Would likely require a combination of other measures to create a complete alternative	None	No	Technical constraints - limited room to move structures
N-1b	Relocation	Almost all lots on the island are developed, so there is essentially no available room to relocate houses	None	No known issues	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Incomplete: Would likely require a combination of other measures to create a complete alternative	None	No	Technical constraints - few available lots to move structures to
N-1c	Demolition	None	None	Property owners and the town of Edisto Beach would likely not consider property buy-outs to be an acceptable solution	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages	Complete: Large-scale demolition could achieve reductions in damages but may not be economically justifiable	None	**Yes**	NA
N-2	Floodproofing Structures	None	None	None	Not known at this time, further analysis would be needed	Would be effective in reducing storm damages from inundation, but not erosion and waves. However, many houses are already floodproofed so effectiveness would be minimal.	Incomplete: Would likely require a combination of other measures to create a complete alternative	Viability is uncertain because measure would be voluntary and mass participation would be unlikely, and there is little interest from the local sponsor.	No	Limited effectiveness and uncertain viability for implementation
N-3	Elevating Structures	None	None	None	Not known at this time, further analysis would be needed	Would be minimally effective as most houses are already elevated	Incomplete: Would likely require a combination of other measures to create a complete alternative	Most houses (97%) are already elevated, so this measure would only be considered on a small percentage of structures. Viability is uncertain because measure would be voluntary and mass participation would be unlikely, and there is little interest from the local sponsor.	No	Limited effectiveness and uncertain viability for implementation
N-4	Regulations	Regulations are already in place	None	No known issues	Efficient, as there are no direct project implementation costs	Shoreline management regulations are an effective method for reducing storm damages and limiting lives lost during hurricanes	Incomplete: Would likely require a combination of other measures to create a complete alternative	Shoreline management regulations are considered an integral part of any alternative, however, they are a local responsibility and proper regulations are already in place	No	Proper and effective regulations are already in place

5.5 Formulation of Alternative Plans

The alternative plans considered consist of one or more management measures identified in the previous section. Some measures may not be compatible with others, while others may need to be combined with others to be effective. For instance, measure S-3b (lengthen groins) would need to be combined with measure S-6b (berm only fill) or S-6c (dune and berm fill) to be effective.

To facilitate alternative evaluation, Edisto Beach was divided into 3 “planning reaches”. The reaches are distinguished by their shoreline morphology and include: the Inlet Reach (I1-I4), Atlantic Reach South (P1, P2, E1-E6), and Atlantic Reach North (E7-E15). No alternatives were formulated for the Edisto Beach State Park area (SP1, SP2) because the area lacks sufficient infrastructure to justify the cost of protecting it. However, any berm feature constructed along the entire Atlantic North Reach would need to be tapered over part of the park.

Some measures are only applicable within certain reaches. As an example, the dune only and sand fencing measures would only be effective in the Inlet Reach because the wide existing berm and accretionary nature of that reach does not require a constructed berm feature.

Four beachfill alternatives were developed and considered. The dimensions of these alternatives are provided in Table 5.2. Profile dimensions vary among the three planning reaches to account for the different morphology and erosional environment within those areas, but were kept consistent within each reach with the exception of some tapering of the berm features. Alternative 1 was designed to approximate the dimensions of the successful 2006 local beach renourishment effort. Alternative 2 was designed as the smallest practicable beachfill plan, while Alternative 3 was designed to be the largest practicable plan. After the first three beachfill alternatives were analyzed (see section 5.6 below), Alternative 4 was developed to better bracket the economic benefits. Alternative 4 generally mimics Alternative 1, but incorporates a higher dune feature. In order to maintain the effectiveness of the groin field with the designed increases in berm width, all the alternatives would require some lengthening of existing groins. Total groin extensions of 1,090, 360, 1,970, and 1,130 linear ft were used for Alternatives 1, 2, 3, and 4, respectively. Details on how these added groin lengths were determined are contained in Appendix A.

Table 5.2: Dimensions of the four beachfill alternatives analyzed.

Reach	Alternative 1: Beach and Dune fill			Alternative 2: Beach and Dune fill (minimum)			Alternative 3: Beach and Dune fill (maximum)			Alternative 4: Beach and Dune fill (bracketing)		
	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width
I1		12	15		10	15		14	15		14	15
I2		12	15		10	15		14	15		14	15
I3		12	15		10	15		14	15		14	15
I4		12	15		10	15		14	15		14	15
P1	taper	12	15	taper	10	15	taper	14	15	taper	15	15
P2	25	14	15	13	12	15	38	16	15	13	15	15
E1	50	14	15	25	12	15	75	16	15	25	15	15
E2	50	14	15	25	12	15	75	16	15	50	15	15
E3	50	14	15	25	12	15	75	16	15	50	15	15
E4	50	14	15	25	12	15	75	16	15	50	15	15
E5	50	14	15	25	12	15	75	16	15	50	15	15
E6	50	14	15	25	12	15	75	16	15	50	15	15
E7	63	14	15	38	12	15	88	16	15	63	15	15
E8	75	14	15	50	12	15	100	16	15	75	15	15
E9	75	14	15	50	12	15	100	16	15	75	15	15
E10	75	14	15	50	12	15	100	16	15	75	15	15
E11	75	14	15	50	12	15	100	16	15	75	15	15
E12	75	14	15	50	12	15	100	16	15	75	15	15
E13	75	14	15	50	12	15	100	16	15	75	15	15
E14	75	14	15	50	12	15	100	16	15	75	15	15
E15	75	14	15	50	12	15	100	16	15	75	15	15
SP	taper			taper			taper			taper		

Two other non-beachfill alternatives were also considered. Alternative 5 consisted of dune sand fencing along reaches I1-I4, which would need to be combined with some sort of beachfill in the remaining reaches. Alternative 6 was a demolition non-structural plan. The non-structural plan was evaluated for only the two most vulnerable reaches - E14 and E15. Additional reaches were to be evaluated only if the non-structural plan yielded the highest net benefits at these two reaches.

To summarize, six action alternatives and the no action were evaluated and compared in more detail. The six action alternatives were:

- Alternative 1: Mid-size dune and berm fill (comparable to 2006 fill) + 1,090 ft of groin lengthening
- Alternative 2: Minimum size dune and berm fill + 360 ft of groin lengthening
- Alternative 3: Maximum size dune and berm fill + 1,970 ft of groin lengthening
- Alternative 4: Mid-size dune and berm fill (economic bracketing alternative) + 1,130 ft of groin lengthening
- Alternative 5: Dune Sand Fencing (reaches I1-I4) + dune and berm fill in remaining reaches.
- Alternative 6: Non-Structural/Demolition (reaches E14, E15)

5.6 Evaluation and Comparison of Alternative Plans

5.6.1 Evaluation of Beachfill Alternatives

The benefits of the four beachfill alternatives were evaluated using the Beach-*fx* model. The Beach-*fx* model is used to estimate the benefits and borrow volumes needed for each alternative. Details related to the model inputs such as storm forecasts and erosion rate assumptions are provided in Appendix A. It should be noted that the costs produced by the model and presented for the alternative screening stage are for comparative purposes only, as they only factor in borrow placement and mob/demob costs, but not other miscellaneous costs (monitoring, tilling, walkway replacement, vegetation planting, real estate, administration, PED, etc). Groin construction costs were also included in the analysis; however, these costs were estimated and incorporated outside of the Beach-*fx* model. The miscellaneous costs would be fairly similar among the various beachfill alternatives, and hence their exclusion would not affect the comparison of alternatives.

In order to avoid large real estate costs related to structure acquisition, a project construction baseline was established. The construction line was set so that the landward toe of the project dune did not intersect any habitable structures. This means the actual constructed project will be offset seaward of the alternatives modeled within Beach-fx. The additional sand volume associated with the offset between the simulated Beach-fx baseline and the construction baseline, and associated project costs, were calculated and incorporated in the analysis outside of the Beach-fx model. This external calculation was necessary because the Beach-fx model does not currently include the capability to specify an offset between the initial condition beach morphology and the constructed with-project morphology. Details on how these offset volumes were calculated are contained in Appendix A (Coastal Engineering).

The alternatives benefit analysis used the simulated Beach-fx baseline for analysis comparison. The difference in the construction baseline and the simulated Beach-fx baseline could overestimate the with-project damages. To compensate for the shift in the actual construction baseline and the modeled baseline an adjustment to the position of the structures relative to the modeled baseline was made. Essentially, the structures were shifted on a reach by reach basis landward an equivalent distance to the shift between baselines. This shift ensures that damages are correctly accounted for within Beach-FX and the calculation of net benefits is appropriate for the selected plan.

A full and detailed project cost was only developed for the recommended plan. Benefits for each alternative are comprised of reductions in structure and content damage, emergency nourishment costs, armoring costs for the state road and land loss as compared to the future without project condition.

5.6.2 Evaluation of Non-Structural Alternative

A total of 19 shorefront houses located within reaches E14 and E15 were evaluated for the nonstructural alternative. Several broad assumptions were made for this analysis, including 100% compliance by property owners and immediate and full implementation of the plan at the start of the project. The goal of this screening level evaluation was to determine if a non-structural measure or plan would a) be economically feasible and b) if it was economically feasible, the magnitude of net benefits would be comparable to those derived from a structural plan. A more refined non-structural analysis would only be conducted if *a* and *b* were found to be true through the initial analysis.

The benefits from the non-structural alternative were calculated based on the assumption that the average future without project condition structure/content damages to these 19 structures (taken from the earlier FWOP Beach-*fx* run) as well as emergency nourishment costs in reaches E14 and E15 would be reduced to zero when the plan is implemented. Costs for the non-structural plan were based on an acquisition cost using the actual land and structure value taken from the Structure Inventory Analysis (Appendix C) for each structure and a demolition cost for each structure. For simplification, an identical demolition/removal and land value acquisition cost was used for every structure and lot. The values were based on the average costs of some demolition/removal activities that took place recently at North Topsail Beach, NC, a $100,000 per lot demolition/removal cost was also applied to the analysis.

5.6.3 Evaluation of Dune Sand Fencing Alternative

Because of the uncertainties regarding how large of a dune would be created by this alternative and how quickly it would be created, several assumptions were made regarding this alternative. First, based on examples of successful sand fencing projects that were implemented at Folly Beach and Myrtle Beach, SC, the creation of a maximum of 2 ft of extra dune via sand capture was considered to be reasonable. This is comparable to the increase in dune height that would be directly added to the Inlet Reach under Alternative 1. Hence, the damage reduction at the Inlet Reach resulting from Alternative 1 was considered the *maximum* damage reduction that could be assumed under the sand fencing alternative. In reality, the damage reduction would likely be less because the dune height increase via windblown sand capture would be much more gradual as compared to directly adding the material through dune construction. Hence, a 90% damage reduction capability as compared to Alternative 1 was initially assumed, although this percentage likely still overestimates the benefit. Costs for this alternative were based on constructing 5,293 ft of fencing and assuming it would need to be completely replaced three times during the 50 year project life.

This initial screening level evaluation was done only to see how this alternative would generally compare to the other alternatives in reaches I1-I4 only. If this initial evaluation revealed that sand fencing in the Inlet Reach could potentially be part of the NED plan, then additional analysis would need to be conducted to better quantify the potential benefits.

5.6.4 NED Comparison of Alternatives

Table 5.3 displays the average annual (AA) net benefits by alternative at each of the individual modeling reaches and a summary of the results by the three planning reaches and the entire study area (AS – Atlantic Reach South, AN – Atlantic Reach North, Inlet Reach). Additional details regarding the calculation of AA net benefits for the alternatives are contained in Appendix B.

Table 5.3: Comparison of average annual net benefits from the 6 alternatives analyzed (FY 2012 interest rate of 4.000%). The highest net benefit for each individual reach is highlighted.

	Average Annual (AA) Net Benefits					
Reach	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**	**Alt 5**	**Alt 6**
I-1	$122,469	$15,882	$222,424	$222,424	$126,686	x
I-2	$57,558	$7,021	$107,922	$107,922	$69,198	x
I-3	$14,156	$2,234	$22,820	$22,820	$18,070	x
I-4	$19,108	$2,416	$33,788	$33,788	$22,476	x
P-1	$9,658	$9,076	$14,436	$17,528	x	x
P-2	-$14,101	$22,457	-$1,185	-$5,344	x	x
E-1	$3,472	$13,017	-$4,736	$9,951	x	x
E-2	$21,848	$22,470	$11,313	$21,978	x	x
E-3	$36,315	$46,123	$26,654	$38,632	x	x
E-4	$81,740	$28,222	$98,315	$93,723	x	x
E-5	$46,145	$27,247	$43,832	$51,606	x	x
E-6	$58,933	$66,524	$53,368	$59,216	x	x
E-7	$18,021	$21,968	$13,804	$16,423	x	x
E-8	$130,028	$104,432	$121,698	$133,471	x	x
E-9	$64,325	$21,001	$91,613	$76,090	x	x
E-10	$135,694	$70,100	$145,367	$151,388	x	x
E-11	$135,277	$67,594	$142,937	$145,952	x	x
E-12	$15,223	$14,570	$7,986	$16,015	x	x
E-13	$60,498	$46,982	$59,520	$61,747	x	x
E-14	$194,443	$113,188	$207,823	$213,951	x	($226,906)
E-15	$126,759	$120,963	$112,765	$130,192	x	($17,935)
Inlet Reach (I1-I4)	**$213,290**	**$27,553**	**$386,954**	**$386,954**	**$236,430**	x
AS Reach (P1-2, E1-E6)	**$244,010**	**$235,136**	**$241,996**	**$287,289**	x	x
AN Reach (E7-E15)	**$880,268**	**$580,798**	**$903,515**	**$945,230**	x	x
Total	**$1,337,568**	**$843,487**	**$1,532,465**	**$1,619,473**	x	x

Alternative 4 yields the highest AA net benefits for each of the planning reaches, the overall study area and the majority of the individual economic reaches. Thus, it is the NED plan. Additionally, based on the results of the initial analysis, it was determined that there were no practicable non-structural alternatives capable of addressing the objectives of this study.

According to ER-1105-2-100, plans should be incrementally justified, meaning that the benefits of each added increment of the plan should exceed the costs of that increment. In the case of this study, these increments are additional lengths of beach, as represented by the 21 modeling reaches used in the analysis. It should be noted that with beachfill projects, small unjustified increments that are bordered by justified reaches on either side may still be included as part of the project, since having short gaps in the project is undesirable and unsustainable from a coastal engineering perspective. All individual modeling reaches, with the exception of P2, are economically justified with positive net benefits solely on the basis of storm damage reduction. Hence, the NED plan is also considered to be incrementally justified.

5.6.5 Comparison of Alternatives by RED, EQ, and OSE Accounts

In addition to the NED comparison shown in the previous section, alternative plans should also be compared based on potential impacts to Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). For the purposes of this comparison, the beachfill alternatives which require groin lengthening are lumped together into one category. Although there could be some differences among these beachfill alternatives as it relates to RED, EQ, and OSE, these differences would be minor and would not affect plan selection. Comparisons in these accounts are thus made between 1) Beachfill with groin extensions, 2) Dune sand fencing with beachfill, 3) Non-Structural alternative and 4) No-Action alternative. These comparisons are presented in Tables 5.4 to 5.6 below.

Table 5.4: OSE comparison of alternatives.

Account: OSE				
	Alternative			
Item	**Beachfill with Groin Extensions**	**Dune Sand Fencing + Beachfill**	**Nonstructural**	**No Action**
Life, Health, and Safety	Significant reduction in stress related to concern of amount of damage and recovery during and after storms. Evacuation would still be required before storm landfall.	Significant reduction in stress related to concern of amount of damage and recovery during and after storms. Evacuation would still be required before storm landfall.	Moderate reduction in stress related to concern of amount of damage and recovery during and after storms. Evacuation would still be required before storm landfall.	No change. Continued stress during damaging storms. Evacuation would still be required before storm landfall.
Community Cohesion	Reduces displacements of all permanent residents and visitors.	Reduces displacements of all permanent residents and visitors.	Permanently displaces oceanfront residents/visitors. Periodic displacement of other residents.	Periodic displacement of all permanent residents and visitors.
Community Growth	Growth trends in population and recreation visitation would continue.	Growth trends in population and recreation visitation would continue.	Permanent population will decrease once oceanfront lots are vacated. Overall recreation visitation would likely decrease as the beachfront erodes away.	Recreation visitation would likely decrease as the beachfront erodes away. Permanent population would likely decrease as lots are abandoned.
Traffic and Transportation	Reduces damages to streets and highways. Minor, short term increase in boat traffic due to dredging operations during initial construction and renourishments.	Reduces damages to streets and highways. Minor, short term increase in boat traffic due to dredging operations during initial construction and renourishments.	Continued risks to streets and highways	Continued risks to streets and highways
Community Growth	Growth trends in population and recreation visitation would continue.	Growth trends in population and recreation visitation would continue.	Permanent population will decrease once oceanfront lots are vacated. Overall recreation visitation would likely decrease as the beachfront erodes away.	Recreation visitation would likely decrease as the beachfront erodes away. Permanent population would likely decrease as lots are abandoned.
Environmental Justice	No effect	No effect	No effect	No effect

Table 5.5: RED comparison of alternatives.

Account: RED				
	Alternative			
Item	**Beachfill with Groin Extensions**	**Dune Sand Fencing + Beachfill**	**Nonstructural**	**No Action**
Sales Volume	Rental sales and tourism sales preserved or increased	Rental sales and tourism sales preserved or increased	Reduced rental market and tourism market	Similar to nonstructural, although likely to occur at a slower pace
Income	Increased recreation visitation may improve the income of service industries and rental properties	Increased recreation visitation may improve the income of service industries and rental properties	Decreased recreation visitation may reduce the income of service industries and rental properties	Similar to nonstructural, although likely to occur at a slower pace
Employment	Seasonal employment may increase due to increased recreation visitation. Temporary increase in employment related to construction activities	Seasonal employment may increase due to increased recreation visitation. Temporary increase in employment related to construction activities	Seasonal employment may decrease due to decreased recreation visitation. Temporary increase in employment related to structure removals	Seasonal employment may decrease due to decreased recreation visitation
Tax Changes	Tax base and property values preserved or increased	Tax base and property values preserved or increased	Loss of tax base due to numerous structures being removed	Loss of tax base when houses are destroyed and cannot be rebuilt

Table 5.6: EQ comparison of alternatives

Account: EQ					
		Alternative			
Item	**Sub-Item**	**Beachfill With Groin Extensions**	**Dune Sand Fencing + Beachfill[1]**	**Nonstructural (E14-E15)**	**No Action**
Marine Environment	**Benthic Resources - Nearshore Ocean**	Short term impacts to benthic macro-invertebrates associated with dredging activities. A small area of sand substrate will be covered by the groin extensions; however, the groins will provide hard substrate for benthic invertebrates	No additional impact	Status quo maintained	Status quo maintained
		Risk of demersal fish entrainment by dredging activities.			
	Benthic Resources - Beach and Surf Zone	Short term and localized impact to surf zone benthic macro-invertebrate community from direct burial and turbidity associated with beach placement of sediment. Invertebrate recruitment will occur relatively quickly post construction.	No additional impact	Short term reduction in surf zone habitat and benthic macro-invertebrate abundance due to erosion, scarping, and scour of beach habitat towards existing infrastructure (i.e. Hwy 174) and long term impacts from the emergency stabilization techniques (i.e. sand bags, revetments) to protect the road.	Long term reduction in surf zone habitat and intertidal benthic macro-invertebrate abundance due to erosion and scour of beach habitat towards existing homes, infrastructure (i.e. roads), and short term stabilization techniques (i.e. sand bags, revetments, etc.). Along the inlet reaches, the status quo would be maintained.
	Turbidity	Short term impacts to adult, larval, and juvenile surf zone fishes from elevated turbidity levels associated with beach placement of sediment and dredging activities.	No additional impact	Short term impacts to adult, larval and juvenile fish from periodic emergency stabilization techniques to protect the road.	Status quo maintained
	EFH-HAPC	Short term impacts to the physiography of borrow areas. The location of the borrow area on an ebb tidal shoal will help to ensure relatively rapid recovery of the borrow area.	No additional impact	Status quo maintained	Status quo maintained
Terrestial Environment	**Beach and Dune**	Short term impacts to portions of the existing dune vegetation during construction of the new dune field. Planting of dune vegetation will mitigate this impact.	Existing dune vegetation will be able to keep pace with the dune accretion.	Long term degradation of beach habitat due to continued erosion of the berm and dune	Long term degradation of beach habitat due to continued erosion of the berm and dune along the atlantic facing reaches. The inlet reaches will continue to accrete and build dune system similar to what is present. The dune system will be more expansive than currently exists. Periodic inundation from storms will allow overwash fans to support bird habitat as well.
		Long term sustainability of dune habitat for nesting sea turtles and other dependent mammal and avian species	No additional impact		
		Short term impacts to ghost crabs and other invertebrates and their beach and dune habitat with long term stability of habitat.	No additional impact	Short term impacts to ghost crabs and their beach and dune habitat from short term resotarion protection measures (ie, beach scraping, sand bags, dune stabilization)	Short term impacts to ghost crabs and their beach and dune habitat from short term protection measures (ie, beach scraping, sand bags, revetments, dune stabilization)
	Shorebird Habitat	Short term impacts to shorebird foraging due to a temporary change in the species and diversity of surf zone macro-invertebrates	No additional impact	Short term reduction in surf zone habitat and benthic macro-invertebrate abundance due to erosion, scarping, and scour of beach habitat towards existing infrastructure (i.e. roads) and short term stabilization techniques (i.e. sand bags).	Long term reduction in surf zone habitat and benthic macro-invertebrate abundance due to erosion and scour of beach habitat towards existing homes, infrastructure (i.e. roads), and short term stabilization techniques (i.e. sand bags).
		Prevention of overwash fan habitat for shorebirds as a result of the constructed dunes.	No additional impact	Short term impacts would result in creation of overwash fan habitat for shorebirds with loss to development in the long term	Short term creation of available overwash fan habitat for shorebirds with loss to development in the long term. The State Park reach will migrate landward. Shorebird foraging habitat should be favorable; however, nests could be compromised by overwash risk.
Threatened and Endangered Species	**Sea Turtles**	Short term decrease in sea turtle nest success associated with changes to the physical chacracteristics of the beach. Construction equipment associated with groin extensions could impede sea turtle ingress to the beach. However, this effect will be minimal as construction will only be on one groin at a time and will proceed along the beach. Therefore, no area will be impacted for a considerable period of time.	Sand fencing design would adhere to the sea turtle requirements. No additional impacts anticipated.	Long term decrease in sea turtle nesting habitat and nest success due to beach erosion, scarping and scouring of the dune.	Long term decrease in sea turtle nest success due to beach erosion, scarping and scouring of the dune. Eventually there may only be a revetment fronting and protecting Hwy 174. In this case, there would be no available nesting habitat for turtles along the atlantic reaches of the Town. However, the inlet reaches would see an increasing beach front as the MHW line moves seaward. The wider beach would likely serve as a site for the turtle volunteers to relocate any nests from the atlantic reaches.
		Long term sustainability of sea turtle nesting habitat due to preservation of the beach berm. The additional groin length will not effect sea turtle nesting/hatchling success.	No additional impact		
		Long term reduction of beach lighting impacts to sea turtles from constructed dune	No additional impact	Risk of increased beach lighting impacts to sea turtles as dune erodes	Risk of increased beach lighting impacts to sea turtles as dune erodes
		Risk of sea turtle entrainment from hopper dredge	No additional impact		
	West Indian Manatee	Minimal threat of collision with whales during dredging and groin construction operations.	No additional impact	Status quo maintained	Minimal impact associated with periodic emergency nourishment which would occur to protect beachfront homes and Hwy 174.
	North Atlantic Right Whale	Minimal threat of collision with whales during dredging and groin construction operations.	No additional impact	Status quo maintained	Minimal impact associated with periodic emergency nourishment which would occur to protect beachfront homes and Hwy 174.
	Atlantic Sturgeon	Minimal risk of Atlantic sturgeon entrainment from hopper dredge.	No additional impact	No additional impact	Minimal risk of Atlantic sturgeon entrainment from dredging during likely periodic emergency nourishment events.
	Red Knot	No impact	No impact	No impact	No impact
	Piping Plover	No impact	No impact	No impact	No impact

Table 5.6 (continued): EQ comparison of alternatives (part 2 of 2)

<table>
<tr><th colspan="6">Account: EQ</th></tr>
<tr><th></th><th></th><th colspan="4">Alternative</th></tr>
<tr><th>Item</th><th>Sub-Item</th><th>Beachfill with Groin Extensions</th><th>Dune Sand Fencing + Beachfill[1]</th><th>Nonstructural</th><th>No Action</th></tr>
<tr><td>Cultural Resources</td><td></td><td>Slight risk of encountering resources associated with beach placement and borrow area dredging, although risk in dredging areas is minimal since they have been surveyed. Long-term protection of any future potential historic resouces that would be affected by natural processes.</td><td>No additional impact or risk</td><td>Even with the removal of the at risk homes in E14 and E15, Hwy 174 will continue to be protected. Source of borrow material will be an issue as it is uncertain where emergency material would be obtained from.</td><td>Potential resources along the Atlantic reaches would continue to be vulnerable to natural processes. Source of borrow material will be an issue as it is uncertain where emergency material would be obtained from.</td></tr>
<tr><td>Water Quality</td><td></td><td>Short term and localized elevated turbidity and suspended solid concentrations offshore and in the surf zone associated with dredging and beach placement as well as groin construction activitites.</td><td>Fewer impacts than the beachfill only alternatives due to elimating need for heavy construction equipment along the inlet reaches.</td><td>Impacts could occur from the removal of the homes and infrastruture (e.g., water, sewer, power lines). Additionally, since emergency actions will still occur to protect Hwy 174, short term impacts to water quality could occur during these actions.</td><td>Since emergency actions will still occur to protect Hwy 174, short term impacts to water quality could occur during these actions. Additionally, certain infrastructure would be at greater risk to being compromised which could affect nearshore water quality (e.g., water, sewer, power lines, etc.).</td></tr>
<tr><td>Air Quality</td><td></td><td>Temporary air pollutant increase associated with dredging and heavy equipment during initial construction and the renourishment events.</td><td>No additional impacts</td><td>Temporary air pollutant increase associated with heavy equipment during structure demolition and removal. Temporary air pollutant increase associated with dredging and heavy equipment during emergency protection events.</td><td>Temporary air pollutant increase associated with dredging and heavy equipment during emergeny protection events.</td></tr>
<tr><td>Noise Quality</td><td></td><td>Temporary noise increase associated with dredging and heavy equipment during initial construction and the renourishment events. These impacts will not affect any property dispropotionately because construction will proceed along the beach.</td><td>No additional impacts</td><td>Temporary noise increase associated with heavy equipment during structure demolition and removal</td><td>Temporary noise increase associated with heavy equipment during periodic emergency protection events.</td></tr>
<tr><td rowspan="3">Recreational and Aesthetic Resources</td><td rowspan="3"></td><td>Improved appearance of beach would enhance recreational experience, and wider berm would increase recreational area. Lengthened groins could exacerbate downdrift scalloping effect that is currently seen along the beachfront.</td><td rowspan="3">There would be no burial of existing vegetation and minimal aesthetic impact to beach goers/homeowners in the inlet reach. Sand fencing may be considered an eyesore to some.</td><td>A more natural appearance along the beach that may be valued more by some users.</td><td rowspan="3">Recreation capacity would decrease as beach erodes. Inlet reach would maintain a high quality beach and dune system as the MHW line moves seaward.</td></tr>
<tr><td rowspan="2">Temporary inconvenience to beach users during initial construction and future maintenance, although these would occur during low visitation months (Winter), when possible</td><td>Recreation capacity would decrease as beach erodes. Emergency protection measures (especially seawalls, revetments) would be a major impediment to beach access as well as an aesthetic eyesore.</td></tr>
<tr><td>Temporary inconvenience to beach users during removal and demolition of structures.</td></tr>
</table>

1: Impacts are only described in this column in terms of effects on the inlet reach. The remaining reaches would receive beachfill with groin extensions and the impacts would be identical to the impacts contained in those columns.

5.7 Plan Selection

5.7.1 National Economic Development Plan

The NED Plan is Alternative 4, as it is the alternative which yields the highest net benefits. The dimensions of the beachfill template for the NED plan are shown in Table 5.7 below. The NED plan also involves lengthening 23 of the existing groins. Table 5.8 shows the amount of required lengthening at these groins and Figure 5.1 shows their locations.

Table 5.7: Beachfill template of the NED plan.

NED Beachfill Template					
Reach	**Length (ft)**	**Berm Width (ft)**	**Dune Height (ft)**	**Dune Width (ft)**	**Dune Slope (X:1)**
I1	1,900	x	14	15	3
I2	2,113	x	14	15	3
I3	645	x	14	15	3
I4	635	x	14	15	3
P1	526	taper	15	15	3
P2	882	13	15	15	3
E1	493	25	15	15	3
E2	869	50	15	15	3
E3	1,226	50	15	15	3
E4	1,748	50	15	15	3
E5	1,257	50	15	15	3
E6	1,230	50	15	15	3
E7	560	63	15	15	3
E8	1,257	75	15	15	3
E9	601	75	15	15	3
E10	1,156	75	15	15	3
E11	616	75	15	15	3
E12	600	75	15	15	3
E13	582	75	15	15	3
E14	1,210	75	15	15	3
E15	1,722	75	15	15	3
SP1	1,000	taper	x	x	x

Table 5.8: Groin extension lengths required for the NED plan.

NED Plan Groin Extension Lengths	
Groin #	**Extension length (ft)**
1	80
2	80
3	90
4	90
5	100
6	100
7	80
8	60
9	50
10	50
11	40
12	40
13	40
14	30
15	20
16	20
17	20
18	20
20	20
21	30
22	30
23	20
24	20
Total	**1,130**

Figure 5.1: Locations of groins to be lengthened under the NED plan.

5.7.2 Identification of NED Renourishment Interval

Beach-fx was used to identify the economically optimized renourishment cycle. The results enable the calculation of a frequency distribution of renourishment cycles which vary between as short as 1 year to as long as 20+ years depending on the sequence and severity of storms encountered in the project life-cycle. For the initial analysis used for developing and screening alternatives, a minimum renourishment trigger of 300,000 cubic yards was used. This volume was selected because it represented approximately a 2:1 placement cost to mobilization cost ratio. A ratio less than 2:1 is generally not considered cost efficient. Subsequently, the NED plan was run at 4, 6, 8, 10, 12, and 16 year renourishment cycles. The renourishment cycle setting in the model determines how often the project is "checked" for a renourishment need. However, in the model, a renourishment will only occur if established triggers are met and each interval has a different trigger based on projected erosion rates. Initial results indicated that the 12 year interval maximized net average annual benefits for the NED plan. However, subsequent revisions to mobilization costs and an update to the interest rate assumption used for the economic calculations caused the renourishment interval to shift from 12 years to 16 years.

Table 5.9 shows the average annual costs, benefits, and net benefits for each of the renourishment cycles, using the FY13 discount rate of 3.75 percent. The average annual costs used for this comparison assume that a mobilization and placement is occurring at each renourishment cycle.

Table 5.9: Comparison of average annual (AA) benefits, costs, and net benefits (3.75% discount rate) for the NED plan at renourishment intervals between 4 and 16 years.

Cycle (yrs)	AA Benefits	AA Placement Cost	AA Mob cost	AA Groin Cost	Total AA Cost	AA Net Benefits
4	$ 2,529,665	$ 453,637	$ 694,910	$ 65,747	$ 1,214,294	$ 1,315,371
6	$ 2,502,654	$ 448,241	$ 480,104	$ 65,747	$ 994,092	$ 1,508,562
8	$ 2,478,624	$ 445,727	$ 372,991	$ 65,747	$ 884,465	$ 1,594,158
10	$ 2,406,228	$ 422,585	$ 313,473	$ 65,747	$ 801,805	$ 1,604,424
12	$ 2,402,784	$ 432,214	$ 266,456	$ 65,747	$ 764,417	$ 1,638,366
14	$ 2,377,453	$ 429,477	$ 248,682	$ 65,747	$ 743,906	$ 1,633,547
16	$ 2,351,072	$ 425,004	$ 213,761	$ 65,747	$ 704,512	$ 1,646,560

Based on the model results, the 16 year renourishment interval was selected because it has the highest projected net average annual benefits.

5.7.3 Locally Preferred Plan (LPP)

No locally preferred plan was pursued.

5.7.4 Recommended Plan

As there is no locally preferred plan, the NED Plan (Alternative 4), is the Recommended Plan.

6. THE RECOMMENDED PLAN*

The purpose of this chapter is to centralize information concerning the Recommended Plan. The details of this plan are discussed in terms of its features, economic costs and benefits, design and construction considerations, operations and maintenance requirements, real estate requirements, any environmental monitoring or mitigation commitments, plan accomplishments and risk and uncertainty.

6.1 Plan Description and Components

The project area and basic features are shown in Figure 6.1. The Recommended Plan consists of the following elements: 1) A 15-foot high (elevation), 15-foot wide dune beginning at the northern end of the project (i.e., Reach E15 – the southern end of Edisto Beach State Park) and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would taper to a 50-foot width over the remaining length of the berm. The width of each end of the berm would taper to match the existing beach profile; 2) Beginning at Reach I4, the dune would transition to a 14-foot high, 15-foot wide dune that extends around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm; and 3) Approximately 1,130 ft of total groin lengthening across 23 of the existing groins.

It is worth noting that the Edisto Beach State Park was initially a part of the study area. However, it was not included in the Recommended Plan because of a lack of existing infrastructure needed to generate enough benefits to justify the cost to protect that portion of beach.

Figure 6.1: Project Area and Basic Features

6.2 Design and Construction Considerations

6.2.1 Initial Construction and Renourishment

The Recommended Plan will require about 924,000 cubic yards of borrow material for initial construction and about 476,000 cubic yards during each renourishment cycle (based on 16 year intervals). During the projected 50 year project life, this would equate to initial construction and 3 renourishment events. A total of about 2.4 million cubic yards of beach-compatible sand would be needed to construct and maintain the project.

The sand would most likely be pumped to the beach by pipeline and shaped using earth-moving equipment. During both initial construction and renourishment events, material between the toe of dune and mean high water line would be tilled to prevent compaction. Due to limitations in the ability of equipment to shape material underwater, the berm is not constructed in the shape of the design berm profile. Instead, the volume of material necessary to create the design berm is pumped out into an initial construction profile (see Figure 6.2).

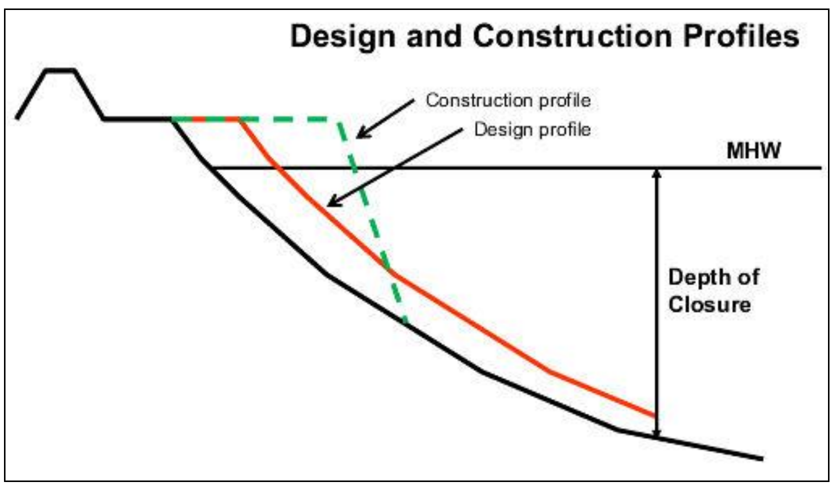

Figure 6.2: Representation of a berm construction vs design profile.

The initial construction profile would extend seaward of the final design berm profile by a variable distance (approximately 100-150 ft) to cover anticipated sand movement during and immediately after construction. Once sand distribution along the foreshore occurs, the adjusted profile should resemble the design berm profile. Initial construction is anticipated to take roughly 120-150 days (4-5 months) using one dredge, and each renourishment is anticipated to take roughly 30 days (1 month) using one dredge.

6.2.2 Dune Vegetation

Project construction may bury existing dune vegetation in some areas, especially along the inlet section of the beach. The dune portions of the project, including the dune foreslope and backslope, would be stabilized against wind losses by planting appropriate native beach vegetation. The total area of necessary dune planting is approximately 29.7

acres. Dune vegetation would be planted during the optimum planting season following dune construction. Plantings will be done in a matrix fashion and consist of native vegetation including, but not limited to sea oats, Bitter panicum, and American beachgrass (Bogue variety) and will follow guidelines from the SCDHEC-OCRM "How to Build a Dune" manual:
(http://www.dhec.sc.gov/environment/ocrm/docs/dunes_howto.pdf).

6.3 Public Parking and Access Requirements

ER 1165-2-130 (Federal Participation in Shore Protection) requires reasonable public parking and access to the beach to be provided by the non-Federal sponsor. These requirements include that the beaches must be available for public use and provide adequate parking and access. As described in paragraph 6.h. of ER 1165-2-130, "Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity", and "public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in the project recommendations or the cost sharing must be based on private use."

Edisto Beach currently meets the necessary parking and access requirements for full federal participation in the recommended plan. The Town has 38 public access points, with an average distance of 400 ft between points. The longest distance between any two access points is 1,425 ft.

As parking and access to the beach are considered items of local cooperation rather than real estate requirements, they are not creditable to the Non-Federal Sponsor as part of the LERRD credits.

6.4 Project Monitoring

In accordance with USACE guidance (Coastal Engineering Manual, Part V, Section 4), a comprehensive monitoring program is planned for the Edisto Beach project to assess and ensure project functionality throughout its design life. Such monitoring supports the design efforts for periodic renourishment and would begin the year following the start of initial construction. Based on the the costs experienced by the non-Federal sponsor since their last renourishment effort, the annual costs for maintenance, repair, replacement and rehabilitation (OMRR&R), including beachfill monitoring over the 50 year project, are estimated to be $83,000 and would include semiannual beach profile surveys through the depth of closure, aerial photography, and an annual monitoring report. These efforts are paid for by the non-Federal sponsor and are not cost shared. Beach profile surveys would allow assessment of beachfill performance and determination of renourishment volume requirements. An aerial photographic record of the beach would further facilitate assessment of the beachfill performance. The annual monitoring report would present the data collected and the corresponding analysis of project performance, including recommendations on renourishment requirements. These reports provide valuable information for future adaptive management opportunities at each renourishment interval.

Shorter-term (5 years) post-construction monitoring to detect any unanticipated adverse impacts of the lengthened groins on downdrift beaches (for Coastal Zone Consistency compliance) is included in the initial construction costs and is cost shared 65 percent Federal and 35 percent non-Federal.

6.5 Dredging and Material Shaping

The following discussion describes the dredging and construction plan.

6.5.1 Dredging Production

Dredging production refers to the average volume transported per day and placed on the shore. The production rate is affected by factors such as dredge plant, material composition, distance transported and weather conditions. This information is used to estimate the cost and construction duration for the project. Due to the proximity of the established borrow area to the area to be nourished, a hydraulic pipeline dredge was used to estimate the cost and construction schedule as this type of dredge is most efficient in this type of project. In addition, since the borrow area is outside the line of demarcation, an ocean certified dredge is required. This limits the choice of dredge plant to a 27" or 30" hydraulic pipeline dredge. A 30" dredge was used to calculate the cost with a production rate of between 21,000 and 22,000 cubic yards per day for both the initial construction and for periodic nourishments.

The use of a hopper dredge is an option for this project. If used, a medium sized hopper dredge with pump-out capability for beach placement would have a production rate of between 11,000 and 12,000 cubic yards per day for both the initial construction and renourishments.

6.5.2 Dredging Window

The USACE will make every effort to adhere to a construction window of November 1 through April 30, which will minimize impacts to sea turtles, fish, shellfish, and infauna, (see USFWS Construction Windows, Appendix A). The use of this window could change due to congressional funding, contractual issues, inclement weather, equipment failure, or other unforeseen difficulties. In this case, endangered species observers would be used.

6.5.3 Recommended Construction Plan

Construction would be by means of either a hydraulic cutterhead dredge or a hopper dredge that would transport the sand through a pipeline. The pipeline will run adjacent to the groins and parallel to the beach. Beach compatible material (sand) from an offshore source would be pumped along the 21,820 linear feet of the project and discharged as slurry. During construction, temporary training dikes of sand would be used to contain the discharge and control the fill placement. Fill sections will be graded by land-based equipment, such as dozers, articulated front-end loaders and other equipment as necessary to achieve the desired beach profile. Equipment would be selected based on its ability to efficiently perform the work and to generate only minimal and acceptable temporary environmental impacts. The sand would be graded, raked and tilled as necessary to comply with recommendations and requirements from regulatory agencies. It is anticipated that initial construction would begin in late-2018 and last approximately 4 to 5 months. Additional details related to the construction plan will be developed during the Preconstruction, Engineering and Design (PED) Phase of this project.

6.6 Real Estate Considerations

The requirements for lands, easements, right-of-ways and relocations, and disposal/borrow areas (LERRDs) include the right to construct a dune and berm system along the shoreline of Edisto Beach within the project limits. Based on project maps, the non-Federal sponsor will be required to acquire approximately 187 Perpetual Beach Storm Damage Reduction Easements over private property where the landward toe of the beach fill material is placed above the mean high water line. Improvements in the project area consist of 80 beach access walkovers throughout the project area and one fishing pier located on the north end of the project. The Storm Damage Reduction Easement does allow owners to construct and maintain walkover structures subject to sponsor approval. Damage to existing structures is not compensable and not creditable as the easement allows for the removal of obstructions within the limits of the easement. The landward construction line of the project will be placed to minimize effects on existing structures and every effort is made during construction to avoid damages to structures. The state of South Carolina claims ownership of all lands seaward of the last line of stable vegetation or all lands below the ordinary mean high water line.

Further details regarding real estate requirements and determinations are provided in Appendix K (Real Estate Plan).

6.6.1 Real Estate Costs

The estimated real estate cost for the project is $989,000. The cost consists of estimated land costs for staging areas and federal and non-federal administrative costs. The cost includes a 26% contingency. Refer to Appendix K for more details regarding the project real estate costs.

6.7 Operation and Maintenance Considerations

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) requirements of the sponsors would consist of project inspection and maintenance. The beachfill monitoring actions are different from the non-Federal sponsors' OMRR&R project inspections and surveillance, which consist of assessing dune vegetation, access facilities, dune crest erosion, trash and debris and unusual conditions such as escarpment formation or excessive erosion, and inspection and repair of the groins. Periodic renourishment and beachfill monitoring (including the semiannual beach profile surveys) are classified as continuing construction, not as OMRR&R. Dune vegetation maintenance includes watering, fertilizing, and replacing dune plantings as needed. Other maintenance is reshaping of any minor dune damage, repairs to walkover structures and vehicle accesses, and grading any large escarpments. Estimated OMRR&R annual costs are $83,000.

6.8 Economics of the Recommended Plan

6.8.1 Recommended Plan— CSDR Benefits

The total expected average annual coastal storm damage reduction benefits (at 3.5% interest rate) for the Selected Plan are estimated to be $2,849,000.

6.8.2 Recommended Plan— Recreation Benefits

Per ER 1105-2-100, the USACE policy on the application of recreation benefits is that "recreation must be incidental in the formulation process and may not be more than fifty percent of the total benefits required for justification. If the criterion for participation is met, then all recreation benefits are included in the benefit to cost analysis." The Recommended Plan is justified based solely on CSDR benefits, therefore all incidental recreation benefits are being claimed for the project.

To determine the recreation benefits of the tentatively selected plan, an economic value must be placed on the recreation experience at Edisto Beach. The value can then be applied to the expected visitation to the project to determine NED recreation benefits. For this report, unit day values (UDV) were used to determine the economic value of recreation at Edisto Beach.

The UDV are determined using a point system that takes into account the following factors: recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental (esthetics) quality. A good deal of judgment is required in the assessment of point values. A group of planning professionals and experts of the study area made independent judgments of the UDV values which were averaged. The differences in the values were applied to the estimated visitation. The difference in the with and without project values of recreation determine the NED recreation benefits. The source of the value of recreation is obtained from the Economic Guidance Memorandum, 13-03, Unit Day Values for Recreation for Fiscal Year 2013. The details of the UDV calculations for this study are contained in Appendix B.

Based on this analysis, the average annual recreation benefit for the Recommended Plan is $573,200.

6.8.3 Recommended Plan— Environmental Benefits

The project would have numerous long term environmental benefits. These include protection and enhancement of dune habitat for various fauna and flora, protection of shorebird nesting, foraging and roosting habitat, and creation of additional sea turtle nesting habitat. Specifically, the project would preserve approximately 13 acres of existing dry beach habitat and would provide protection to approximately 22 acres of dune habitat and 14 acres of maritime forest. After construction, the project would result in a net increase of approximately 24 acres of sea turtle nesting habitat.

6.8.4 Recommended Plan— Total Benefits

Combining the CSDR benefits and the recreation benefits yields a total average annual benefit for the Recommended Plan of $3,467,200.

6.8.5 Recommended Plan—Costs

Determining the economic costs of the Recommended Plan consists of four basic steps. First, project First Costs are computed. First Costs include expenditures for project design and initial construction and related costs of supervision and administration. First Costs also include the lands, easements, and all rights-of-way. Total First Costs are estimated to be $21,129,000 at FY14 price levels. See Table 6.2 for cost breakdown of First Costs. Details regarding determination of this cost are contained in Appendix L (Cost Engineering).

For the economic project cost, the constant dollar cost was used from the Total Project Cost Summary. Neither discounting to present value, nor escalation for anticipated inflation is included in the determination of these costs. As detailed in Appendix B and shown in Table 6.2 and 6.3, the estimated cost is $21,129,000 for initial construction and $10,914,000 for each renourishment. The costs of the renourishments were discounted to the same price level as the initial construction cost to determine total first economic cost. The initial construction cost plus present value of the three renourishment cost were summed to calculate interest during construction. Interest during Construction is computed from the start of Preconstruction Engineering and Design (PED) through the 4 month initial construction period and includes the present value of future planned nourishments. Interest during Construction for the Selected Plan is estimated to be $106,800. The project First Cost plus Interest during Construction represents the Total Investment Cost required to place the project into operation. Total Investment Cost for the Selected Plan (Initial Construction plus renourishments and IDC) is estimated to be $33,252,800.

Next, Scheduled Renourishment Costs are computed. Those costs are incurred in the future for each of the 3 planned renourishments. Neither discounting to present value, nor escalation for anticipated inflation is included in the determination of these costs. As detailed in Appendix B and shown in Table 6.3, the estimated cost is $10,914,000 for each renourishment.

Finally, Expected Annual Costs are computed. Those costs consist of interest and amortization of the Total Investment Cost and the equivalent annual cost of project OMRR&R and beachfill monitoring costs (see sections 6.04 and 6.08). The Expected Annual Costs provide a basis for comparing project costs to expected annual benefits.

Expected Annual Costs for the Selected Plan are estimated to be $1,501,000. A summary of the computations involved in each of these four steps is presented in Table 6.1.

Table 6.1: Recommended Plan annual costs (FY14 price level)

Initial Construction	$ 21,129,000
1st Renourishment	$ 6,294,200
2nd Renourishment	$ 3,629,900
3rd Renourishment	$ 2,093,400
Total First Cost	$33,146,400
Interest During Construction	$106,800
Total Project Cost	$33,252,800
Average Annual First Cost	$1,418,000
O&M	$83,000
Total Average Annual Cost	**$1,501,000**

Table 6.2: Recommended Plan Initial Construction First Costs (FY14 price level)

ACCT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL COST
1	LANDS AND DAMAGES	1	LS	JOB	$785,000	$204,000	$,989,000
10	GROIN EXTENSIONS	1	LS	JOB	$2,120,000	$551,000	$2,671,000
17	BEACH REPLENISHMENT	1	LS	JOB	$12,830,000	$3,336,000	$16,166,000
30	PLANNING, ENGINEERING, AND DESIGN	1	LS	JOB	$839,000	$222,000	$1,061,000
31	CONSTRUCTION MANAGEMENT	1	LS	JOB	$195,000	$51,000	$246,000
	TOTAL FIRST COST				$16,769,000	$4,360,000	$21,129,000

Table 6.3: Recommended Plan Nourishment Cycle Construction Costs (FY14 price levels)

ACCT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL COST
17	BEACH REPLENISHMENT	1	LS	JOB	$7,911,,000	$2,294,000	$10,206,000
30	PLANNING, ENGINEERING, AND DESIGN	1	LS	JOB	$446,000	$132 ,000	$578 ,000
31	CONSTRUCTION MANAGEMENT	1	LS	JOB	$103 ,000	$31,000	$134,000
	TOTAL FIRST COST				$8,460,,000	$2,454,,000	$10,914,,000

6.8.6 Benefit to Cost Ratio

With expected annual benefits of $3,467,200 and average annual costs of $1,501,000, the benefit to cost ratio for the Selected Plan, is 2.3 to 1. The annual net benefits are $1,966,200.

6.9 Evaluation of Risk and Uncertainty

6.9.1 Residual Risks

The proposed beachfill plan would greatly reduce, but not completely eliminate, future storm damages. The Recommended Plan would reduce coastal storm damages to structures and contents by approximately 62 percent over the 50 year period of analysis. The project is designed to reduce damages from storm waves, direct flooding, and erosion. The project would not prevent any damage from back bay flooding; therefore, any ground-level floors of structures, ground-level floor contents, vehicles, landscaping and property stored outdoors on the ground would still be subject to saltwater flooding that flows in through the inlets and the back bay channels. However, back bay flooding is a relatively minor issue in the front rows of the island which is where the benefits of the project are being measured. Because the project is not claiming any benefits beyond the first two rows of the island, damages from flooding to structures past the second row have not been calculated. However, in major storm events, those structures could be subject to back bay flooding. Structures would also continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from severe storm events. Also, the condition of the CSDR project at the time of storm occurrence can affect the performance of the project for that event.

The proposed beachfill would reduce damages but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project purpose is storm damage reduction and the berm-and-dune is not designed to prevent loss of life. Loss of life is prevented by the existing procedures of evacuating the barrier island completely, well before expected hurricane landfall and removing the residents from harm's way. The erratic nature and unpredictability of hurricane path and intensity require early and safe evacuation. That policy should be continued both with and without the storm damage reduction project.

6.9.2 Risk and Uncertainty in Economics

The Beach-*fx* model accounts for uncertainty in the economic evaluations through the use of Monte-Carlo simulations to model future damages. The average annual damages reported in this study are based on the damages averaged across 300 life cycles, with each life cycle experiencing a different suite of storms during the period of analysis. Additionally, uncertainty is accounted for in the damage functions that are used to determine the amount of damage incurred to a structure and its contents from a given storm. Each structure type is assigned a minimum, maximum, and most likely damage function, meaning that the amount of damage experienced by a structure due to a specific amount of erosion or water depth can vary between life cycles. An example of one of these damage functions is shown in Figure 6.3 below, the entire suite of damage functions used in this study are contained in Appendix B.

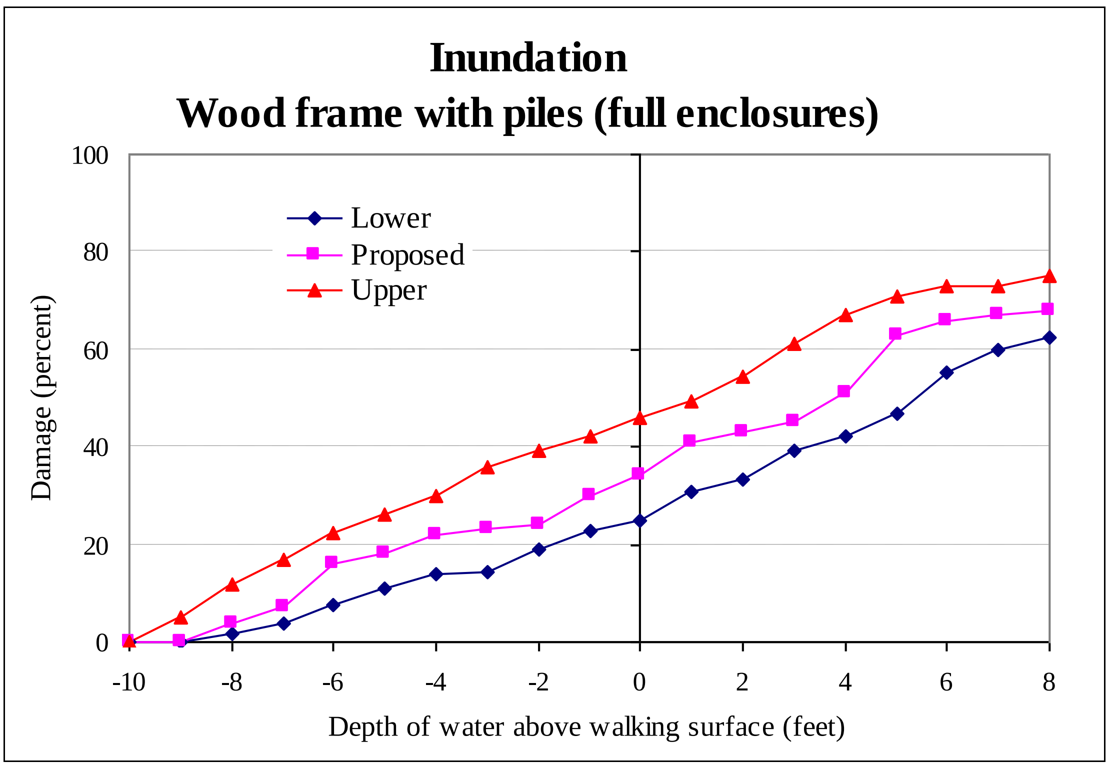

Figure 6.3: Damage functions used to measure erosion damage to fully enclosed structures with piles.

6.9.3 Risk and Uncertainty in Project Costs

In order to account for uncertainties in the final project costs, which could result from a variety of factors, all costs include an appropriate contingency on top of the actual estimated cost. For this project, a contingency of 26 percent is currently being utilized for initial construction. Due to escalating costs from fuel above escalation indices a contingency of 29 percent is used for future renourishment cycles (Appendix L).

The analysis of benefits and costs is based on average annual values. One of the sources of uncertainty in these estimates is driven by the number of storm events which might occur over the life of the project. It is plausible that the next 50 years could see more or less than the average number of storms. A higher number of storms would be expected to have a positive effect on net project benefits because the additional benefits accrued with additional storms would exceed the additional costs. To evaluate the potential impacts of this uncertainty on project cost, a sensitivity analysis was conducted to evaluate a future scenario where more storms than the average occur. Under this scenario, additional renourishments and greater total volumes of renourishments could be required over the life of the project as a result of the damage resulting from an above average number of storms. For this sensitivity analysis, it was assumed that four renourishments at a cost of $10 million each (FY14 dollars) would be required instead of three. Results of the analysis are summarized in Table 6.4, below. The results indicate that average annual cost increases from $1,501,000 to $1,724,300. This represents a change of about 15%. Based on these results, the sensitivity of the project costs to the uncertainty in the occurrence of storms is relatively low.

Table 6.4 Cost risk analysis summary (FY 2014 price level)

Initial Construction	$ 21,129,000
1st Renourishment	$ 7,222,700
2nd Renourishment	$ 4,779,900
3rd Renourishment	$ 3,163,200
4th Renourishment	$ 2,093,400
Total First Cost	$38,388,200
Interest During Construction	$110,300
Total Project Cost	$38,498,500
Average Annual First Cost	$1,641,300
O&M	$83,000
Total Average Annual Cost	$1,724,300

6.9.4 Risk and Uncertainty in Borrow Availability

An estimated 2.4 million cubic yards of borrow material would be needed over the 50 year project. The required project volumes are well below the amount of compatible material (about 7.2 mcy) that has currently been estimated to be available at the offshore borrow location. The overall project is anticipated to utilize only about 25% of the total volume available at the borrow site. Therefore, the risk of running out of material over the 50 year project life is minimal, even if further investigations during PED reveal that less material than originally estimated is actually available at the borrow site.

6.9.5 Risk and Uncertainty in Sea Level Rise Assumptions

Per EC 1165-2-212, a sensitivity analysis on the economics of the Recommended Plan using low (Modified NRC Curve 1) and high (Modified NRC Curve 3) accelerated sea level rise rates was conducted. A full discussion of the accelerated sea level rise rates and how they were calculated for the project area is contained in Appendix A.

The Recommended Plan was re-run through Beach-*fx* using historical, Curve1, and Curve 3 sea level rise rates. Figure 6.4 displays how the average annual project costs, benefits, and net benefits change under each of these three scenarios. As shown in the figure, as sea level rise accelerates, the project costs increase. However the project benefits increase even more (because with higher sea level rise structures would be subject to even greater potential damages in the FWOP condition), meaning that the project net benefits would actually be the highest under the Curve 3 sea level rise scenario.

6.9.6 Risk and Uncertainty in Coastal Storms

Uncertainty regarding the number and intensity of future storms in the area is handled through the Beach-*fx* Monte Carlo simulation, whereby each lifecycle randomly selects (base on actual probabilities of storm occurrence) a suite of storms that will hit the project area over a given lifecycle. The storm suite is selected from a group of 468 plausible storms, as detailed in Appendix A. However, while the storms are randomly selected, the effect of any given storm on a given shore profile is determined by the SBEACH software, and is fixed.

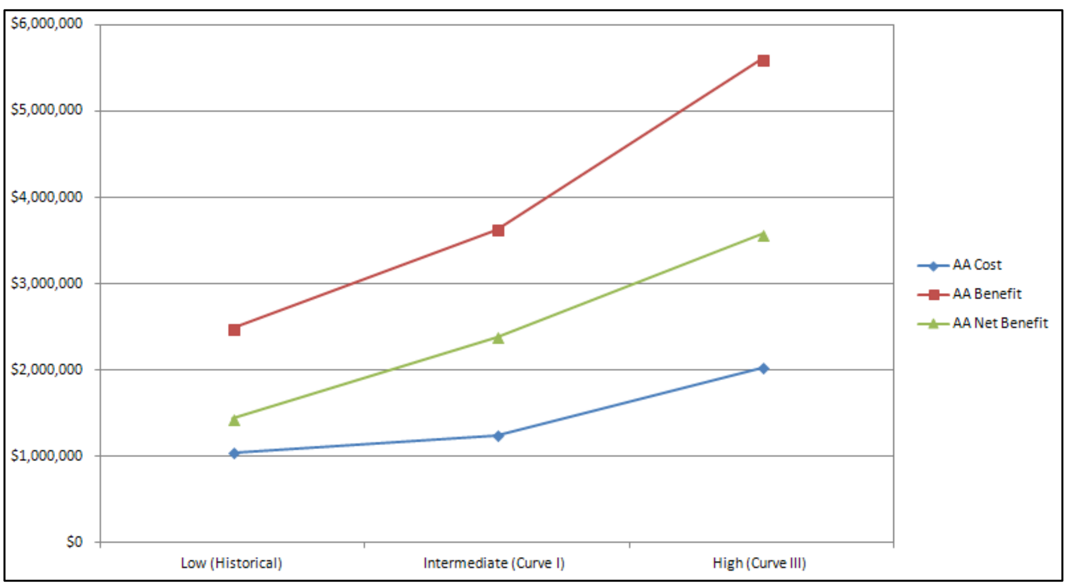

Figure 6.4: Changes in average annual costs, benefits, and net benefits (3.75% interest rate) under three different sea level rise scenarios.

7. ENVIRONMENTAL EFFECTS*

This section describes the probable effects of the proposed project and associated actions on significant environmental resources within the proposed beach placement locations and within the borrow areas. Table 5.6 earlier in the report provides a comparative analysis of environmental impacts associated with beach fill, non-structural, and no action alternatives.

7.1 Dredging Methods

Sediment will be dredged from the borrow areas and placed on the project area beaches utilizing hydraulic dredges. Hydraulic dredges are characterized by their use of a pump to dredge sediment and transport a slurry of dredged material and water to identified discharge areas along the beach. The ratio of water to sediment within the slurry mixture is controlled to maximize efficiency. The main types of hydraulic dredges are cutterhead suction and hopper dredges, and dredging for this project could occur using either dredge plant. Therefore, potential impacts to specific resource categories evaluated throughout this section will consider both of these actions as appropriate. The following paragraphs discuss the specific operating conditions of these dredge types.

7.1.1 Cutterhead Suction Dredge

Cutterhead dredges are designed to handle a wide range of materials, including sands. They are used for new work and maintenance in projects where suitable placement and disposal areas are available and operate in an almost continuous dredging cycle resulting in maximum production, economy, and efficiency. Cutterhead dredges are capable of dredging in shallow or deep water and have accurate bottom and side slope cutting capability. Limitations of cutterhead dredges include relative lack of mobility, long mobilization and demobilization, and inability to work in high wave action and currents.

Cutterhead dredges are rarely self-propelled and; therefore, must be transported to and from the dredge site. Cutterhead dredge size is based on the inside diameter of the discharge pipe which commonly ranges from 6” to 36”. The pipeline associated with CSDR projects is often larger in diameter. They require an extensive array of support equipment including pipeline (floating, shore, and submerged), boats (crew, work, survey), barges, and pipe handling equipment. The cutterhead is a mechanical device that has rotating teeth to break up or loosen the bottom material so that it can be sucked through the dredge.

Moving cutterhead suction dredges is a slow process; therefore, efficiency is maximized by dredging in localized areas with deeper dredge cut volumes where the cutterhead is buried in the bottom. A cutterhead removes dredged material through an intake pipe and then pushes it out the discharge pipeline directly into the placement/disposal site. Most, but not all, cutterhead dredging operations involve upland placement/disposal of the dredged material. Therefore, the discharge end of the pipeline is connected to shore pipe.

When effective pumping distances to the placement/disposal site become too long, a booster pump is added to the pipeline to increase the efficiency of the dredging operation.

7.1.2 Hopper Dredge

The hopper dredge, or trailing suction dredge, is a self-propelled ocean-going vessel with a section of the hull compartmented into one or more hoppers. Fitted with powerful pumps, the dredges suck sediment from the channel bottom through long intake pipes, called drag arms, and store it in the hoppers. Normal hopper dredge configuration has two dragarms, one on each side of the vessel. A dragarm is a pipe suspended over the side of the vessel with a suction opening called a draghead for contact with the bottom. Depending on the hopper dredge, a slurry of water and sediment is generated from the plowing of the draghead "teeth," the use of high pressure water jets, and the suction velocity of the pumps. The dredged slurry is distributed within the vessel's hopper allowing for solids to settle out and the water portion of the slurry to be discharged from the vessel during operations through its overflow system. When the hopper attains a full load, dredging stops and the ship travels to a pump-out location where the dredged material is re-slurried within the hopper and pumped out to the beach disposal area through a series of shore-pipe.

Hopper dredges are well suited to dredging sand. They can maintain operations safely, effectively, and economically in relatively rough seas and because they are mobile, they can be used in high-traffic areas. They are often used at ocean entrances and offshore, but cannot be used in confined or shallow areas. Hopper dredges can move quickly to disposal sites under their own power (maximum speed unloaded - ≤ 17 knots; maximum loaded - ≤ 16 knots), but since the dredging stops during the transit to and from the disposal area, the operation loses efficiency if the haul distance is too far. Based on the review of hopper dredge speed data provided by the USACE's Dredging Quality Management (DQM) program, the average speed for hopper dredges while dredging is between 1-3 knots, with most dredges never exceeding 4 knots. Hopper dredges also have several limitations. Considering their normal operating conditions, hopper dredges cannot dredge continuously. The precision of hopper dredging is less than other types of dredges; therefore, they have difficulty dredging steep side banks and cannot effectively dredge around structures. In order to minimize the risk of incidental takes of sea turtles, the USACE requires the use of sea turtle deflecting dragheads on all hopper-dredging projects where the potential for sea turtle interactions exist.

7.2 Beach Fill Placement Activities

The history of beach fill placement activities, including both disposal of navigation maintenance dredged material and shore protection projects throughout the South Carolina coastline consists of many actions performed by local, State, and Federal entities. The following paragraphs discuss the construction activities associated with placement of sediment on the beach for the purpose of CSDR:

7.2.1 Construction Operations

For hydraulic pipeline and hopper dredge operations that include the placement of dredged material on the beach, a pipeline route is extended from the dredge plant to the beach fill placement location. Prior to the commencement of dredging, shore pipe is mobilized to the beach in segments of varying sizes in length and diameter. The mobilization process usually requires the use of heavy equipment to transport and connect pipe segments from the beach access point to the designated placement area. The placement of shore pipe is generally on the upper beach, away from existing dune vegetation and seaward of the toe of the primary dune. The width of disturbance area required to construct the pipeline route varies depending on the size of pipe used for the project. Site context and environmental features are considered for each project so that construction activities are confined to areas with minimal impact to the environment. Once the heavy equipment and pipe is on the beach and the pipes are connected, heavy equipment operation is generally confined to the vicinity of the mean high water line, away from dune vegetation on the upper beach. Within the active disposal area, heavy equipment operates throughout the width of the beach in order to manage the outflow of sediment and construct target elevations for the appropriate beach profile.

The beach building process typically involves the use of bulldozers and sometimes backhoes to distribute the sediment as it falls out of suspension at the outflow end of the pipeline. The sediment slurry is diffused as it is released from the terminal pipe in order reduce the flow velocity onto the beach and minimize the risk of creating scour holes. Dikes are constructed on one or two sides of the effluent area to allow for extended settlement time of suspended solids in order to reduce turbidity levels in the near shore environment.

7.3 Wetlands

The proposed borrow area for the project is between 1.5 and 2.5 miles offshore; therefore, dredging operations would not be expected to adversely affect wetlands of the study area. Beach nourishment operations would not be expected to adversely affect wetlands either.

7.4 Sand and Mud Flats

Neither the dredging operation nor the beach placement will have any adverse effects on sand and mud flats near the project vicinity. The South Edisto River inlet flats could experience faster accretion than at present due to the greater updrift supply of sand. If this occurs than the flats would be expanded. Since direct burial will not occur there are no concerns about the recolonization/recovery of the flats.

7.5 Nearshore Ocean

Oceanic nekton are active swimmers and are distributed in the relatively shallow oceanic zone. Any entrainment of adult fish, and other motile animals in the vicinity of the borrow area during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas. Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi 1983). Impacts to the nekton community of the nearshore ocean will be temporary and minor.

7.6 Maritime Shrub Thicket

The majority of maritime shrub thicket (maritime forest) occurs along the inlet reach of the proposed project and at the Edisto Beach State Park reach. The upland construction limit of the project avoids impacting this valuable and rare habitat.

7.7 Beach and Dune

The proposed project consists of a 21,820 ft long main beachfill, with berm and dune construction along the entire length. Where existing dunes are less than 14 ft elevation, the constructed dune will cover existing vegetation. All constructed dunes will be vegetated with native dune grasses to offset any impacts to existing vegetation. The constructed beach berm and dune profile would result in a seaward movement of the shoreline.

Project construction and periodic nourishment would not be expected to have an adverse effect on wildlife found along the beach or that uses the dune areas. However, short-term transient effects could occur to mammalian species using the dune and fore-dune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during construction and periodic nourishment events. Vegetation of constructed dunes would be expected to increase the amount and quality of habitat available to mammalian and avian species dependent on those areas and would offset impacts to existing vegetation.

Project construction would result in disturbance and removal of some of the existing vegetation along the seaward side of the existing dune. However, construction would be followed by measures designed to stabilize the constructed dunes. Dune stabilization would be accomplished by planting vegetation on the dune during the optimum planting seasons and after the berm and dune construction. Representative native planting stocks may include sea oats (Uniola paniculata), American beachgrass (Ammophila breviligulata), and panic grass (Panicum amarum). The vegetative cover would extend from the landward toe of the dune to the seaward intersection with the storm berm for the length of the dune. Sea oats would be the predominant plant with American beach grass and panic grass as a supplemental plant. Planting would be accomplished during the season best suited for the particular plant. Periodic nourishment of the project would involve placing material along the berm and dune as needed. Additional dune planting during renourishment would occur if necessary. Therefore, minimal impacts to dune vegetation would be expected from implementing the project.

Using GIS, it was determined that roughly 5.96 acres of dune habitat along the Atlantic facing shoreline and 7.63 acres along the inlet facing shoreline will be impacted by direct burial during the construction process (e.g., dune fell within project footprint). These impacts will be offset by the planting of native vegetation along the entire length of the constructed dune. The use of native vegetation will provide an environmental enhancement to the beach front while helping to stabilize the constructed dune. Plantings will be completed in a matrix fashion and consist of native vegetation including but not limited to sea oats, Bitter panicum, and American beachgrass (Bogue variety). While the analysis shows that approximately 14 acres of dune habitat will be impacted, there are extensive dunes adjacent to the inlet portion of the project area, which will aid in the establishment of a healthy dune community on the constructed dune system.

The placement of sediment along the study area would be expected to directly affect ghost crabs through burial (USACE 2004, Lindquist and Manning 2001, Peterson et al. 2000, Reilly and Bellis 1983). Because ghost crabs are vulnerable to changes in sand compaction, short-term effects could occur from changes in sediment compaction and grain size. According to Hackney et al. (1996), management strategies are recommended to enhance recovery after beach nourishment are (1) timing activities so that they occur before recruitment and, (2) providing beach sediment that favors prey species and burrow construction. Ghost crabs are present on the project beach year-round (Hackney et al. 1996), therefore, direct effects from burial could occur during the proposed construction time frame of December 1 to March 31. However, the peak larval recruitment time frame would be avoided and, because nourished sediment will be compatible with the native beach, it is expected that ghost crab populations would recover within one year post-construction (USACE 2004, Lindquist and Manning 2001, Peterson et al. 2000, Reilly and Bellis 1983). Because ghost crabs recover from short-term effects and because recommended management strategies to avoid long-term effects would be followed, no significant long-term impacts to the ghost crab population would be expected.

7.8 Surf Zone Fishes

The surf zone is a dynamic environment, and the community structure of organisms that inhabit it (e.g., surf zone fishes and invertebrates) is complex. Representative organisms of both finfish and the invertebrate inhabitants they consume exhibit similar recruitment periods, typically spring through summer. The anticipated construction time frame for the project is between November 1 and April 30, which would avoid a majority of the peak recruitment and abundance periods of surf zone fishes and their benthic invertebrate prey source. Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for finfish species. However, during disposal operations, the dredged material slurry is managed through the construction of dikes to allow for a larger settling time and reduction of turbidity loads into the surf zone environment. Even though turbidity reduction practices are used, feeding activities of some species could be interrupted in the immediate area of beach sand placement. These affects will be temporary and minor and should return to normal shortly after dredging concludes.

7.9 Anadromous Fishes

Similar to other fish, anadromous fishes are active swimmers, not at the mercy of the currents. Any entrainment of adult fish, and other motile animals in the vicinity of the borrow area during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas. Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi 1983). Since these species spawn in freshwater (except for the catadromous American eel) the potential for egg and larval entrainment is minimal.

7.10 Benthic Resources

7.10.1 Beach Zone

Beach nourishment may have negative effects on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. While beach nourishment may produce negative effects on intertidal macrofauna, they would be localized in the vicinity of the nourishment operation.

In a 1999 Environmental Report on the use of Federal offshore sand resources for beach and coastal restoration, U.S. Department of Interior, Bureau of Ocean Energy Management (BOEM) (Previously Minerals Management Service (MMS) provided the following assessment of potential effects on beach fauna from beach nourishment:

> *"Because benthic organisms living in beach habitats are adapted to living in high energy environments, they are able to quickly recover to original levels following beach nourishment events, sometimes in as little as three months (Van Dolah et al. 1994, Levisen and Van Dolah 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of a lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al. 1996), the vast majority of beach habitats are re-colonized by the same species that existed before nourishment (Van Dolah et al. 1992, Nelson 1985, Levisen and Van Dolah 1996, Hackney et al. 1996)."*

Construction and subsequent nourishments will occur during the winter months when possible. Because of this, beach nourishment would therefore be completed before the onshore recruitment of most surf zone fishes and invertebrate species. To assure compatibility of nourishment material with native sediment characteristics and minimize impacts to benthic invertebrates from the placement of incompatible sediment, all sediment identified for use for this project has gone through compatibility analysis to assure compatibility with the native sediment. Historically, SC beaches have seen rapid recovery (one to six months) of beach sediment characteristics and infauna (Bergquist et. al, 2008; Van Dolah Et al., 1992; Van Dolah et. al., 1994; Jutte et al., 1999). In summary, only temporary effects on intertidal macrofauna in the immediate vicinity of the beach nourishment project would be expected as a result of discharges of nourishment material on the beach.

7.10.2 Nearshore Ocean

The post-dredge infilling rate and quality and type of the material are contributing factors to the recovery of the area dredged. A change in the hydrologic regime as a consequence of altered bathymetry may result in the deposition or scour of fine sediments, which may result in a layer of sediment that differs from the existing substrate. Benthic organisms within the defined borrow area dredged for construction and periodic nourishment would be lost. However, recolonization by opportunistic species would be expected to begin soon after the dredging activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Rapid recovery would be expected from recolonization from the migration of benthic organisms from adjacent areas and by larval transport. SCDNR has recommended the use of ebb-tidal shoal complexes on the downdrift end of beaches in order to assist in the faster recovery of the borrow area. In addition, if a hopper dredge is used at the borrow area, impacts will likely be minimized (SCDNR, 2009a).

7.11 Hardbottom Resources

Results of a cultural and hardbottom resource survey performed in 2013 determined that there were no areas of hardbottom habitat located within the proposed borrow area and a 0.25 mile buffer surrounding the area. Hardbottom resources will not be affected by the proposed project.

7.12 Essential Fish Habitat

The proposed project will involve impacts to marine and estuarine water column and unconsolidated bottom. The overall magnitude of these impacts is expected to be short term and minor under the dredging operations to be employed. Recolonization of both the borrow area and beach face are expected to occur within 1 to 2 years, or faster. The use of best management practices should limit the extent and duration of turbidity impacts, which will temporarily alter fish dynamics in the vicinity of the construction activities. Overall, the impacts to EFH and HAPC related to the proposed beach project at Edisto Beach will be temporary and will not result in significant effects on managed species. A summary of EFH categories and potential impacts from the project is shown in Table 7.1. For more details on EFH please see Appendix G.

Table 7.1: EFH categories and potential project impacts.

Habitat Type	Habitat Name	Project Area	Potential Impacts	
			Dredging at borrow site	Beach Placement
Estuarine	Estuarine Emergent Wetland (tidal marsh)	Yes	No	No
Estuarine	Estuarine Scrub/shurb mangroves	No	No	No
Estuarine	Sea grass	No	No	No
Estuarine	Oyster reefs and shell banks	Yes	No	Yes
Estuarine	Intertidal flats	Yes	No	No
Estuarine	Palustrine emergent and forested wetland	No	No	No
Estuarine	Aquatic beds	No	No	No
Estuarine	Estuarine Water Column	Yes	No	Yes
Estuarine	Unconsolidated Bottom	Yes	Yes	Yes
Marine	Live/Hard bottoms	No	No	No
Marine	Coral and coral reefs	No	No	No
Marine	Artificial/manmade reefs	No	No	No
Marine	Sargassum	No	No	No
Marine	Surf Zone	Yes	No	Yes
Marine	Marine water column	Yes	Yes	Yes

7.13 Avian Species

Although the project area is heavily developed and sustains recreational use, migratory shorebirds can still use the project area for foraging and roosting habitat. Beach nourishment activities could temporarily affect the roosting and intertidal macro-fauna foraging habitat; however, recovery often occurs within one year if nourishment material is compatible with native sediments. Since shorebirds focus their foraging in intertidal areas, and the amount of intertidal habitat will not be reduced by the project, there will be no impact to foraging habitat. Similarly, since shorebirds roost in areas of high beach as well as marsh, and the project will result in an increase in dry beach habitat, the project will benefit shorebird roosting. Additionally, because (1) areas of diminished prey base are temporary and isolated, (2) recovery occurs within one year if material is compatible, and (3) adjacent unaffected foraging and roosting habitat would be available throughout the project, it would not be expected that foraging and roosting habitat would be significantly affected by implementing the proposed action.

7.14 Coastal Barrier Resources

As stated earlier in the report, the Town of Edisto Beach lies between two Coastal Barrier Resources Systems (CBRS) units, the Edisto Complex Unit (M09 and M09P) and the Otter Island Unit (M10) (Figure 3.9). Unit M09P is an “Otherwise Protected Area” (OPA) and is not a part of the CBRS. Through coordination with the USFWS it has been determined that the proposed borrow site that would be used for a nourishment project is not located in the CBRS (USFWS, letter dated Jan 27, 2010). Additionally, the proposed project would not be expected to cause any additional erosion concerns for Otter and Pine Islands (the two resources within ACE Basin that are in the area of potential effects). Research by Coastal Science and Engineering has shown that no erosion has occurred south of Edisto Beach as a result of the relatively short groins on the beach (CSE 2013).

Since the amount of proposed lengthening of the southernmost groins is minimal (~20 – 60 feet) and the groin cells will be completely filled with sand, there will be no appreciable erosion to Otter or Pine Islands.

7.15 Threatened and Endangered Species

The following subsections present a summary of the effect determination for each threatened or endangered species relevant to this project and the summary of protective measures from the Biological Opinion.

7.15.1 Sea Turtles

The project would preserve approximately 13 acres of existing dry beach habitat and it would provide protection to approximately 22 acres of dune habitat and 14 acres of maritime forest. After construction, the project would result in a net increase of approximately 24 acres of sea turtle nesting habitat.

Loggerhead sea turtle nesting activities have been recorded within the project area. The placement of sand and construction activities associated with the placement of that sand on this reach of beach could adversely affect any existing sea turtle nests and sea turtles attempting to nest. The extent of nesting on Edisto Island beach is somewhat irregular when compared with many other beaches along the coast; however, it does average approximately 14 nests per mile (despite the high erosion rate and resultant damage). Placement of the dredged material is anticipated to occur during the months of November through April; however, it is possible that the start of construction work would be delayed until nesting season or that completion of the project would be delayed and construction will extend into the nesting season. If any construction work occurred during sea turtle nesting season, the following precautions would be taken to minimize the effects to sea turtles:

- If any construction of the project occurs during the period between May 1 and September 15, the dredging contractor will provide nighttime monitoring along the beach where construction is taking place to ensure the safety of female turtles attempting to nest. Cease construction activities if a sea turtle is sighted on an area of beach scheduled for fill until the turtle returns to the ocean. A buffer zone around the female will be imposed in the event of an attempt to nest.
- If any construction of the project occurred during the period between May 1 and September 15, daily nesting surveys would be conducted starting either May 1 or 65 days prior to the start of construction, whichever is later. These surveys would be performed between sunrise and 9:00 A.M. and will continue until the end of the project, or September 15, whichever is earlier. Any nests found in the area that would be impacted by construction activities would be moved to a safe location. The nesting surveys and nest relocations would only be performed by people with a valid South Carolina DNR license.

- If all construction occurs during the period September 15 to April 30, no nesting surveys will be performed.
- For construction activities occurring during the period May 1 through October 31, staging areas for equipment and supplies would be located off of the beach to the maximum extent possible.
- For construction activities occurring during the period May 1 through October 31, use of heavy equipment would be limited to the area undergoing renourishment or dune building and shaping.
- For construction activities occurring during the period May 1 through October 31, all on-beach lighting associated with the project would be limited to the minimum amount necessary around active construction areas to satisfy Occupational Safety and Health Administration (OSHA) requirements.
- For construction activities occurring during the period May 1 through October 31, use predator proof trash receptacles to minimize presence of species that prey upon hatchlings.
- The USFWS and SCDNR must be notified immediately if a sea turtle, nest, or hatchlings are impacted by the construction.
- For construction activities occurring during the period May 1 through October 31, hold a preconstruction meeting between the contractor, USFWS, and SCDNR
- If a hopper dredge is used, in order to minimize the risk of incidental takes of sea turtles, the USACE requires the use of sea turtle deflecting dragheads on all hopper-dredging projects where the potential for sea turtle interactions exist.

Immediately after completion of the project, the USACE will perform tilling in order to reduce compaction associated with newly placed sand. Visual surveys for escarpments along the project area will be made immediately after completion of the project and prior to May 1 for 3 subsequent years, if needed. Results of the surveys will be submitted to the USFWS prior to any action being taken. Since the project should not occur during the sea turtle nesting season, escarpment leveling will not be performed until immediately prior to the nesting season. The USFWS will be contacted immediately if subsequent reformation of escarpments exceeding 18 inches in height for a distance of 100 feet occurs during nesting and hatching season. This coordination will determine what appropriate action must be taken. An annual summary of escarpment surveys and action taken will be submitted to the USFWS.

Adherence to the above precautions should minimize the effects to nesting loggerhead sea turtles and emerging loggerhead sea turtle hatchlings. The monitoring and relocation program will minimize potential adverse affects to nesting sea turtles. Completion of the project will recreate lost habitat and protect existing turtle nesting habitat as well as the structures on the island. However, because of the possibility of missing a sea turtle nest during the nest monitoring program or inadvertently breaking eggs during relocation, it has been determined that the proposed project may adversely affect the loggerhead sea turtle for beach placement activities. This determination has been made per USFWS ESA Consultation Handbook and states that, "in the event the overall effect of the proposed action is beneficial to the listed species, but also is likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species." Since leatherback nesting has been documented in the past but is not common, the proposed project may affect but is not likely to adversely affect the leatherback sea turtle for beach placement activities. There will be no effect on all other sea turtle species for beach placement activities.

Should the schedule necessitate work during the sea turtle nesting time period, in order to minimize impacts to nesting sea turtles a beach monitoring and nest relocation program for sea turtles will be implemented. This program will include daily patrols of sand placement areas at sunrise, relocation of any nests laid in areas to be impacted by sand placement, and monitoring of hatching success of the relocated nests. Sea turtle nests will be relocated to an area suitable to both the USFWS and the SCDNR. The Town of Edisto Beach will perform any necessary maintenance of beach profile (tilling and shaping or knocking down escarpments).

During construction of this project, staging areas for construction equipment will be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use shall be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all dredge pipes that are placed on the beach will be located as far landward as possible without compromising the integrity of the existing or reconstructed dune system. Temporary storage of pipes will be off the beach to the maximum extent possible. Temporary storage of pipes on the beach will be in such a manner so as to impact the least amount of nesting habitat and will likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline will be recommended as the method of storage).

Dredging operations have also been known to negatively impact sea turtles; these effects are the result of hopper dredges and not hydraulic cutterhead dredges. Therefore, the proposed dredging activity will have no effect on sea turtles if performed by a cutterhead dredge and is likely to adversely affect several species of sea turtle (i.e., loggerheads, greens, and Kemp's ridleys) if performed by a hopper dredge. Since all in water dredging activities are addressed and covered by reference in the 1997 NMFS SARBO, no additional sea turtle consultation with NMFS is required.

During construction of this project, all on-beach lighting associated with the project will be limited to the immediate area of active construction only. Such lighting will be shielded, low-pressure sodium vapor lights to minimize illumination of the nesting beach and nearshore waters. Red filters will be placed over vehicle headlights (i.e., bulldozers, front end loaders). Lighting on offshore equipment will be similarly minimized through reduction, shielding, lowering, and appropriate placement of lights to avoid excessive illumination of the water, while meeting all U.S. Coast Guard and OSHA requirements.

Shielded, low pressure sodium vapor lights will be highly recommended for lights on any offshore equipment that cannot be eliminated.

USFWS has concurred with the USACE Biological Assessment effect determinations and has issued an Incidental Take Statement as per section 7(b)(4) and section 7(o)(2) of the ESA provided that certain terms and conditions are met. The terms and conditions are outlined within Appendix M (USFWS Biological Opinion), and will be implemented upon construction of this project. Formal consultation will need to be reinitiated if critical habitat for the Northwest Atlantic population of the loggerhead sea turtle is officially designated.

7.15.2 Piping Plovers

All construction activities will avoid USFWS designated critical habitat areas. Direct loss of nests from the disposal of the dredged material should not occur, as the species is not known to nest in the project area. Potential piping plover foraging habitat on the beach during the winter months may be altered as beach food resources may be affected by placement of material along the project area, however they are not known to occur on Edisto Beach. Such disruptions will be temporary and of minor significance. Since only a small portion of the foraging habitat is directly affected at any point in time during pump out and adjacent habitat is still available, overall direct loss of foraging habitat will be minimal and short-term.

Any shorebird habitat area originally existing along the length of the island has suffered severe erosion. Dredged material will likely help restore the habitat lost to erosion in this area while the protective berm is being constructed. The placement of dredged material into the intertidal zone will provide additional foraging habitat for the wintering piping plover. For these reasons, it has been determined that the proposed project not affect the piping plover. Additionally, since the project is far enough removed from areas of Piping Plover Critical Habitat, it will have no affect on critical habitat.

7.15.3 Red Knot

Placement of the dredged material is anticipated to occur during the winter months. Direct loss of nests from the disposal of the dredged material will not occur, since the species does not nest in the project area. Red knot foraging distribution on the beach during the spring and fall migrations and winter months may be altered as beach food resources may be affected by placement of material along the project area; however, this impact is expected to be minor since most birds use areas outside of the immediate project area. In addition, previous studies of beach nourishment projects have shown a short term impact to the beach and surf zone infaunal community with a recovery within six months (SCDNR, 2009b). Due to the expected short term impacts to the beach infaunal community and since the number of red knots in the immediate project area is limited, it has been determined that the proposed project may affect but is not likely to adversely affect the rufa red knot.

7.15.4 Sturgeon

Atlantic sturgeon have been taken by hopper dredges in the past and to lesser extent mechanical (including cutterhead/pipeline) dredges. Therefore, the proposed dredging activity will have no effect if performed by a cutterhead dredge and may affect, likely to adversely affect the Atlantic sturgeon if performed by a hopper dredge. Since USACE has initiated consultation with NMFS on a new regional Biological Opinion, no additional Atlantic sturgeon consultation with NMFS is required.

Since shortnose sturgeons rarely inhabit coastal ocean waters, and tend to stay closer to the freshwater/saltwater divide, it is unlikely that the shortnose sturgeon occur in the project area along the beachfront of Edisto Beach. However, should it occur, its habitat would be only minimally altered by the proposed project. Any shortnose sturgeon in the area should be able to avoid being taken by a slow moving pipeline dredge or hopper dredge. Although hopper dredges have been known to impact shortnose sturgeon, dredging for this project will occur in offshore environments, outside of its habitat range. Therefore, impacts from dredges are not anticipated, but are covered by reference in the 1997 NMFS SARBO. For beach placement activities it has been determined that the proposed project would have no effect on shortnose sturgeon.

Endangered species observers (ESOs) on board hopper dredges, as well as trawlers, will be responsible for monitoring for incidental take of shortnose and Atlantic sturgeon species. For hopper dredging operations, dragheads as well as all inflow and overflow screening will be inspected for sturgeon species following the same ESO protocol for sea turtles. Furthermore, all ESOs on board trawlers will be capable of identifying shortnose and Atlantic sturgeon as well as following safe handling protocol as outlined in Moser *et. al.* 2000.

7.15.5 Whales

Since the construction is anticipated to be scheduled during the right whale migration period, personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing right whales. The Contractor may be held responsible for any whale harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The time when most right whale sightings occur is December, January, and February. The Contractor will be instructed to take necessary precautions to avoid any contact with whales. If whales are sighted within 1000 feet of the borrow area, all appropriate precautions shall be implemented to ensure protection of the whale. In addition, the Contractor will stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than this distance.

7.15.6 Manatees

Since the habitat and food supply of the manatee would not be significantly impacted, overall occurrence of manatees in the project vicinity is infrequent, all dredging will occur in the offshore environment and precautionary measures for avoiding impacts to manatees, as established by USFWS, will be implemented for transiting vessels associated with the project, the proposed action is not likely to adversely affect the west Indian manatee.

Should a change in the schedule necessitate work during the manatee migration period, personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing manatees. The Contractor may be held responsible for any manatee harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The standard manatee conditions apply annually from 1 June to 30 September, however in order to take precaution for the early and late sightings noted by SCDNR reporting, these protective measures would be implemented if construction occurs between April 1 – October 31. The Contractor would be instructed to take necessary precautions to avoid any contact with manatees. If manatees are sighted within 100 yards of the dredging area, all appropriate precautions would be implemented to insure protection of the manatee. The Contractor would stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment.

7.16 Cultural Resources

There are no properties along the beachfront of Edisto that are either on the National Registry or listed to be included on the National Registry of Historic Places. Therefore, the placement of sands on the beach will have no impact on any historic properties. Additionally, the borrow area was surveyed using a magnetometer, side scan sonar and a sub-bottom profiler. This study determined that the entire Edisto Beach study area has the slight possibility of containing eroded prehistoric archaeological sites, particularly Middle Archaic sites because the area was an exposed paleocoastal or paleoestuarine configuration at times when people may have been in the area. Two areas of potential paleolandscape settings were identified and recommended for avoidance or further investigation. One area includes an exposed paleolandscape with multiple logs that has one feature of possible upright postes indicating a possible shallowly buried structure in the northeastern quadrant of the study area. The second is a buried paleolandscape feature with horizontal margins in the far southeastern corner. Both areas will be avoided using a buffer with a radius of 1,500 feet placed around the center points (Figure 7.1). A letter of concurrence from the SC Institute of Anthropology and Archaeology can be found in Appendix I (Correspondence). Any inadvertent discovery of potential archaeological materials (i.e., wood structures, prehistoric lithics, ceramics, etc) dredging up during construction should be reported to their office and construction should cease until further inspections reveal the source of the material.

7.17 Water Quality

Dredging in the selected borrow area would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended sediment and turbidity generated during dredging. Factors that are known to influence sediment spread and turbidities are grain size, water currents and depths. During construction, there would be elevated turbidity and suspended solids in the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 nephelometric turbidity units [NTUs]) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would hug the shore and be transported with waves either up-drift or down-drift depending on wind conditions. Because of the low percentage of silt and clay in the borrow areas (less than 10 percent), turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events from erosion and riverine input. Any increases in turbidity in the borrow area during project construction and maintenance would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the surf zone when dredging ends.

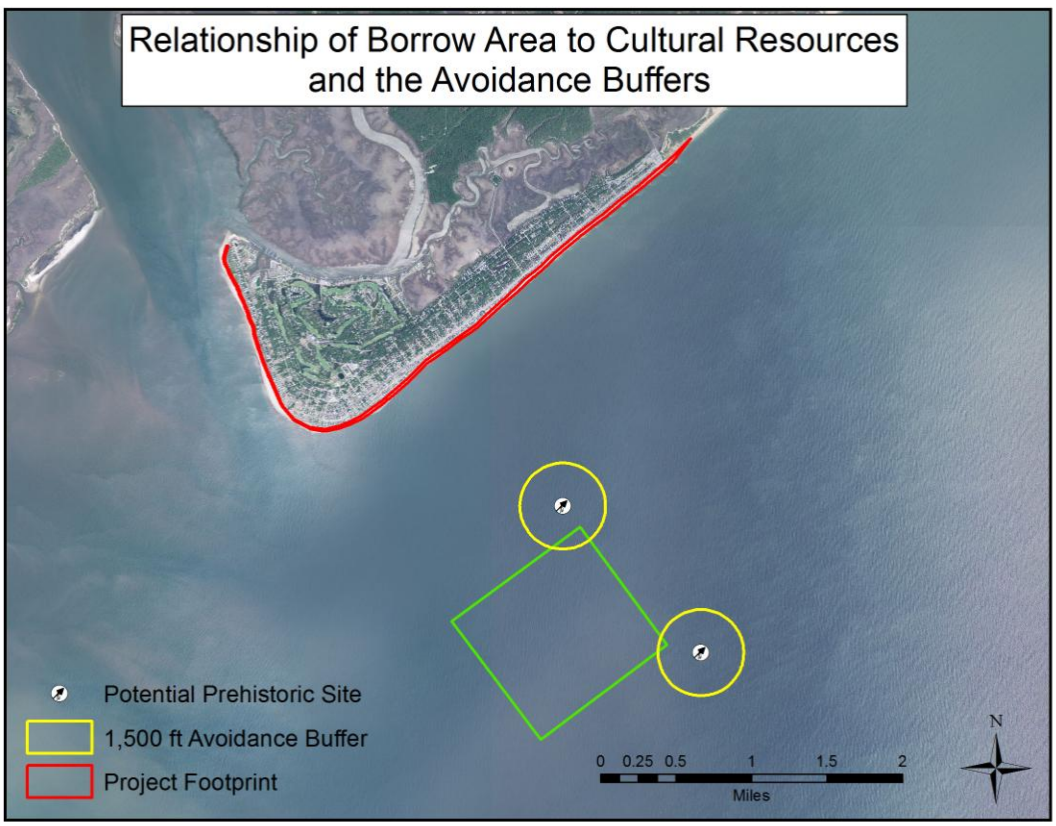

Figure 7.1: Relationship of borrow area to cultural resources and avoidance buffers.

A 401 Water Quality Certification is not needed for this project. SCDHEC has temporarily waived these certifications and states the following:

> *"Groins and beach renourishment activities have very few water quality impacts. As a general rule, the concerns and comments that the Department receives during a 401 Water Quality Certification review for these activities are directed towards the issue of threatened or endangered species. These activities will still require comments from the US Fish and Wildlife Service and/or the National Marine Fisheries Service which have jurisdiction over threatened and endangered species before the Corps can issue their 404 permit. Therefore, the Department has a reasonable assurance that these concerns will be addressed. Further, the Department's OCRM office will still continue to issue direct permits for alteration of the critical area for these activities that also provide a means to address the threatened or endangered species concerns."*

Pursuant to Section 404 of the Clean Water Act, the effects associated with the discharge of beach fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) evaluation in Appendix H.

7.18 Air, Noise, and Aesthetics

Temporary increases in exhaust emissions from construction equipment are expected during the construction and periodic renourishment of Edisto Beach; however, the pollution produced would be similar to that produced by other large pieces of machinery and would be readily dispersed. All dredges must comply with the applicable EPA standards. The air quality in Colleton County, South Carolina, is designated as an attainment area. A conformity determination is not required for this project because of the following reasons: 1) it is located in an attainment area; 2) the direct and indirect emissions from the project fall below the prescribed de minimus levels; and 3) the ambient air quality for Colleton County has been determined to be in compliance with the National Ambient Air Quality Standards.

Noise in the outside environment associated with beach construction activities would be expected to minimally exceed normal ambient noise in the project area. However, construction noise would be attenuated by background sounds from wind and surf. In-water noise would be expected in association with the dredging activities. Specifically, noise associated with dredging could occur from (1) ship/machinery noise—noise associated with onboard machinery and propeller and thruster noise, (2) pump noise—noise associated with pump driving the suction through the pipe, (3) collection noise—noise associated with the operation and collection of material on the sea floor, (4) deposition noise—noise associated with the placement of the material within the barge or hopper, and (5) transport noise—noise associated with transport of material up the suction pipe.

Reine et al (2012) found that the majority of underwater sounds produced by hydraulic cutterhead dredging operations were of relatively low frequency (< 1000 Hz). Their study was conducted during rock fragmentation and therefore represented a worst case scenario. The source level was estimated to be between 170 and 175 dB re 1uPa@1-m. These sound levels decreased with increasing distance from the source. The authors determined that the area of influence was limited to less than 100 m from the source. At 100 m, received levels were less than 150 dB re 1uPa rms. NMFS is developing new guidelines for determining sound pressure level thresholds for fish and marine mammals. However, based on existing studies, the NMFS current thresholds for determining impacts to marine mammals is between 180 and 190 dB re 1 uPa for potential injury to cetaceans and pinnipeds respectively, and 160 dB re 1 uPa for behavioral disturbance/harassment from an impulsive noise source, and 120 dB re 1 uPa from a continuous source. Reine et al (2012) found that the 120 dB re 1uPa proposed threshold was exceeded by ambient noises in their study area. Based on reviews by Popper et al (2006) and Southall et al (2007) it is unlikely that underwater sound from conventional dredging operations can cause physical injury to fish species.

Many of the homes along the beach front of Edisto are single story homes with patios or decks that are on the ground or low to the ground. The construction of a dune system ranging in height from 14 feet NAVD 83 to 15 feet NAVD 83 will likely impede the view of the beach and ocean for many of the beach front residents.

7.19 Hazardous, Toxic, and Radioactive Waste

The USACE's standard tiered approach for analyzing the potential for encountering contaminated sediments in the potential borrow areas was used to assess the potential borrow areas for HTRW. According to that analysis, before any chemical or physical testing of sediments would be conducted, a reason to believe that the sediments could be contaminated must be established. The sources of the sediments in the selected borrow areas are derived from sediment transport and deposition by ocean currents. In addition, the sediment is predominantly sand and shell hash which organic and inorganic contaminants typically don't adhere to. The probability of the areas being contaminated by pollutants is low.

7.20 Environmental Justice

Executive Order 12898 requires Federal agencies to develop a strategy for its programs, policies, and activities to avoid disproportionately high and adverse impacts on minority and low-income populations with respect to human health and the environment. The USACE is committed to the principles of environmental justice. Although the coastal side of the Town of Edisto Beach is the project, all long-term impacts should be of a positive nature and benefit the residents and visitors with greater recreational opportunities and a higher level of storm protection. There are no minority or low-income populations present in the study area, therefore, the proposed work would not result in adverse impacts to any populations specified in E.O. 12898.

7.21 Cumulative Effects

The Council on Environmental Quality (CEQ) defines cumulative impact as,

> "*the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (*40 CFR 1508.7)."

The cumulative impacts of the proposed project will be to provide improved and longer-term coastal storm damage reduction for the dwellings and infrastructure of Edisto Beach. In addition, these improved beach conditions, with a more extensive dune development, will increase the area for use by the general public while providing a valuable habitat for the loggerhead turtle. Since the beachfront is currently fully developed, the project will not likely contribute to increased beachfront development. Any new development would have to comply with the State Beachfront Management Act. Cumulative effects of multiple, simultaneous beach nourishment operations could be harmful to fishes of the surf zone. However, because of the high quality of the sediment selected for beachfill and the small amount of beach affected at any time, the proposed activity would not be expected to pose a significant threat. The initial construction and each nourishment interval will utilize varying components of the borrow site with a sequence of temporary impacts to benthic resources over the life of the project. Subsequent intervals of dredging within the borrow area will likely occur in portions not previously been dredged. This cyclic use of borrow areas would result in cumulative effects from space crowded perturbations on a local scale. However, as previously indicated, recovery of these sites is anticipated and will be monitored. Adaptive management will be utilized where practical.

8. PLAN IMPLEMENTATION

This chapter will contain the project implementation schedule, division of plan responsibilities including cost sharing breakout by project purpose, and views of the non-Federal sponsor and any other agencies having implementation responsibilities.

8.1 Project Schedule

Table 8.1 shows the current project schedule following authorization of the project. The schedule assumes expeditious review and approval of the project through all steps, including authorization and funding, and as such is subject to change.

Table 8.1: Project schedule following authorization

Activity	Date
Signed Chief's Report	2014
Start PED	2015
Project Authorization (WRDA)	2016
Sign PPA	2016
Complete Real Estate Acquisition	2016
Pre-Construction Plans and Specs	2017
Award Construction Contract	2018
Begin Initial Construction	2018
Complete Initial Construction	2018
Begin First Renourishment	2034
Complete First Renourishment	2034

8.2 Division of Plan Responsibilities

8.2.1 General

Federal policy requires that costs for water resources projects be assigned to the various purposes served by the project. These costs are then apportioned between the Federal government and the non-Federal sponsor according to percentages specified in Section 103 of the WRDA of 1986 (P.L. 99-662). For projects that provide damage reduction to publicly owned shores, the purposes are usually (1) coastal storm damage reduction and (2) separable recreation. There is no separable recreation component for the Edisto Beach project.

8.2.2 Cost Sharing

All project costs are allocated to the purpose of hurricane and storm damage reduction. Cost sharing for initial construction of the Selected Plan would be consistent with that specified in Section 103(c)(5) of WRDA 1986 as amended by WRDA 1996 (generally 65 percent Federal and 35 percent non-Federal). Non-Federal interests are required to provide all LERRDs necessary for the project. The value of the non-Federal portion of the LERRD is $989,000 and is included in the non-Federal share of initial project construction costs. The remainder of the non-Federal share of initial project construction costs consists of a $6,392,150 cash contribution.

Cost sharing for periodic nourishment (continuing construction) would be consistent with Section 215 of WRDA 99, which requires that such costs be shared 50 percent Federal and 50 percent non-Federal. Annual beachfill monitoring, for the life of the project is also considered part of continuing construction and would be cost shared 50/50 as well. However, shorter-term (5 years), post-construction monitoring required by the State of South Carolina to verify that there are no unanticipated adverse impacts resulting from groin lengthening would be cost shared 65/35.

Annual OMRR&R costs, such as inspection costs and dune vegetation maintenance costs, are 100 percent non-Federal responsibility. The Federal government is responsible for preparing and providing an OMRR&R manual to the sponsor.

As noted previously, current Federal policy requires that, unless there are other, overriding considerations, the plan that produces the maximum net benefits, the NED plan, would be the selected plan recommended for implementation. In this case, the plan recommended for implementation is the NED plan. Cost sharing for the recommended plan is shown in Table 8.2 at 2014 price levels.

8.2.3 Financial Analysis

The non-Federal sponsor is required to submit a statement of financial capability to the USACE. This certification has been obtained and has been submitted along with the final version of this report.

8.2.4 Project Partnership Agreement

A model PPA, based on the selected plan, will be fully discussed with the non-Federal sponsor at the appropriate time. The non-Federal sponsor has a clear understanding of the type of agreement that must be signed before the start of project construction. The terms of local cooperation to be required in the Project Partnership Agreement (PPA) are described in Section 11, Recommendations.

Federal commitments regarding a construction schedule or specific provisions of the PPA cannot be made to the non-Federal sponsors on any aspect of the recommended plan or separable element until the following are true:

- The recommended plan is authorized by Congress;
- Construction funds are provided by Congress, apportioned by the Office of Management and Budget (OMB), and their allocation is approved by the Assistant Secretary of the Army for Civil Works (ASA(CW));
- The draft PPA has been reviewed and approved by the ASA(CW).

Table 8.2: Cost allocation and apportionment (2014 price levels)

Initial project construction costs					
	Project first cost	Apportionment %		Apportionment $	
Project purpose		Non-Federal	Federal	Non-Federal	Federal
Coastal storm damage reduction	$21,129,000	35%	65%	$7,395,150	$13,733,850
LERRD credit	$989,000	100%	0%	$989,000	
Cash portion				$6,406,150	$13,733,850
Preconstruction Engineering and Design Costs					
	Project first cost	Apportionment %		Apportionment $	
Project purpose		Non-Federal	Federal	Non-Federal	Federal
Preconstruction Engineering and Design	$400,000	35%	65%	$140,000	$260,000
Total renourishment costs					
	Total Cost (3 renourishments)	Apportionment %		Apportionment $	
Project purpose		Non-Federal	Federal	Non-Federal	Federal
Coastal storm damage reduction	$32,742,000	50%	50%	$16,371,000	$16,371,000
Annual OMRR&R costs					
	Cost per year	Apportionment %		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
General repair, maintenance, inspection	$83,000	100%	0%	$83,000	$0

After this report is approved, the project is authorized and the project is budgeted for construction, the USACE will conduct negotiations with the non-Federal sponsor regarding the PPA. The USACE will submit the PPA package to the ASA(CW) for review and approval. The PPA would not be executed until it is approved and construction funds have been budgeted.

8.3 Views of the Non-Federal Sponsor

The Town of Edisto Beach fully supports Recommended Plan. A sponsor letter of support is provided in Appendix I.

9. ENVIRONMENTAL COMPLIANCE AND COMMITMENTS*

Project commitments to minimize and mitigate for environmental impacts are listed in Table 9.1. Table 9.2 summarizes the relationship between the proposed action and various Federal laws and Executive Orders.

Table 9.1: Project environmental commitments.

Sediment Compatibility	(1) Only beach compatible sediment would be placed on the beach as a component of this project. (2) If the dredging operations encounter sand deemed non-compatible with native grain size or sorting characteristics of the native beach, the Charleston District would make the decision on a suitable contingency measure that may include moving the dredge to another site in the borrow area and would notify SCDHEC-OCRM and other resource agencies of such a contingency measure.
Manatee	(3) The Contractor will follow the standard manatee conditions and take necessary precautions to avoid any contact with manatees if construction occurs between April 1 and September 30. If manatees are sighted within 100 yards of the dredging area, all appropriate precautions will be implemented to insure protection of the manatee. The Contractor will stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment.
Large Whales	(4) ESO's would be on board all hopper dredges and would record all large whale sightings and note any potential behavioral effects. The Corps and the contractor would keep the date, time, and approximate location of all marine mammal sightings. They would take care not to closely approach (within 500 yards) any whales, manatees, or other marine mammals during dredging operations or transport of dredged material. An observer would serve as a lookout to alert the dredge operator or vessel pilot or both of the occurrences of such animals. If any marine mammals are observed during dredging operations, including vessel movements and transit to the borrow site, collisions would be avoided either through reduced vessel speed, course alteration, or both.

Sturgeon Species	(5) Endangered species observers (ESOs) on board hopper dredges as well as trawlers will be responsible for monitoring for incidental take of Atlantic and Shortnose sturgeon. For hopper dredging operations, dragheads as well as all inflow and overflow screening will be inspected for sturgeon species following the same ESO protocol for sea turtles. Furthermore, all ESOs on board trawlers will be capable of identifying sturgeon species as well as following safe handling protocol as outlined in Moser *et al.* 2000.
Sea Turtles	(6) The Corps would strictly adhere to all conditions outlined in the most current NMFS Regional Biological Opinion (RBO) for dredging of channels and borrow areas in the southeastern United States. Furthermore, as a component of this project, hopper dredging activities for both initial construction and each nourishment interval would adhere, to the maximum extent practicable, to a dredging window of November 1 to April 31 (USFWS window) to avoid periods of peak sea turtle abundance. Turtle-deflecting dragheads, inflow and overflow screening, and NMFS-certified turtle observers would also be implemented. (7) To determine the potential taking of whales, turtles, and other species by hopper dredges, NMFS-certified observers would be on board during all hopper dredging activities. Recording and reporting procedures would be followed in accordance with the conditions of the current NMFS RBO. (8) Immediately after completion of the project, the Corps of Engineers will perform tilling in order to reduce compaction associated with newly placed sand. (9) Visual surveys for escarpments along the Project area will be made immediately after completion of the project and prior to May 1 for 3 subsequent years, if needed. Results of the surveys will be submitted to the USFWS prior to any action being taken. Since the Project should not occur during the sea turtle nesting season, escarpment leveling will not be performed until immediately prior to the nesting season. The USFWS will be contacted immediately if subsequent reformation of escarpments exceeding 18 inches in height for a distance of 100 feet occurs during nesting and hatching season. This coordination will determine what appropriate action must be taken. An annual summary of escarpment surveys and action taken will be submitted to the USFWS. (10) Local lighting ordinances would be encouraged to the maximum extent practicable to reduce lighting impacts to nesting females and hatchlings.

Sea Turtles (continued)	(11) If any construction of the project occurs during the period between May 1 and September 15, daily nesting surveys will be conducted starting either May 1 or 65 days prior to the start of construction, whichever is later. These surveys will be performed between sunrise and 9:00 A.M. and will continue until the end of the project, or September 15, whichever is earlier. Any nests found in the area that will be impacted by construction activities will be moved to a safe location. The nesting surveys and nest relocations will only be performed by people with a valid South Carolina DNR license. (12) For construction activities occurring during the period May through October 31, staging areas for equipment and supplies will be located off of the beach to the maximum extent possible. (13) For construction activities occurring during the period May through October 31, the dredging contractor will provide nighttime monitoring along the beach where construction is taking place to ensure the safety of female turtles attempting to nest. A buffer zone around the female will be imposed in the event of an attempt to nest. (14) For construction activities occurring during the period May through October 31, all on-beach lighting associated with the project will be limited to the minimum amount necessary around active construction areas to satisfy Occupational Safety and Health Administration (OSHA) requirements.
Terrestrial Habitat	(15) Land-based equipment necessary for beach nourishment work would be brought to the site through existing accesses. If the work results in any damage to existing accesses, the accesses would be restored to pre-project conditions immediately on project completion. (16) Dune disturbance along the beach would be kept to a minimum. (17) Impacts to martime forest will be avoided. (18) Dune stabilization would be accomplished by planting vegetation on the dune during the optimum planting seasons and after the berm and dune construction. Representative native planting stocks may include sea oats (*Uniola paniculata*), American beachgrass (*Ammophila breviligulata*), and panic grass (*panicum amarum*). (19) To prevent leakage, dredge pipes would be routinely inspected. If leakage is found and repairs cannot be made immediately, pumping of material must stop until such leaks are fixed. (20) The placement of shore pipe is generally on the upper beach, away from existing dune vegetation and seaward of the toe of the primary dune.

Benthic Invertebrates and Borrow Area Recovery	(21) The anticipated construction time frame for initial and periodic nourishment events would avoid peak recruitment and abundance time period for surf zone fishes and benthic invertebrates. (22) Initial construction would be completed over 3-4 months with renourishment every 16 years. With this approach, effects would be expected to be localized, short-term, and reversible. . (23) The Corps' Contractor will ensure that a 1 foot vertical buffer is applied to all borrow area dredging in order to help facilitate faster benthic community recovery. (24) The Corps will work with the Contractor to optimize the size and depth of each nourishment project borrow area to balance environmental and economic considerations. (25) A monitoring program will be implemented to determine impacts to and recovery of the macroinvertebrate community within the borrow site. This program will be coordinated with SCDNR and NMFS. The monitoring program should include, but not be limited to benthic taxonomy, sediment grain size analysis, and post-construction bathymetric surveys.
Cultural and Historic Resources	(26) A buffer of 1,500 ft will be adhered to around the two potential prehistoric sites identified in the cultural resources survey for this project. (27) Any inadvertent discovery of potential archaeological materials (i.e., wood structures, prehistoric lithics, ceramics, etc) dredging up during construction should be reported to both SCIAA and SHPO and construction should cease until further inspections reveal the source of the material.
Native American Tribal Commitments	(28) The Catawba Indian Nation will be notified when the dredging occurs, as per letter correspondence from the Tribal Historic Preservation Officer, Wenonah Haire, dated Sept 9, 2008 (Appendix I)
Water Quality	(29) SCDHEC has waived 401 requirements for beach nourishment and groin projects; therefore, there are no special water quality commitments to adhere to. (30) Temporary dikes would be used to retain and direct flow of material parallel to the shoreline to minimize surf zone turbidities. The temporary dikes would be removed and the beach graded in accordance with approved profiles on completion of pumping activities in that section of beach.
Other Commitments	(31) Sponsor must comply with Federal flood insurance and floodplain management program requirements (ER 1105-2-100, Appendix E, Table E-1) (32) If results of beach profile monitoring determine that the (23) lengthened groins have increased erosion on downdrift beaches,

	USACE must be committed to removing the lengthened section of groins. (33) Placement of rocks to lengthen groins must occur during the winter months outside of sea turtle nesting season unless construction occurs from the land/beach. (34) The seaward ends of the groins should taper down to the bottom to mimic natural contours

Table 9.2: Compliance status of the project as it relates to relevant Federal laws and Executive Orders.

Public Laws		
Title of Public Law	**US Code**	**Compliance Status**
Abandoned Shipwreck Act of 1987	43 USC 2101	Full Compliance
Anadromous Fish Conservation Act of 1965, As Ammended	16 USC 757 a et seq.	FullCompliance
Archeological Resources Protection Act of 1979, As Amended	16 USC 469	Full Compliance
Bald and Golden Eagle Act of 1972	16 USC 470	Not Applicable
Clean Air Act of 1972, As Amended	42 USC 7401 et seq.	Full Compliance
Clean Water Act of 1971, As Amended	33 USC 1251 et seq.	Full Compliance
Coastal Barrier Resources Act of 1982	16 USC 3501-3510	Full Compliance
Coastal Zone Management Act of 1972, As Ameded	16 USC 1451 et seq.	Full Compliance
Comprehensive Environmental Responses, Compensation and Liability Act of 1980	42 USC 9601	Not Applicable
Endangered Species Act of 1973	16 USC 1531	Full Compliance
Federal Environmental Pesticide Act of 1972	7 USC 136 et seq.	Full Compliance
Fish and Wildlife Coordination Act of 1958, As Amended	16 USC 661	Full Compliance
Flood Control Act of 1944, As Amended, Section 4	16 USC 460b	Full Compliance
Magnuson-Stevens Fishery Conservation and Management Act	16 USC 1801	Full Compliance
Marine Mammal Protection Act of 1972, As Amended	16 USC 1361	Full Compliance
Marine Protection, Research and Sanctuaries Act of 1972	33 USC 1401	Not Applicable
Migratory Bird Conservation Act of 1928, As Amended	16 USC 715	Full Compliance
Migratory Bird Treaty Act of 1918, As Amended	16 USC 703	Full Compliance
National Environmental Policy Act of 1969, As Amended	42 USC 4321 et seq.	Full Compliance
National Historic Preservation Act of 1966, As Amended	16 USC 470	Full Compliance
National Historic Preservation Act Amendments of 1980	16 USC 469a	Full Compliance
Noise Control Act of 1972, As Amended	42 USC 4901 et seq.	Full Compliance
River and Harbor Act of 1888, Sect 11	33 USC 608	Not Applicable
River and Harbor Act of 1889, Sections 9, 10, 13	33 USC 401-413	Full Compliance
River and Harbor and Flood Control Act of 1962, Section 207	16 USC 460	Not Applicable
River and Harbor and Flood Control Act of 1970, Sections 122, 209, and 216	33 USC 426 et seq.	Full Compliance
Submerged Lands Act of 1953	43 USC 1301 et seq.	Full Compliance
Superfund Amendments and Reauthorization Act of 1986	42 USC 9601	Not Applicable
Toxic Substances Control Act of 1976	15 USC 2601	Not Applicable
Executive Orders		
Title of Executive Order	**Exec. Order Number**	**Compliance Status**
Protection and Enhancement of Environmental Quality	11514/11991	Full Compliance
Protection and Enhancement of the Cultural Environment	11593	Full Compliance
Floodplain Management	11988	Full Compliance
Protection of Wetlands	11990	Full Compliance
Federal Compliance with Pollution Control Standards	12088	Full Compliance
Offshore Oil Spill Pollution	12123	Full Compliance
Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	12843	Full Compliance
Federal Compliance with Right-To-Know Laws and Pollution Prevention	12856	Full Compliance
Federal Actions to Address Environmental Justice and Minority and Low-Income Populations	12898	Full Compliance
Implementation of the North American Free Trade Agreement	12889	Full Compliance
Energy Efficiency and Water Conservation at Federal Facilities	12902	Full Compliance
Federal Acquisition and Community Right-To-Know	12969	Full Compliance
Protection of Children from Environmental Health Risks and Safety Risks	13045	Full Compliance
Coral Reef Protection	13089	Full Compliance
Invasive Species	13112	Full Compliance
Marine Protected Areas	13158	Full Compliance
Consultation and Coordination with Indian Tribal Governments	13175	Full Compliance
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full Compliance
(Items identified as being in "Full Compliance" assumes their compliance status upon completion of the NEPA process; Items identified as being in "Partial Compliance" indicates that concurrence is needed from another Agency, and will be completed prior to the Final Environmental Assessment.)		

9.1 Adaptive Management

The purpose of adaptive management is to improve the success of the overall project by proactively incorporating flexibility where significant risk and/or uncertainty exist. It is implemented through a process designed to monitor the success of the action, compare the results to what was expected and make adjustments to improve success. The basic elements of adaptive management are: (1) Assess; (2) Design; (3) Implement; (4) Monitor; (5) Evaluate; and (6) Adjust. Monitoring includes the systemic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to realize project benefits.

The Recommended Plan is not burdened by significant risk or uncertainty regarding the performance of the project; however some risks remain. These include: 1) the recovery of the borrow area, 2) the functioning of the extended groins, and 3) use of the beach by nesting sea turtles.

Beach nourishment projects have been well documented and monitored over the years, and the USACE has made numerous efforts to evaluate the impacts of nourishment projects (Myrtle Beach and Folly Beach). Similar to other USACE beach projects, USACE will initiate a monitoring program of the borrow area recovery. SCDNR has been actively involved in monitoring of other borrow sites throughout the state and USACE will work with SCDNR to design a monitoring program to assess the impacts and recovery of the borrow area. Previous research has led the USACE to the selection of the current borrow area and the minimization techniques that will be utilized (described in Table 9.1). If results of this monitoring show that operational changes are recommended, future renourishment projects will be modified. Since this project involves the modification of 23 groins by varying amounts of lengthening, the USACE will work with the Town of Edisto Beach to monitor the condition of the beach to determine if unexpected down-drift impacts are resulting from the project. Changes to the project will be implemented to remain consistent with SCDEC-OCRM regulations for beachfront management. To address the nesting of sea turtles, information will be collected each year from SCDNR and the Town of Edisto Beach volunteer sea turtle program, locally termed the “turtle patrol.” Future renourishment projects will consider any changes that could improve nesting on the beach and still meet the storm damage reduction requirements of the project.

Executive Order 11988 requires federal agencies avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps reflect the decision-making process required in Section 2(a) of the EO. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year). The proposed action is on the beachfront and therefore within the base floodplain. However, the project is designed to reduce damages to existing infrastructure located landward of the proposed project. The damage that would be avoided is caused primarily by erosion during significant storm events.

2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain. Chapter 5 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated and evaluated, including non-structural measures such as retreat, demolition and land acquisition.

3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

A scoping letter was sent to all Federal and state agencies and local agencies. The Town of Edisto Beach coordinated closely with its residents and constituents including the town's beachfront management committee. A public scoping meeting was held early in the project and a public meeting was held during the public review period for the Integrated Feasibility Report and Environmental Assessment. The electronic versions of the documents were also made available on compact disc and online. The meetings were well attended and a rich diversity of views were expressed in multiple formats.

4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.

The anticipated impacts associated with the Recommended Plan are summarized in Chapters 6 and 7 of this report. The project would not alter or impact the natural or beneficial flood plain values.

5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.

An evaluation of practicable measures and alternatives is presented in Chapter 5 of this report. The project will not encourage development in the floodplain, as development is expected to continue the same as it would in both FWOP and FWP conditions. The project provides benefits for existing development. The project would not change the base flood plain.

6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the “no action” alternative.

There is no mitigation expected to be necessary for the Recommended Plan. The project would not induce development in the flood plain and the project will not impact the natural or beneficial flood plain values. Chapter 5 of this report summarizes the alternative identification, screening and selection process. This process carries the “no action” alternative through the entire assessment and selection process.

7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.

The Draft Integrated Feasibility Study and EA was provided for public review and a public meeting was be held. Comments received and responses to the comments are provided in Appendix I of the report. Additionally, specific public concerns related to the renourishment interval and the sizes of dunes and some of the groins were addressed at a follow-up meeting in Edisto Beach.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.

The Recommended Plan is the most responsive to all of the study objectives described in Chapter 4, and it is consistent with the requirements of EO 11988. This project reduces damages caused by erosion, and flooding is not the major problem or concern in the project area.

10. PUBLIC INVOLVEMENT AND AGENCY COORDINATION*

10.1 Public Scoping

The USACE held a public scoping meeting at the Edisto Beach Civic Center on October 29, 2009. A total of 13 people attended this meeting. Most of the dialogue at this meeting focused on USACE processes, potential measurement measures and sources of sand and funding. A questionnaire was available for attendees to fill out; four took advantage of the opportunity (Appendix I). Based on the data produced by the questionnaire, the following conclusions were drawn:

- Most year round residents visit the beach at least three times a week,
- Most use the beach for recreational purposes
- None of those that responded had experienced any storm related property damage.

The overall opinion of the attendees was favorable towards a beach fill project. One attendee expressed concerns that the placement of additional material may accelerate the filling in of St. Helena Sound, causing a navigational problem.

10.2 Resource Agency Opinions

Various resource agencies offered opinions on a variety of management measures that were initially considered. Opinions were initially solicited during a meeting held on January 20, 2010, and several agencies subsequently followed up with letters. These letters, as well as further coordination documentation, are included in Appendix I.

In general, beach fill was the agencies' preferred management measure as it would have minimal environmental impact to existing flora and fauna, assuming appropriate dredging windows were utilized, and it would also potentially increase turtle nesting habitat. The resource agencies were universally against the construction of any new groins and were not in favor of lengthening existing groins.

The draft feasibility report/EA has been submitted to resource agencies for input and consideration. Conservation recommendations and all views/opinions have been presented and considered in the final report/EA.

10.3 Public Opinions

A public meeting was held on August 26, 2013 in association with the public review of the Draft report/EA. The meeting was well attended by local residents and a few special interest groups. Appendix I documents the public meeting and the comments received during that meeting. Generally, the public was in favor of the project. A variety of concerns were expressed related to the height of the dune, groin length determinations and renourishment interval. These concerns have been addressed both within the report and with the comment/responses provided in Appendix I. They were also addressed during a follow up meeting with with the non-Federal sponsor and interested citizens to discuss final resolution of technical issues and general concerns on October 22, 2013.

11. RECOMMENDATIONS

This study addresses the needs for coastal storm damage reduction for the Town of Edisto Beach, SC. The following recommendations include items for implementation by Federal, State, and local governments and agencies, including the structural coastal storm damage reduction project. It is critical to emphasize that the purpose of the project is to reduce damages to structures and contents, not to reduce loss of life and risks to personal safety that can occur during hurricanes and other coastal storms. In order for risks to life and safety to be reduced, any structural project should be accompanied by additional measures meant to assure that residents have sufficient warning, knowledge and resources to evacuate the area well ahead of hurricane arrival. Recommendations for these types of measures are listed below. While many of these recommendations may already be in place, due to their importance they are being reinforced as a component of this project.

On the basis of the conclusions of this study, I recommend the implementation of the Recommended Plan, identified as Alternative 4. The Recommended Plan consists of the following elements: 1) A 15-foot high (elevation), 15-foot wide dune beginning at the northern end of the project (i.e., Reach E15 – the southern end of the park) and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would taper to a 50-foot width over the remaining length of the berm. The width of each end of the berm would taper to match the existing beach profile; 2) Beginning at Reach I4, the dune would transition to a 14-foot high, 15-foot wide dune that extends around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm; and 3) Approximately 1,130 ft of total groin lengthening across 23 of the existing groins.
The baseline cost estimate for construction in FY 2018 is $21,129,000.

As a result of the Feasibility study and EA, I recommend that the project be authorized and implemented in accordance with the findings of this report.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and as further specified below:

> (1) Enter into an agreement which provides, prior to construction, 35 percent of design costs;

(2) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

(3) Provide all lands, easements, and rights-of-way, and perform or ensure the performance of any relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;

(4) Provide, during construction, any additional amounts as are necessary to make its total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Continue to maintain public access every ½ mile and adequate parking within the project limits in accordance with USACE requirements for participation in cost sharing with the Federal Government for the project as follows:

(1) For so long as the project remains authorized, the Non-Federal Sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

(2) Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

(3) At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal Government.

c. Shall not use funds from other Federal sources, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project;

d. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

e. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

g. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

h. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

i. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

l. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

m. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

o. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

q. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

r. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The total first cost of the project, at 2014 price levels, is $21,129,000. The Federal share of the total first project cost is estimated at $13,733,850. The non-Federal share of the total first project cost is estimated at $7,395,150. The estimated Total Construction and

Nourishment Cost, which includes the project first cost as well as the constant dollar cost at the current price level for all future periodic renourishments is $100,699,000. As previously indicated, the total project benefit-cost ratio is 2.3 to 1, which means that for every dollar spent for the project, 2 dollars and 30 cents are realized in NED benefits from the project.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for implementation funding. However, prior to transmittal to the Congress, the sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

12. POINT OF CONTACT*

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EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX A
COASTAL ENGINEERING

1.0 History of Shoreline Management

Coastal Science & Engineering (CSE) has been retained by the Town of Edisto Beach for a number of years to perform annual beach condition monitoring and numerous studies of the Edisto Island shoreline. Many of CSE's reports and beach monitoring data products have been used during this feasibility study to better understand the history of shoreline management and the existing conditions on Edisto Island.

Historical erosion of Edisto Island has lead to a long history of shoreline management activities. For instance, the first two groins were constructed near the pavilion in 1948. Construction of additional groins continued over the next decade, bringing the total number of groins on the Edisto Beach shoreline to 17 by 1958. The groins were built from north to south and as the erosion continued to move down the beach additional groins were constructed in an attempt to keep pace with the subsequent erosion moving downdrift (south). By 1975, a total of 34 groins had been constructed along the Edisto Beach shoreline. The last groin constructed (#34) is located approximately 3,000 feet from the mouth of Big Bay Creek, along the South Edisto River inlet shoreline (CSE 2006). Table 1 below provides details on the groin construction timeline.

Table 1: Groin Construction Chronology

Groin #	Construction Completion
1	(1948)
2	1948
3-4	1949
5-8	1954
9-12	1953
13-17	1958
18-19	1962
20-21	1964
22-25	1969
26	1970
27-29	1972
30-33	1974
34	1975

Despite the construction of groins, erosion continued to threaten Palmetto Boulevard near the pavilion. As a result, in 1954 the South Carolina Highway Department undertook the first nourishment of Edisto Beach. Approximately 830,000 cubic yards of material, consisting of a mixture of sand, shells, and mud, was dredged from the marsh behind the island and placed between groins 1 and 12. Unfortunately, much of the material was not suitable for beach fill and the fine portions washed away quickly. The coarser sand and shell fractions remained on the beach and added to those transported to Edisto from Edingsville Beach (CSE 2006).

Through their studies and monitoring program of Edisto Beach, CSE has concluded that while localized erosion problems have persisted along Edisto Beach, the groin field significantly reduces the rate of sand loss along the oceanfront. More specifically, their periodic surveys have shown that erosion rates in groin cells 1–27 have been less than 1 cubic yard per foot per year (cy/ft/yr) in recent years (CSE 2003). They conclude that such low rates are due to the exposure of the groins and the creation of nearly isolated groin cells that exchange little sand from cell to cell. During the past decade, groin exposures reached as high as 8 ft along the intertidal beach profile (CSE 2006).

The next beach nourishment project on Edisto Island took place in 1995 when approximately 155,000 cubic yards of fill was placed between groins 1 to 17 (Pavilion to Chancellor Street) and groins 24 to 28 (Laroche Street to Billow Street). This beach fill project was accompanied by major improvements to the groins in those areas.

Shoreline erosion continued along Edisto Beach and in 2001, two houses in the 700 block of Palmetto Blvd (near groin 12) were lost. Despite the groin improvement and beach fill project in 1995, the Edisto Beach shoreline continued to be vulnerable to chronic erosion and storm events. The Town of Edisto Beach and the South Carolina Department of Parks Recreation and Tourism decided to plan for another beach nourishment project. This most recent beach nourishment project on Edisto Island was constructed between March and May 2006. The project added approximately 850,000 cubic yards (192,100 cy in the State Park area) of beach compatible material along 18,258 feet (3,200 feet in the State Park) of shoreline from the State Park to groin 27. The project was completed by Great Lakes Dredge and Dock (GLDD) at a cost of $7,697,500 (CSE 2006). The locations of the 1954, 1995 and 2006 beach nourishment projects are illustrated in Figure 1.

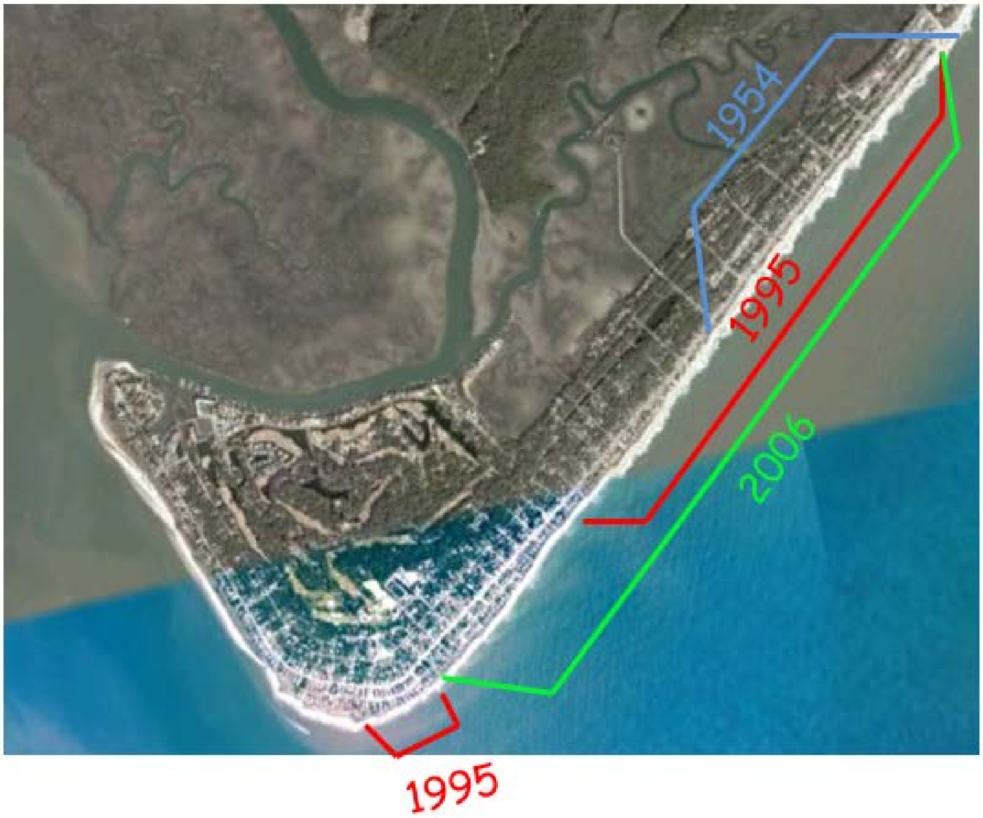


Figure 1: Historic beach nourishment placement areas.

2.0 Existing Coastal Processes

This section provides a summary of the key environmental conditions, active coastal processes, and the geological framework that characterize the vulnerability of Edisto Beach to economic losses through coastal storm-induced damages to existing infrastructure.

a. Coastal Storm Climatology

Existing coastal processes at Edisto Beach are driven by high energy waves and water levels generated by both tropical and extratropical storms. Significant tropical storm events impacted the Edisto Beach shoreline at a frequency of approximately once every 4 years over the past 100 years. These tropical storms occur between June and November with more than 65 percent of them occurring in the months of August and September. Extratropical storms, on the other hand, are a frequently occurring storm type that impacts Edisto Beach annually with significant events occurring on average once every year and a half. Extratropical storms typically occur in the late summer and early fall (September and October) and again in late winter and early spring (January through March) with most occurring in February. Tropical storm events are typically fast moving storms associated with elevated water levels and large waves whereas extratropical storms are slower moving with comparatively lower water level elevations and large wave conditions. Both storm types can produce beach erosion and morphology change as well as coastal inundation leading to economic losses to improved property backing the ocean and inlet shorelines of Edisto Beach. Although economic losses are most often realized in the wake of major storm events it is long-term chronic erosion that creates the vulnerability to major economic losses through volumetric depletion of beach material in the active profile, reduction in beach berm width and reduction in dune crest elevation and dune volume. Not all storms in the storm climatology produce measurable economic damages but they contribute to setting up vulnerability for economic losses. The long-term chronic erosion is driven by gradients in the longshore sand transport rate and depends on sediment supply from updrift beaches.

b. Longshore Sediment Transport Regime

Net longshore sand transport along Edisto Beach is from north to south and the magnitude of the longshore sand transport rate tends to increase moving from north to south. Intra-annual reversals in the longshore transport direction at Edisto Beach can be significant and are readily observed by shoreline position changes within groin compartments. These intra-annual transport direction reversals are driven by seasonal changes in the incident wave direction. Generally speaking, during the more stormy late Fall/Winter/early Spring seasons net transport direction is to the south, whereas during the milder fair weather late Spring and Summer season the net transport direction is often directed to the north. Within the groin compartments, an accretional berm fillet will develop on the updrift side of the groin and an associated erosional scarp will develop on the downdrift side of the groin. Consequently, when sand transport is in the long-term net direction (north to south) a wider beach berm is observed at southern end of the groin compartment whereas narrower beach berms are present at the northern end of the groin compartment. The opposite occurs during periods of net longshore transport reversals with accretion and wider beaches at the northern end of the groin compartment and narrower beaches at the southern end of the groin compartment. For this reason, characteristic representative beach profiles developed for modeling purposes were generated using an average of all surveyed profiles within a given groin compartment.

Taking a wider view of the regional coastal setting improves the overall understanding of the coastal processes that have lead to the increasing vulnerability of Edisto Beach to storm-induced damages. Figure 2 provides an aerial view of the South Carolina coastal region between North Edisto Inlet (upper right) and South Edisto Inlet (lower left). Net longshore transport is directed north along Botany Bay Island, located to the south of North Edisto Inlet, a reversal in the net transport direction to the south occurs near Edingsville Beach, which is centrally located between the two large inlets. The barrier island at Edingsville Beach is low lying and frequently overwashed during storm conditions. Sand is sequestered in the extensive inlet shoals and is washed over the low-lying barriers into the coastal marshes. As a result, the sand supply delivered to Edisto Beach by the prevailing coastal processes has diminished considerably over the past century and is expected to continue to diminish into the future. The presence of the groin field at Edisto Beach has significantly reduced shoreline erosion within the project study area and has been essential to the stabilization of the Edisto Beach shoreline. Nevertheless, sand supply to Edisto Beach from the north is insufficient to maintain natural storm protection in the form of significant beach berm widths and a protective dune feature. In the absence of beach nourishment erosion within the groin cells will continue and ultimately exchange of sediment between groin cells will be cut-off. When this occurs it is expected that shoreline erosion will increase first in the vicinity of the point and along the South Edisto Inlet shoreline and then progress to the north along the ocean-facing groin cells.

Gross longshore sand transport rates in the vicinity of Edisto Beach have been estimated at approximately 210,000 cy/year, about 44,000 cy/year directed to the north and about 167,000 cy/year directed to the south. The net longshore sand transport rate is estimated at approximately 123,000 cy/year and directed to the south (CSE, 1993).

Figure 2: Longshore sand transport regime between North Edisto Inlet and South Edisto Inlet.

c. Geomorphology of Edisto Beach

Edisto Beach is at the southern end of what was once a classical prograding drumstick shaped barrier island common in South Carolina. However, over time erosion in the central portion (Edingsville Beach area) of the larger barrier island system due to a net longshore transport divergence has resulted in opening of new tidal inlets (Frampton Inlet, Jeremy Inlet, and a un-named inlet north of Frampton Inlet) and loss of littoral sediments to developing shoal features at those inlets. Continued erosion has reduced the central barriers to little more than swash shoals that allow littoral material to wash over the barriers and become trapped in the coastal marshes. As a consequence the barrier island at Edisto Beach is transitioning to a landward migrating transgressive barrier island.

The geomorphology of Edisto Beach is unique among South Carolina beaches in that the sediment composition of the beach is coarser grained than most South Carolina beaches with a median grain size of approximately 0.4 mm (CSE, 2006) and significant shell content. The relatively coarse median sediment grain size results in comparatively steep foreshore slopes. Within the oceanfront groin compartments the foreshore slope is approximate 1 on 10, within the State Park north of Edisto Beach the foreshore slope is slightly milder at 1 on 15 and the foreshore slope along inlet shoreline is milder still at approximately 1 on 25. These steep foreshores slopes together with a fairly high tidal range (average spring tide range is 6.3 ft) reduces the beach area between the low-tide terrace and the foredunes compared to other South Carolina beaches. Due to these geomorphic conditions wave energy associated with storm conditions is not dissipated to any large degree before it reaches the relatively low foredunes present on the barrier island. The overall average dune crest elevation within the project study area is about 10.5 ft (NAVD88) although dune crest elevations vary between a minimum of 8.5-ft (NAVD88) and 12-ft (NAVD88) in different reaches within the study area. In the State Park area and in the vicinity of the point the average dune crest elevation is 10 ft (NAVD88). Along the Edisto Beach ocean-fronting shoreline the average dune crest elevation is 11.5 ft (NAVD88) and on the inlet-fronting shoreline the average dune crest elevation is approximately 9 ft (NAVD88). Dune volume above the berm elevation can be used as an indicator of storm vulnerability, within the project study area the overall average dune volume above the berm elevation was estimated at approximately 4.3 cy/ft based on representative idealized beach profiles developed for modeling purposes. However, as with the dune crest elevation this quantity varies between a minimum of approximately 1.4 cy/ft north of the camping area in the State Park and the inner inlet sub-reach to a maximum of 7.9 cy/ft in groin cell 6. In the State Park area the average dune volume above the berm elevation is 3.3 cy/ft. Along the Edisto Beach ocean-fronting shoreline the average dune volume above the berm elevation is 5.5 cy/ft whereas in the vicinity of the Point the average dune volume above the berm elevation drops to 3.7 cy/ft and along the inlet shoreline the average dune volume above the berm elevation drops to just 2.8 cy/ft.

A detailed description of the analysis performed to develop the representative idealized profiles for modeling purposes is provided in section 4.0.

d. Sea Level Rise

The mean sea level trend at Charleston, South Carolina (NOAA 8665530) is 3.28 millimeters/year (1.08 feet/century) with a standard error of 0.14 mm/yr based on monthly mean sea level data from 1921 to 1999 (Figure 3). The mean sea level trend for Fort Pulaski, Georgia (NOAA 8670870) is 3.05 millimeters/year (1.00 feet/century) with a standard error of 0.2 mm/yr based on monthly mean sea level data from 1935 to 1999.

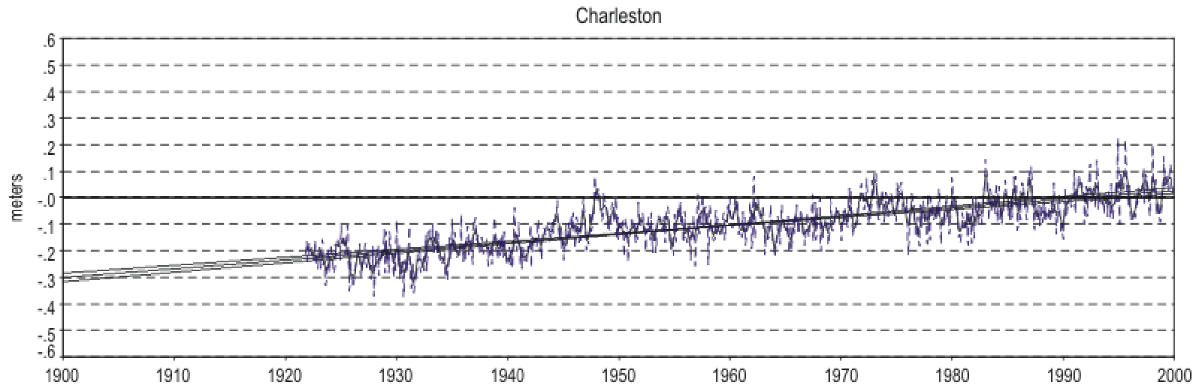


Figure 2: Mean sea level change trend at Charleston, SC.

The mean sea level trend for Edisto was estimated based on the relative position of Edisto to Charleston and Ft. Pulaski. Edisto is approximately 31.5 miles from Charleston and 47.0 miles from Ft. Pulaski.

$$MSL\ Trend = \left(1 - \frac{31.5}{78.5}\right)(3.28) + \left(1 - \frac{47.0}{78.5}\right)(3.05) = 3.19\ mm/yr$$

This historical rate of mean sea level change trend of 3.19 mm/year was applied in all Beach-fx simulations representing the "Low" future rate of sea level change in accordance with EC 1165-2-212. The "Intermediate" rate of future sea level change was computed using modified NRC Curve 1 and equations 2 and 3 in EC-1165-2-212 Appendix B. The "High" rate of future sea level change was computed using modified NRC Curve III and equations 2 and 3 in EC-1165-2-212 Appendix B. The relationships for future sea level change as outlined in EC-1165-2-212 are coded within Beach-fx and sea level change is internally computed continuously throughout the simulated project lifecycle.

3.0 Development of Storm Suite

Storm-generated water levels along the open coast and up the major tributaries of South Carolina have previously been investigated by Dr. Norman W. Sheffner of the U.S. Army Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL) of the Waterways Experiment Station (WES) in Vicksburg, Mississippi for the US Army Engineer District, Charleston. The findings of that investigation are presented in the report titled "Coast of South Carolina Storm Surge Study" and dated May 2000. Tropical and extratropical storm events that have historically impacted South Carolina were simulated with the ADCIRC (ADvanced CIRCulation) long-wave hydrodynamic model.

a. ADCIRC Modeling

The large-domain long-wave hydrodynamic Advanced CIRCulation (ADCIRC) model (Luettich, Westerink, and Scheffner 1992) has been used to provide water-surface elevations for this study. The ADCIRC model is an unstructured grid finite-element long-wave hydrodynamic model developed under the U.S. Army Corps of Engineers (USACE)

Dredging Research Program (DRP). The model was developed as a family of two- and three-dimensional codes with the capability of the following:

- Simulating tidal circulation and storm surge propagation over large computational domains while simultaneously providing high resolution in areas of complex shoreline and bathymetry. The targeted areas of interest include continental shelves, nearshore areas, and estuaries.
- Representing all pertinent physics of the three-dimensional equations of motion. These include tidal potential, Coriolis, and all nonlinear terms of the governing equations.
- Providing accurate and efficient computations over time periods ranging from months to years.

The ADCIRC model solves the depth-averaged Generalized Wave Continuity Equation (GWCE) formulation of the governing equations and has been extensively applied to projects requiring frequency analysis of storm events. The general methodology developed for these previous studies was applied to the South Carolina storm surge investigation (Scheffner, 2000). Tidal and storm surge water surface elevation data were archived at 38 stations, including one station immediately north of Edisto Island (-80.18945 32.56440) and one station immediately south of Edisto Island (-80.35598 32.48759).

b. Computational Grid

A problem often encountered in the modeling of nearshore flow dynamics is that the computational boundaries of the model are not well removed from the area of interest. For example, the continental shelf can substantially affect the amplitude and phase of a storm surge or tide propagating from open water onto the shelf. If the model boundary conditions are specified on the shelf, then boundary condition errors are introduced into the solution because the assumed boundary conditions are posed in a dynamic flow region, i.e., the transformation of the flow field over rapidly changing bathymetry. An advantage for the use of large domains is that boundary conditions can be defined in deep water where nonlinear effects of the continental shelf are minimal. This approach to specification of boundary conditions virtually eliminates contamination of model results from poorly defined boundary conditions (Scheffner, 2000).

The 20,000 node computational domain (shown in Figure 4) used in the generation of the DRP east coast, Gulf of Mexico, and Caribbean Sea tidal data base formed the initial grid for this study because the tidal boundary conditions along the eastern boundary (60^{o} east Longitude) had already been determined. Additionally, proper flow connectivity between the Gulf of Mexico, Caribbean Sea, and the South Atlantic Bight was assured by accurately defining the bathymetry of all basins. For example, by modeling the entire domain, the flow and surge distribution resulting from hurricanes moving toward the study area from the Caribbean or Gulf of Mexico is properly simulated. Minimum node-to-node spacing of this initial grid was on the order of 5 km. Minimum resolution along the open coast and up the major tributaries of the study area was decreased to approximately 700 m in order to provide sufficient detail of the local bathymetry and topography. The increased resolution of the study area shown is Figure 5.

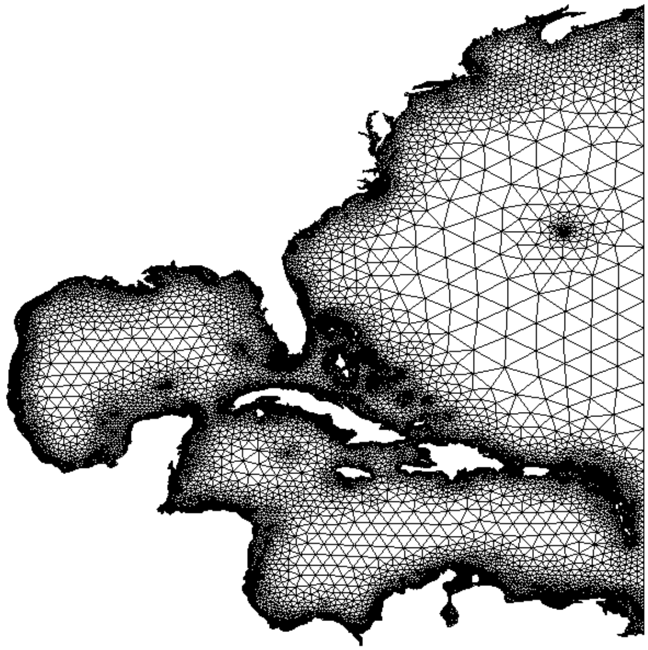


Figure 4: The Dredging Research Program grid of the East Coast, Gulf of Mexico and Caribbean Sea.

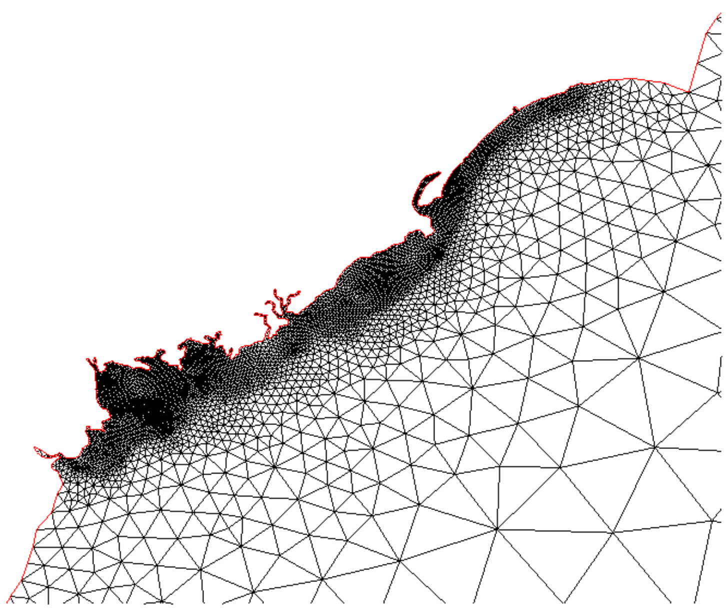


Figure 5: Grid resolution in the South Carolina study domain.

1) Tropical Storms

A tropical storm database (Scheffner, et al 1994) was generated during the DRP through simulation of 134 historically based storm events along the east coast, Gulf of Mexico, and Caribbean Sea. For 486 discrete locations along the U.S. coast, storm events which produced a storm surge of at least 1.0 ft. were archived and indexed according to event, location, and surge. This indexed database was used to define an initial training set for the present study (Scheffner, 2000).

Ideally, historical events represent the full range of possible event intensities. If this occurs, the historical events can be used directly to develop the full training set of storms. For extratropical events, this is generally the case because extratropical events occur often, cover extremely large areas, and persist for long periods of time (i.e., days). However, with tropical events this is often not the case. At many locations, the worst case tropical event scenario may not yet have occurred in the historical record, but may represented by a historic event with a slightly shifted path or larger/smaller radius to maximum wind. Because of this, some augmentation of the historic events is often necessary. This was found to be necessary for the South Carolina study because station locations of interest span over 150 miles. For example, Hurricane Hugo made a near-perpendicular landfall near Charleston on 21 September 1989. Hurricane Hugo produced severe surges for areas north and east of Charleston, however, areas south and west of landfall were not significantly impacted (Scheffner, 2000).

In order to supplement the training set so that all stations within the study experience a maximum intensity event, and thereby fill the vector space with events ranging from nominal to intense, six (6) additional storm events were added to the initial training set. Four of these events were developed as perturbations of Hurricane Hugo, and two were developed as perturbation of the unnamed hurricane of 1910, the two most intense events in the historical record. As a result, maximum surge elevations were experienced just east of landfall, however, negligible surge elevations were experienced southwest of landfall and the surges were minimal further northeast of landfall. Four hypothetical events were created by assuming the historical path of Hurricane Hugo was shifted 1 and 2 degrees west of landfall and 1 and 2 degrees east of landfall. These four combinations, along with the historical event produced maximum surges throughout the study area. For the 1910 hurricane two hypothetical events were created by assuming the historical path wave was shifted 1 degree both east and west of landfall. The final training set consisted of 30 events; 24 historical, and 6 hypothetical (4 representing perturbations of Hurricane Hugo and 2 representing perturbations of the hurricane of 1910). The final training set is shown in Table 2 (Scheffner, 2000).

Table 2: Tropical Storm Training Set Inventory.

HURDAT* Storm #		Given name	Date*(mm/dd/yyyy)
1.	194	NOT NAMED	10/09/1910
2.	194A	1910-A	--
3.	194B	1910-B	--
4.	196	NOT NAMED	08/23/1911
5.	217	NOT NAMED	07/11/1916
6.	292	NOT NAMED	09/06/1928
7.	296	NOT NAMED	09/22/1029
8.	299	NOT NAMED	08/31/1930
9.	353	NOT NAMED	08/29/1935
10.	398	NOT NAMED	08/05/1940
11.	440	NOT NAMED	10/12/1944
12.	449	NOT NAMED	09/12/1945
13.	463	NOT NAMED	09/20/1947
14.	465	NOT NAMED	10/09/1947
15.	521	NOT NAMED	08/28/1953
16.	526	FLORENCE	09/23/1953
17.	541	HAZEL	10/05/1954
18.	562	FLOSSY	09/21/1956
19.	589	GRACIE	09/20/1959
20.	597	DONNA	08/29/1960
21.	643	ALMA	06/04/1966
22.	669	GLADYS	10/13/1968
23.	777	DAVID	08/25/1979
24.	797	DENNIS	08/07/1981
25.	839	KATE	11/15/1985
26.	872	HUGO	09/10/1989
27.	872A	HUGO-A	--
28.	872B	HUGO-B	--
29.	872C	HUGO-C	--
30.	872D	HUGO-D	--

*The HURDAT storm number designation refers to the storm identification number of the events in the National Hurricane Center data base of historic tropical events and the time signifies the first time of storm on record.

2) *Extratropical Storms*

In a similar manner to the tropical event database described above, an extratropical storm event database was generated within the DRP. This database was constructed by driving the ADCIRC model with wind fields extracted from the U.S. Navy Fleet Numerical Meteorology and Oceanography Center's database of winds for the 16-year winter storm period (defined as September through March) of 1977 through 1993 (77-78, 78-79, etc). These data are provided at 6-hour intervals on a 2.5^{o} latitude and longitude grid. The extratropical storm database consists of surface elevation and current hydrographs at each of the 486 stations described above. These data contain severe events occurring during the 16-year sequence of winter months; however, unlike tropical events that are clearly distinguishable, identification of individual extratropical events within the records requires additional analysis (Scheffner, 2000).

Time series surface elevation plots corresponding to an archived station near the center of the study area were analyzed. Each time series represented surge with no tide. The time series of water surface elevations for the 16 year seasons were plotted and 9 extratropical events were identified and extracted from the time series to populate the extratropical storm event database. The 9 extratropical storm events selected were those that produced the highest elevation peak storm surge. Maximum wave height and storm duration did not enter into the extratropical storm selection process. The approximate starting time for each of the 9 events is shown in Table 3 (Scheffner, 2000).

Table 3: Extratropical Storm Training Set Inventory

Storm Number	Starting Date (mm/dd/yyyy)
1.	02/13/1979
2.	09/01/1979
3.	02/08/1983
4.	02/24/1983
5.	03/13/1983
6.	09/05/1984
7.	10/24/1985
8.	01/01/1987
9.	02/13/1987

c. *Development of Plausible Storm Suite*

The historical (and hypothetical) tropical and extratropical storm events identified as discussed above were expanded to form what is known as a plausible storm suite that will be used to drive beach evolution within Beach-*fx*. The procedure followed to generate a site-specific plausible storm suite for Edisto Beach for use in the numerical estimation of storm-induced beach morphology response during this feasibility study involved five (5) broad steps:

- Identification of project specific significant storm events (discussed previously).
- Extraction of the storm surge hydrographs corresponding to the identified significant storm events.
- Estimation of wind wave conditions corresponding to the identified significant storm events.
- Statistical characterization of project specific astronomical tides and estimation of representative high, mean, and low tidal ranges.
- Development of 12 plausible total water level hydrographs for each of the identified significant storm events.

The first two steps were completed by reviewing and utilizing the data from the SC Storm Surge study detailed above. Final storm surge hydrographs were constructed by averaging the hydrographs from the two Edisto stations for each tropical and extratropical storm in the database.7

Preparation of the storm surge hydrographs for their use in SBEACH simulations involved identifying the portion of the ADCIRC simulation relevant to morphology response modeling and processing the storm surge hydrographs, which involved clipping the storm surge hydrographs and applying a mild smoothing of the hydrographs as necessary. The storm surge hydrographs were analyzed to identify which portions of the modeled event were essential for capturing the beach response in SBEACH. For example, if the averaged, hydrograph from the SC Storm Surge Study was 150 hours long and only the 100 hours in the middle of the data were appropriate and necessary, the 25 hours at the beginning and the 25 hours at the end were clipped from the record. The next step was to smooth portions of the time series that required some degree of smoothing.

The contribution of astronomical tides to the total water elevation hydrograph was developed by first performing a statistical analysis of tides as Edisto Beach. The aim of the analysis was to estimate three statistically significant tidal ranges. Specifically, to quantify:

1. A high tidal range representing the mean of the highest 25 percent of all tidal ranges occurring at Edisto Beach;
2. A mean tidal range representing the mean of the central 50 percent of all tidal ranges occurring at Edisto Beach;
3. A low tidal range representing the mean of the lowest 25 percent of all tidal ranges occurring at Edisto Beach.

Next semi-diurnal cosine tide signals were generated with ranges corresponding to the computed high, mean, and low tidal ranges. Each of the historical and hypothetical storm surge hydrographs were combined with the idealized cosine astronomical tide hydrographs to generate the suite of plausible total water elevation time series. For each tide range (high, mean, and low) the storm surge hydrograph was added to the cosine astronomical tide hydrograph at four phases of the tide signal; aligning peak storm surge with high tide, mean tide falling, low tide and mean tide rising. This procedure produces 12 plausible total water elevation representations of each of the historical storm events. Those events associated with the mean tide range are weighted double the weight of those events associated with the high and low tide ranges. For the two historical storms that involved hypothetical representations, the hurricane of 1910 and Hurricane Hugo, the combined weight of all representations of the historical is equal to the combined weight of the other historical events. The plausible storm suite includes 5 representations of Hurricane Hugo, four hypothetical storm tracks and the historical storm track, whereas the other hurricanes (with the exception of the hurricane of 1910) involved just the historical storm track. So, for example, the combined total weight of the 12 representations of Hurricane Dennis is 16 (4 with a weight of 1 associated with the high tide range, 4 with a weight of 2 associated with the mean tide range, and 4 with a weight of 1 associated with the low tide range), whereas for Hurricane Hugo which involves 5 representations of the storm (1 historical and 4 hypothetical) the weighting is as follows: 20 with a weight of 0.2 associated with the high tide range, 20 with a weight of 0.4 associated with the mean tide range and 20 with a weight of 0.2 associated with the low tide range, which results in a combined weight of 16, the same as Hurricane Dennis.

Waves for the extratropical events were available from the Wave Information Studies (WIS) database. All of the wave height time series (tropical and extratropical) were reduced, where applicable and necessary, by limiting wave heights according to the depth limited breaking wave criteria based on water depth during the event at the SBEACH computational boundary. When the wave time series length was shorter than the surge time series, a standard minimum wave height and period were added to the time series. The minimum wave height was selected as a weighted average of the mean wave heights of the first two bins in the WIS analysis. Bin1 (0.0-0.5 m) was assigned 0.25 meters and represented 11.67% of the 20-year record, while Bin2 (0.5-1.0 m) was assigned 0.75 meters and represented 49.49% of the 20-year record.

$$0.25(0.1167/0.6116) + 0.75(0.4949/0.6116)=0.65 \text{ meters} = 2.1 \text{ feet}$$

Adjustments to the timing of the peak wave heights with regards to the timing of the peak storm surge so that the peaks were more or less aligned. Wind waves for the tropical storms were obtained from the WIS hindcast for those storms occurring between 1980 and the present. For those tropical storms occurring prior to 1980 a parametric prediction technique was employed as described in the Coastal Engineering Manual, Section II-2-2-c *parametric prediction of waves in hurricanes.*

4.0 Representative Beach Profiles

The Coastal Engineering Manual (CEM) provides some guidance on how to determine baseline damages by including the existing or without-project condition of the project study domain. Morphologic features of the existing beach, such as dune height, berm width, and offshore profile shape, typically vary along the project study domain. To accurately estimate storm erosion response for the existing condition, the CEM suggests developing a set of representative morphologic reaches to describe variations in profile shape along the project domain. Morphology analysis software applications such as BMAP or RMAP can be used to define morphologic reaches by analyzing profiles, grouping similar profiles, and calculating an average representative profile for each reach. According to the CEM, the profile characteristics that should be considered when developing morphologic reaches include dune height and width, berm width, nearshore and offshore profile slopes, sand grain size, presence of seawalls or other structures, and proximity to inlets.

The Edisto Beach Hurricane and Storm Damage Reduction feasibility study will employ BEACH-*fx*, the Corps' Monte Carlo life-cycle simulation model for estimating shore protection project evolution and cost benefit analyses. For a general description of the principles upon which Beach-*fx* operates the reader is directed to Gravens, et al. (2007). An overview of the general hierarchical data structure employed in Beach-*fx* is provided in Figure 6. Within Beach-*fx* the overall unit of analysis is the "project," a shoreline area for which the analysis is to be performed. The project is divided, for purposes of analysis, into "reaches," which are contiguous, morphologically homogeneous areas. The structures within a reach are referred to as Damage Elements (DEs), and are located within lots. All locations are geospatially referenced using a cartographic coordinate system such as state plane coordinates. This project definition scheme is shown schematically in Figure 7, in which the shoreline is linearized into reaches. Each reach is associated with a representative beach profile that describes the shape of the cross-shore profile and beach composition.

The profile is the basic unit of beach response. Natural beach profiles are complex; for the modeling, a simplified or idealized beach profile, representing key morphological features defined by points, is used as shown in Figure 8. The idealized profile represents a single trapezoidal dune with a horizontal berm and a horizontal upland landward of the dune feature.

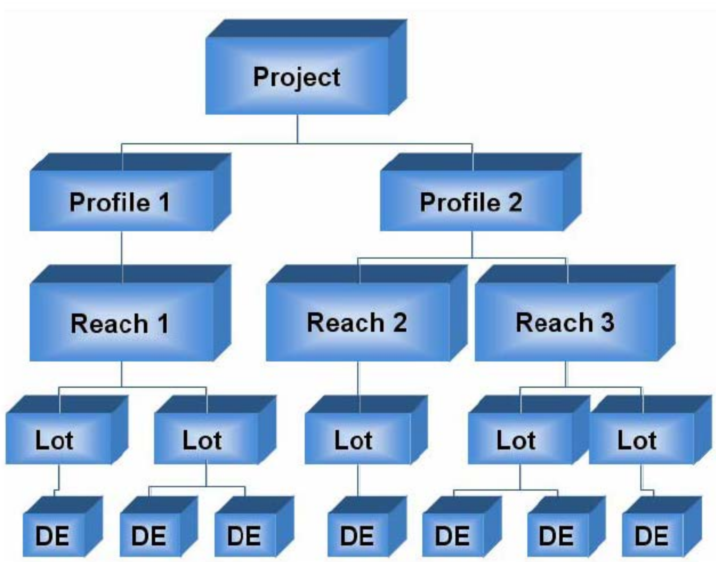


Figure 6: Hierarchical representation of Beach-fx data elements (taken from Beach-fx Users Manual, Version 1.0).

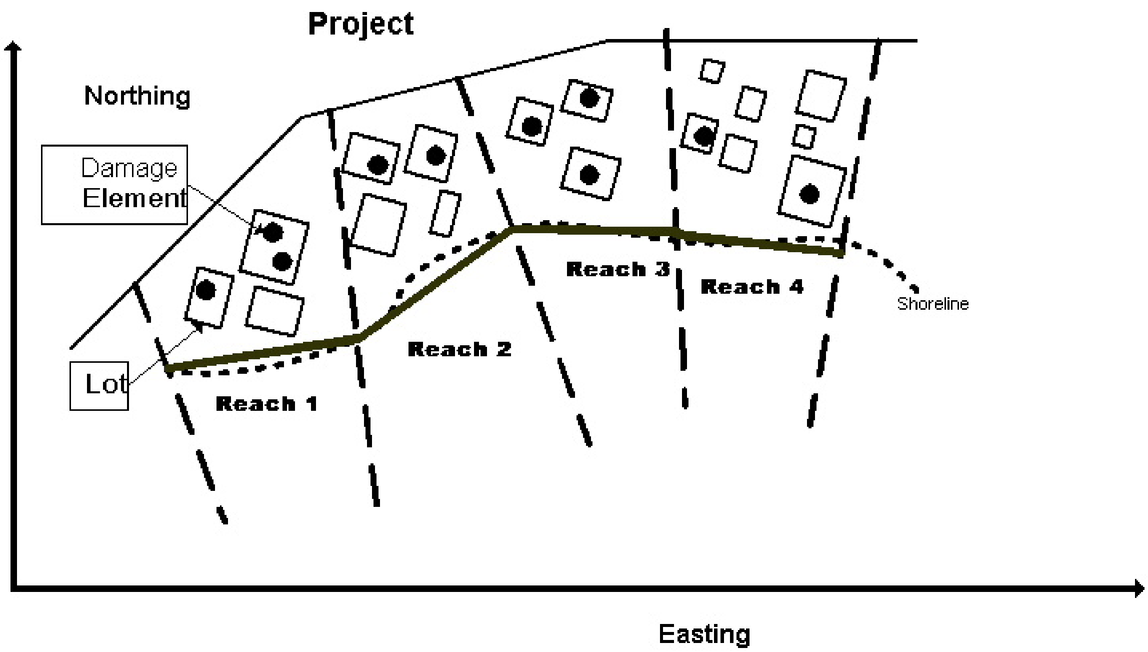


Figure 7: Beach-*fx* schematization of the project study area.

The submerged portion of the profile is represented by a detailed series of distance-elevation points that are determined through an analysis of available beach profile information. For the Edisto Beach project, the detailed submerged beach profile was developed by averaging across multiple surveyed beach transects containing similar offshore slopes.

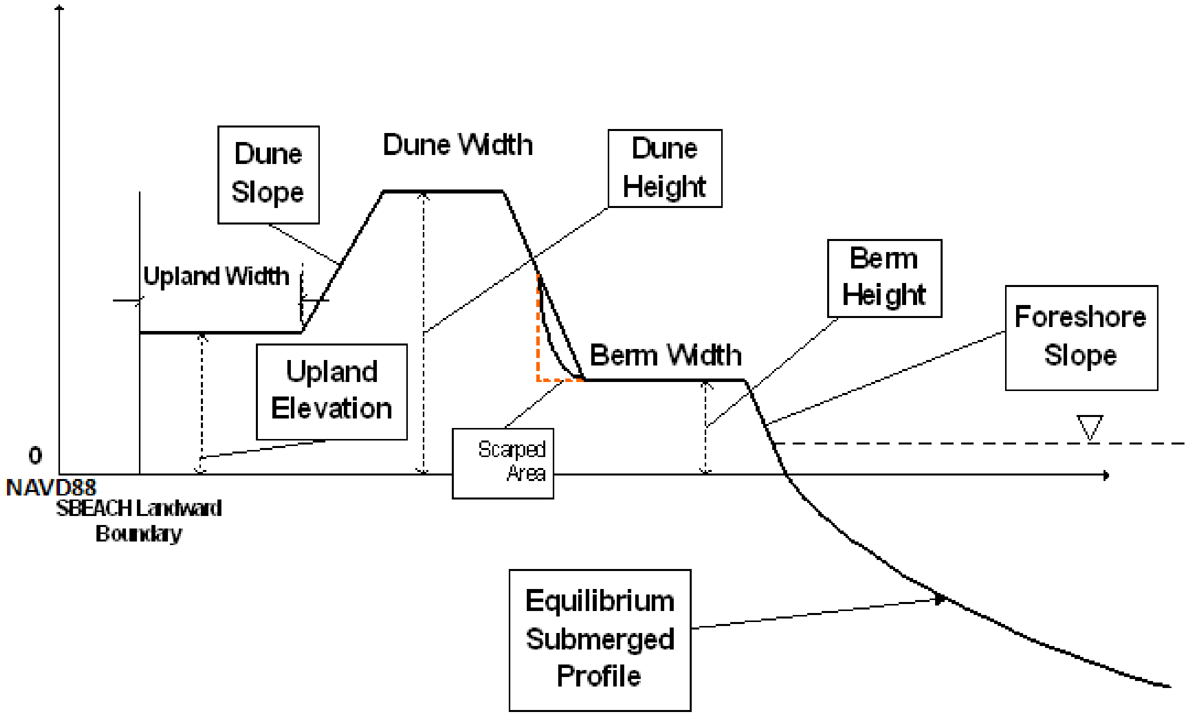


Figure 8: Beach-*fx* idealized beach profile.

The beach morphology of Edisto Island, particularly the Town of Edisto Beach, is heavily influenced by the presence of the 34 groins, which are spaced an average of every 600 feet along the Atlantic shoreline of the Town of Edisto Beach. The Town's coastal engineering consultant, Coastal Science and Engineering, Inc. (CSE), has laid out their beach monitoring stations in such a way as to be able to capture the beach profile characteristics at an average of three locations between successive groins. CSE has been monitoring Edisto Island with beach profiles at 90 locations along the Edisto shoreline yearly since 2004. Figure 9 shows the distribution of these 90 locations and clearly shows that the primary area of emphasis is the Atlantic shoreline of the Town of Edisto Beach. Figure 10 provides a more detailed view of some of the monitoring locations and their relationship to the groins. The beach profile monitoring data produced by CSE is not the only source of temporal and spatial varying beach profile data for the island, since the South Carolina Office of Coastal Resource Management (OCRM) also collects beach profiles along the island. Profiles have been collected since 1988 at 21 monument locations setup by the South Carolina Coastal Council (SCCC), which was the predecessor to OCRM. Table 4 provides a list of the available beach profile survey information that was available for this analysis.

Because of the greater number of profiles in the CSE dataset and the fact that the CSE dataset included profiles at some of the same locations as the OCRM dataset, the OCRM dataset was not used for determining representative morphologic profiles. The CSE dataset provides sufficient coverage of the project domain and enough detail of the beach profile characteristics in order to delineate discrete morphologic profiles.

Table 4: Summary of beach profile survey data.

Date	Source	Date	Source	Date	Source
Oct-1988	OCRM	Apr-1995	OCRM	Dec-1999	OCRM
June-1990	OCRM	May-1995	OCRM	May-2000	OCRM
Nov-1990	OCRM	Nov-1995	OCRM	Apr-2001	OCRM
May-1991	OCRM	Apr-1996	OCRM	Aug-2002	OCRM
Oct-1991	OCRM	June-1996	OCRM	June-2004	OCRM
Nov-1991	OCRM	Sep-1996	OCRM	Aug-2004	CSE
June-1992	OCRM	Apr-1997	OCRM	July-2005	OCRM
Sep-1992	OCRM	May-1997	OCRM	Nov-2005	CSE
Apr-1993	OCRM	Sep-1997	OCRM	Aug-2006	CSE
May-1993	OCRM	Apr-1998	OCRM	Nov-2006	OCRM
Sep-1993	OCRM	May-1998	OCRM	July-2007	CSE
Dec-1993	OCRM	Sep-1998	OCRM	Dec-2007	OCRM
Apr-1994	OCRM	Oct-1998	OCRM	July-2007	CSE
Oct-1994	OCRM	Jan-1999	OCRM		
Dec-1994	OCRM	Apr-1999	OCRM		

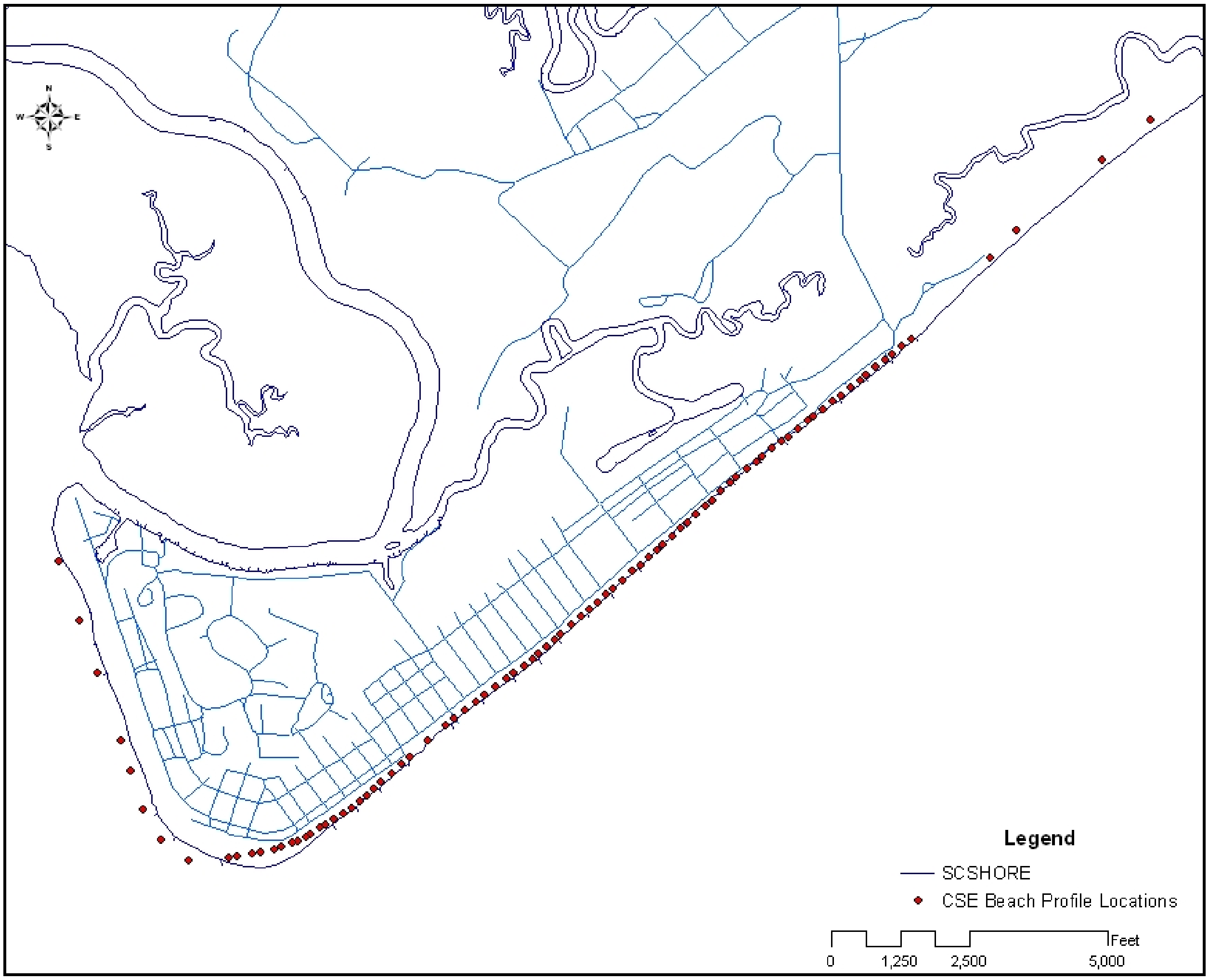


Figure 9: Location of CSE beach profile monitoring stations.

The beach profile analysis that lead to the development of the idealized representative beach profile began by first computing the average beach profiles within each of the groin compartment. The profile surveys employed in this analysis were those surveyed in August 2004, November 2005, July 2007, and July 2008. Although a survey was performed in July 2006 this survey data set was not used because of the influence of the beach nourishment that occurred between April and May 2006. As a result of the recently completed beach nourishment project offshore beach profiles were over-steepened due the placement of approximately 850,000 cy of nourishment sand. After computing the average submerged profile within each of the groin compartments the shape of the offshore profile was compared across all the groin compartments and similar profiles were combined and an average submerged profile was computed for similar shape offshore profiles across multiple groin cells. In the end, a total of 14 representative submerged beach profiles were developed to characterize the project study area as illustrated in Figure 11. In this figure the green polygons represent the lot parcels and the blue brackets show the spatial distribution of the developed representative submerged profiles. Table 5 defines the relationship between groin cells and the representative submerged beach profiles.

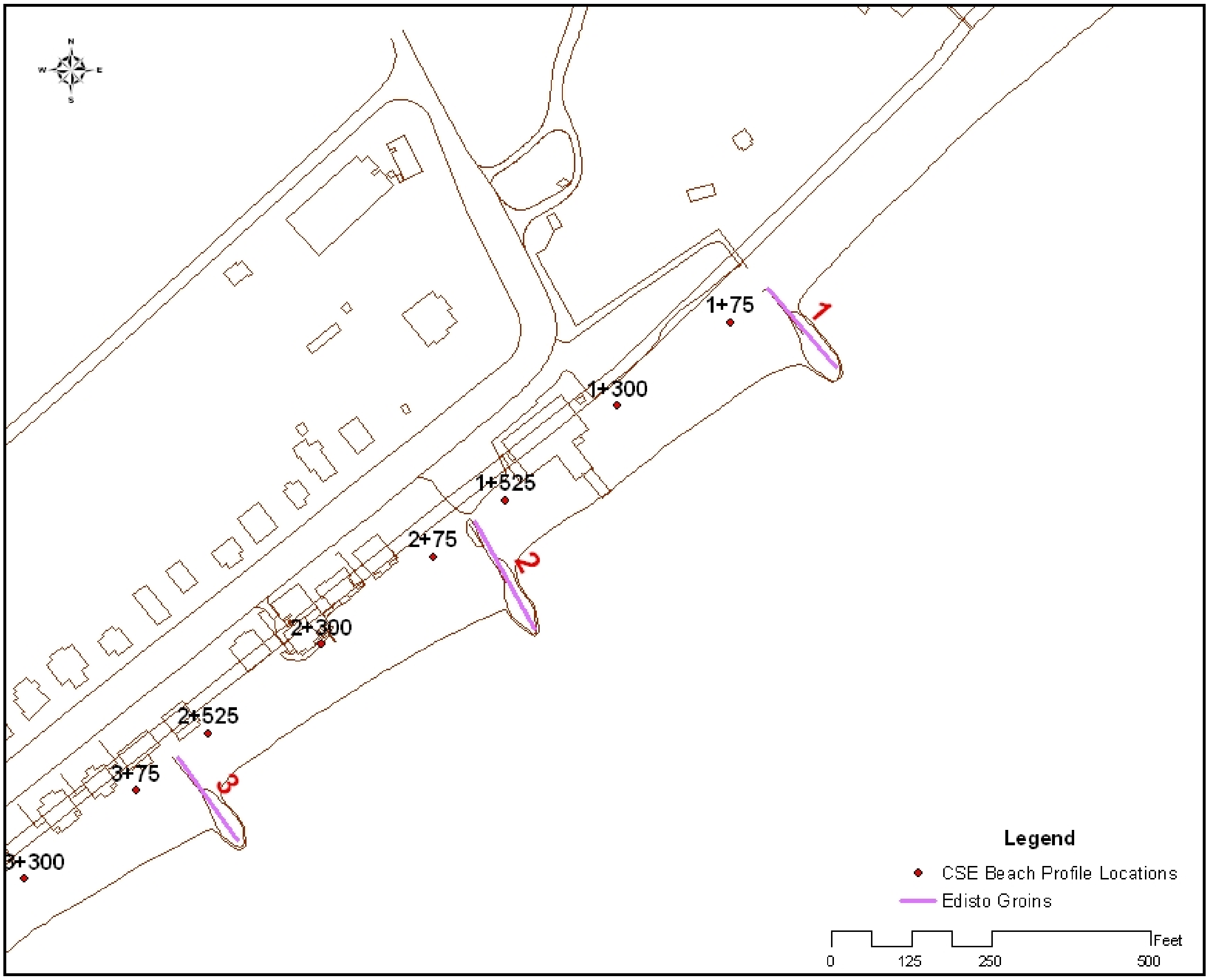


Figure 10: Location of CSE beach profile monitoring stations with respect to groins on Edisto Beach.

The next step in the development of the representative beach profiles for input into Beach-*fx* involved characterizing the upland dune and berm portion of the profiles. For this analysis only the July 2008 profile survey was used because the intent is to characterize the initial condition upper beach profile characteristics for initializing the lifecycle simulations performed within Beach-*fx*. The analysis involved first aligning the survey profile information within each groin cell such that the cross-shore position of the dune crest shared a common cross-shore position. Then an average profile was computed which yielded an average dune crest elevation within the groin cell as well as a representative average berm width within the groin compartment. Finally, an idealized profile suitable for input to Beach-*fx* (horizontal upland, trapezoidal dune section with constant landward and seaward dune slopes, a horizontal berm section, and constant a foreshore slope down to datum) was generated. In a number of the groin cells the upland, dune, and berm characteristics of the average upper beach profile was similar and in those cases a single idealized upper beach profile was generated. Figures 12 through 30 illustrate the idealized upper beach profiles that define the Beach-*fx* reaches used in this feasibility study. In Figures 12 through 30 the green line depicts the developed representative beach profile the red line depicts the idealized profile that defines the initial condition in Beach-fx. As seen in Figures 15 through 29 the placement of sand fencing along the back berm has resulted in berm accretion above the natural berm elevation. The idealized beach profiles (red line) reflect the natural berm elevation of 7 ft NAVD whereas, sand accumulation near the sand fencing results in berm elevations 1 to 2 ft higher than the natural berm on the representative profiles (green line).

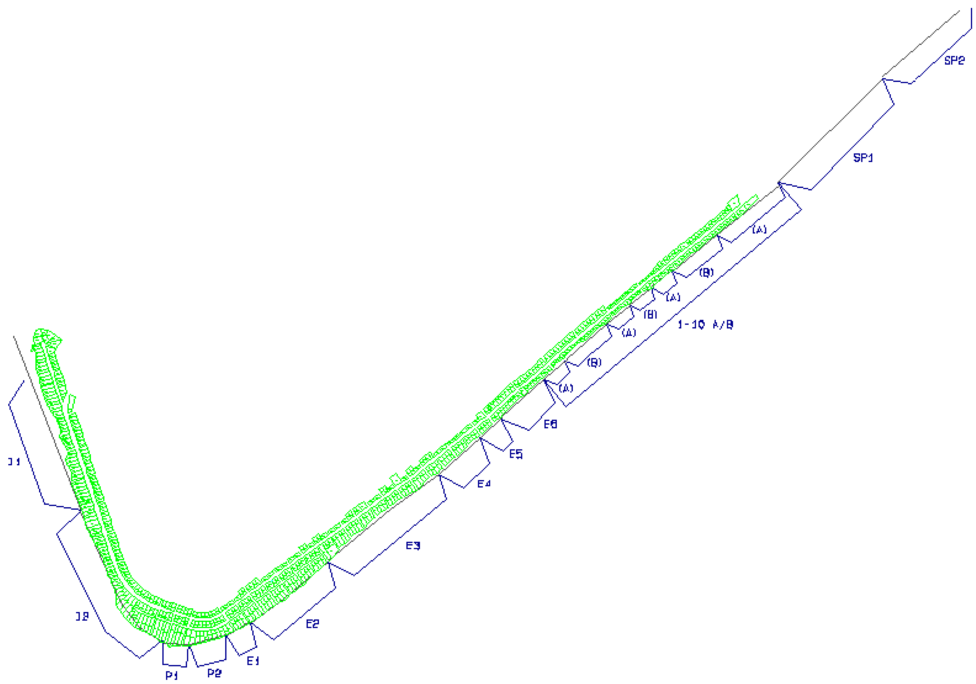


Figure 11: Spatial distribution of representative submerged beach profiles.

Table 5: Representative Submerged Profile Relationship to Groin Cells

Submerged Profile Name	Spatial Description
I1	0.75 mile segment of shoreline from Big Bay Creek towards the point
I2	0.6 mile segment of shoreline between I1 and the point
P1	Groin cell 28
P2	Groin cells 26 and 27
E1	Groin cells 24 and 25
E2	Groin cells 20, 21, 22, and 23
E3	Groin cells 16, 17, 18, and 19
E4	Groin cells 14 and 15
E5	Groin cell 13
E6	Groin cells 11 and 12
A	Groin cells 1, 2, 5, 7, and 10
B	Groin cells 3, 4, 6, 8, and 9
SP1	0.6 mile segment of shoreline extending north

	from groin 1
SP2	0.4 mile segment of shoreline north of SP2

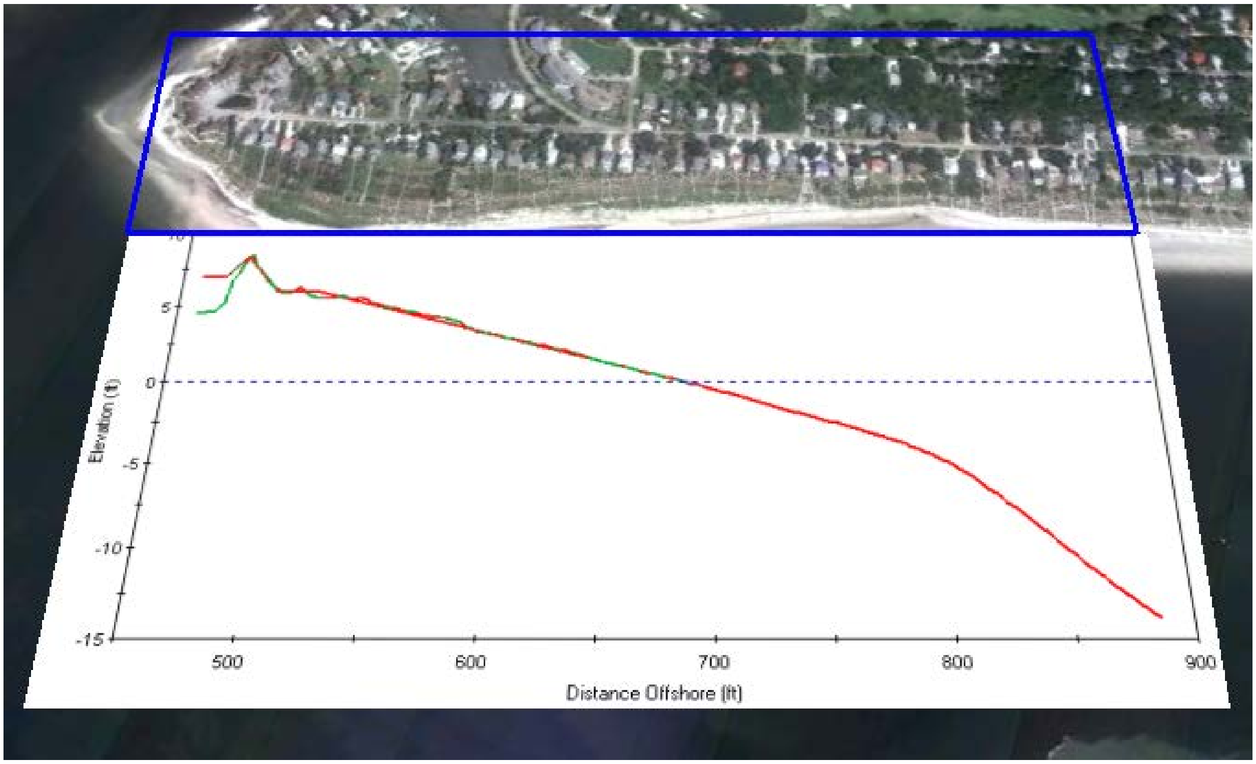


Figure 12: Representative and idealized beach profile for Reach I1.

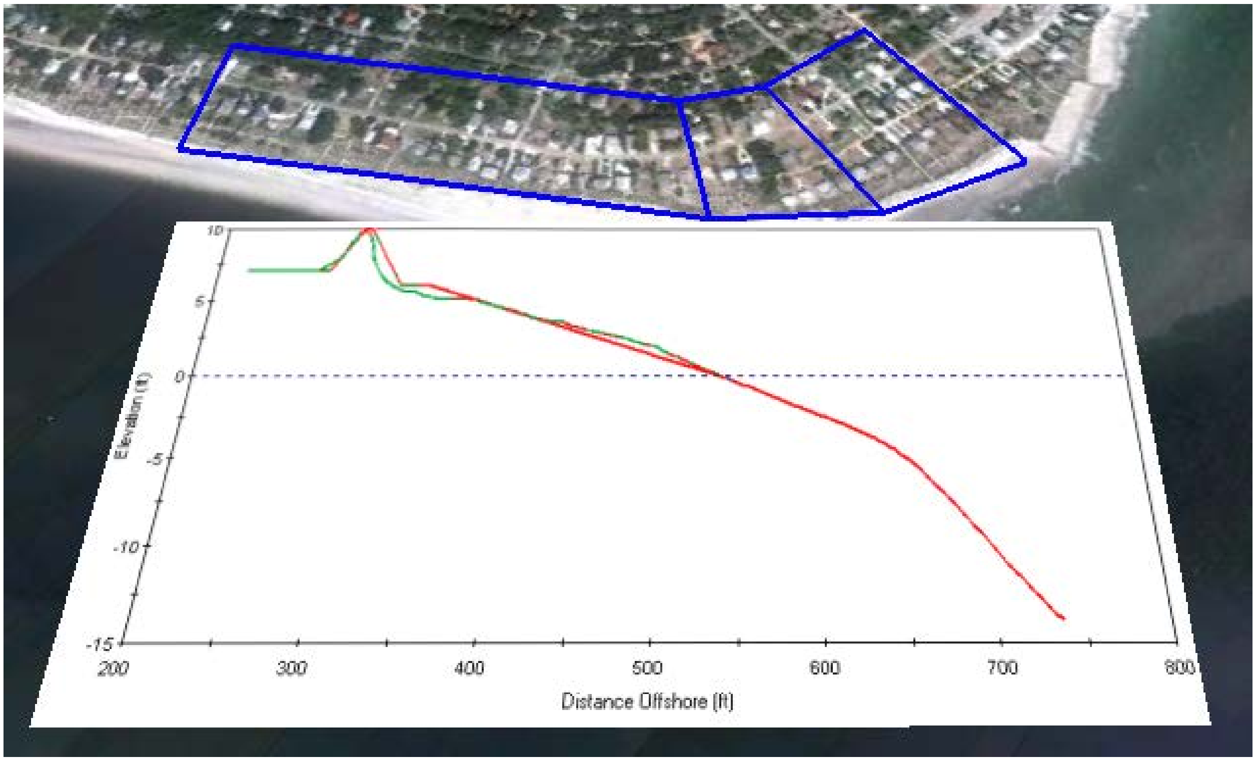


Figure 13: Representative and idealized beach profile for Reaches I2 through I4.

Figure 14: Representative and idealized beach profile for Reach P1.

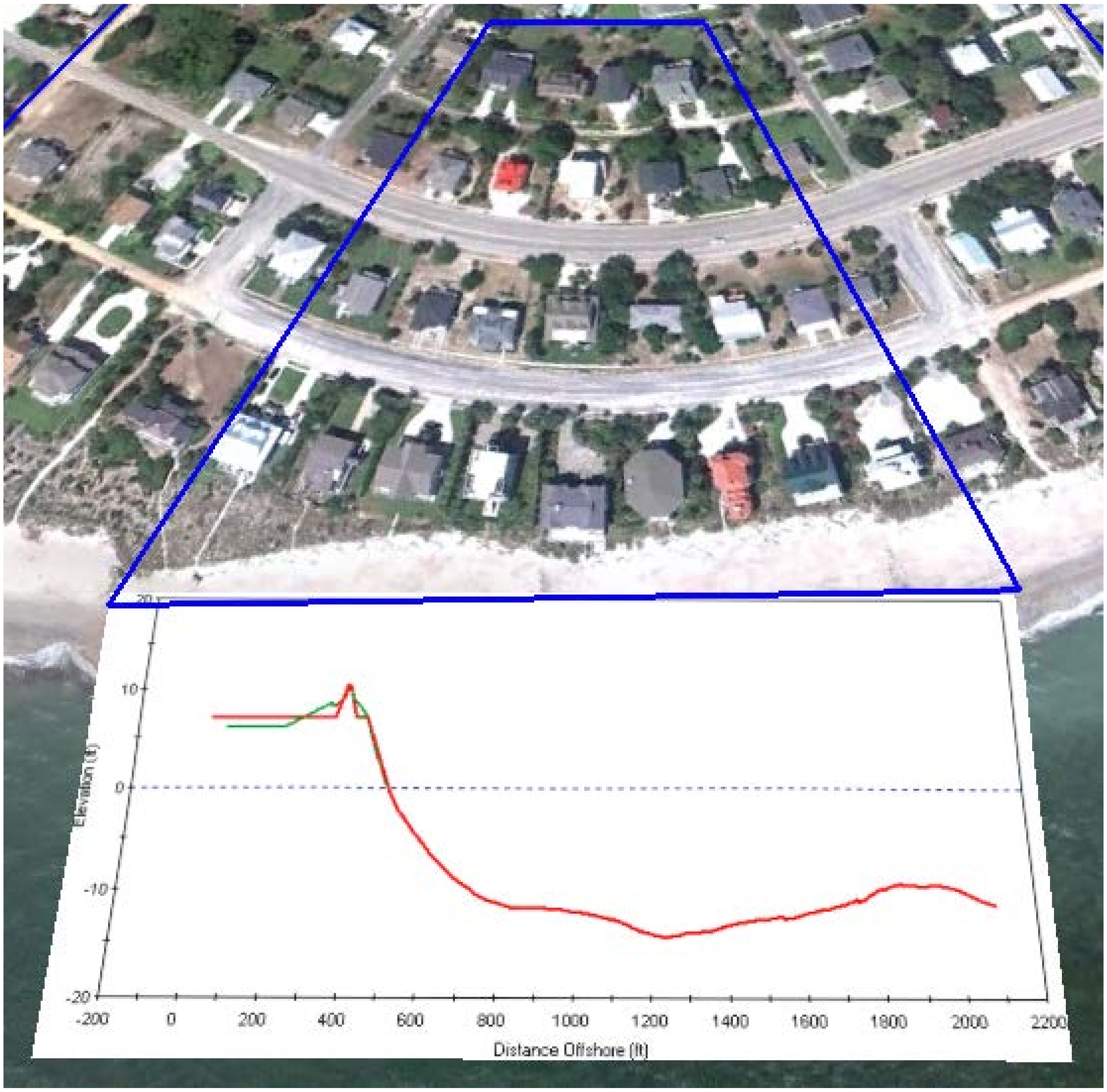


Figure 15: Representative and idealized beach profile for Reach P2.

Figure 16: Representative and idealized beach profile for Reach E1.

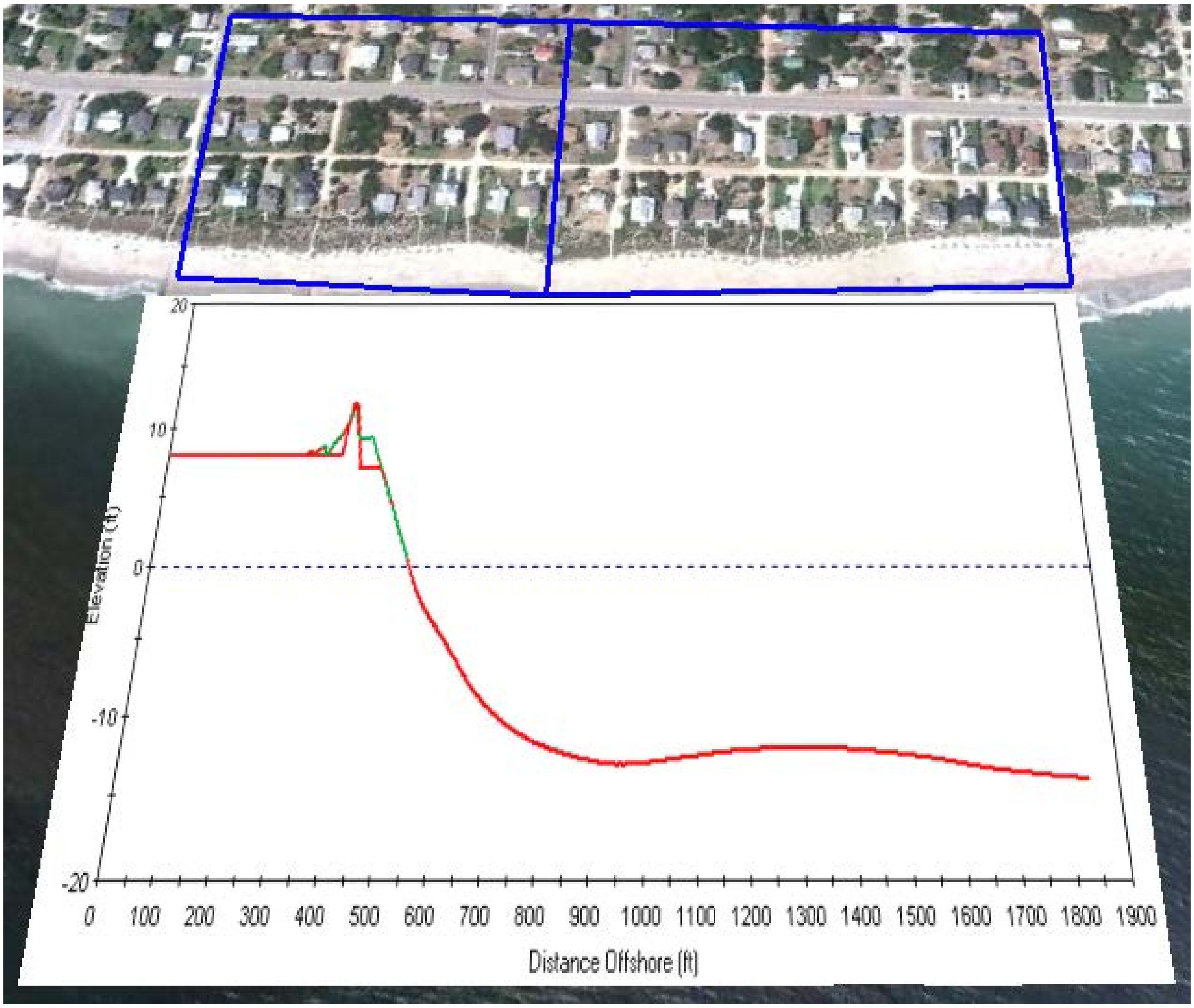


Figure 17: Representative and idealized beach profile for Reaches E2 and E3.

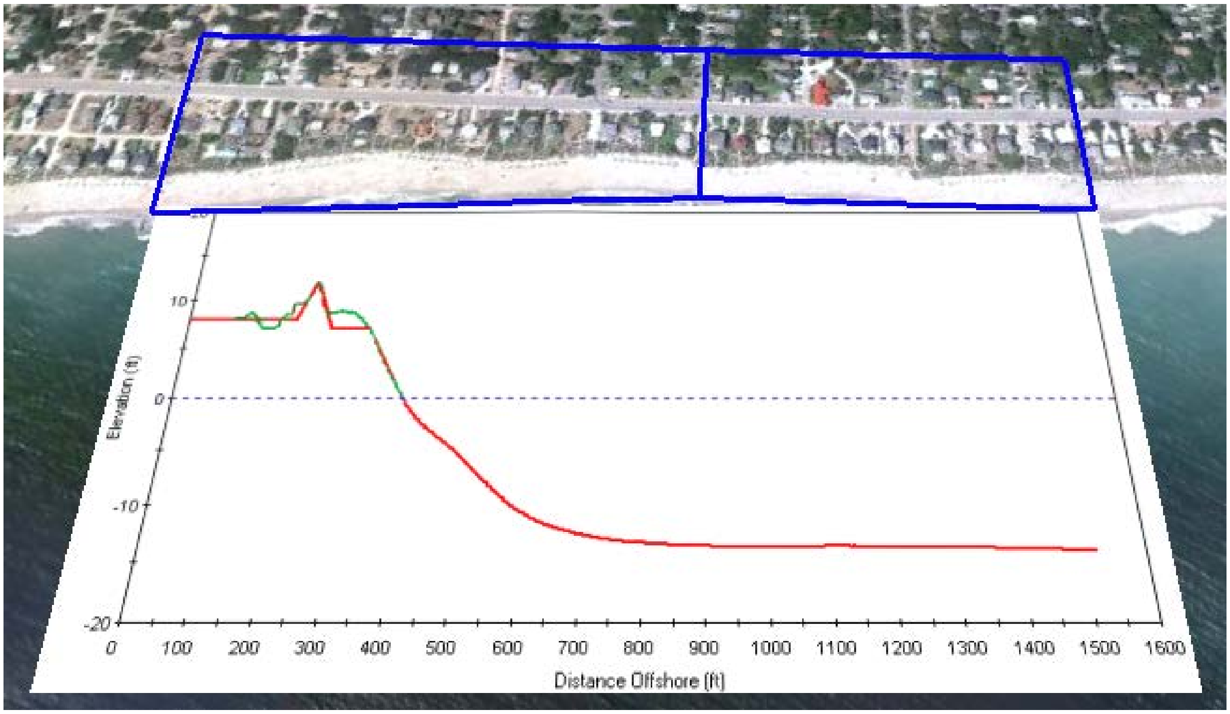


Figure 18: Representative and idealized beach profile for Reaches E4 and E5.

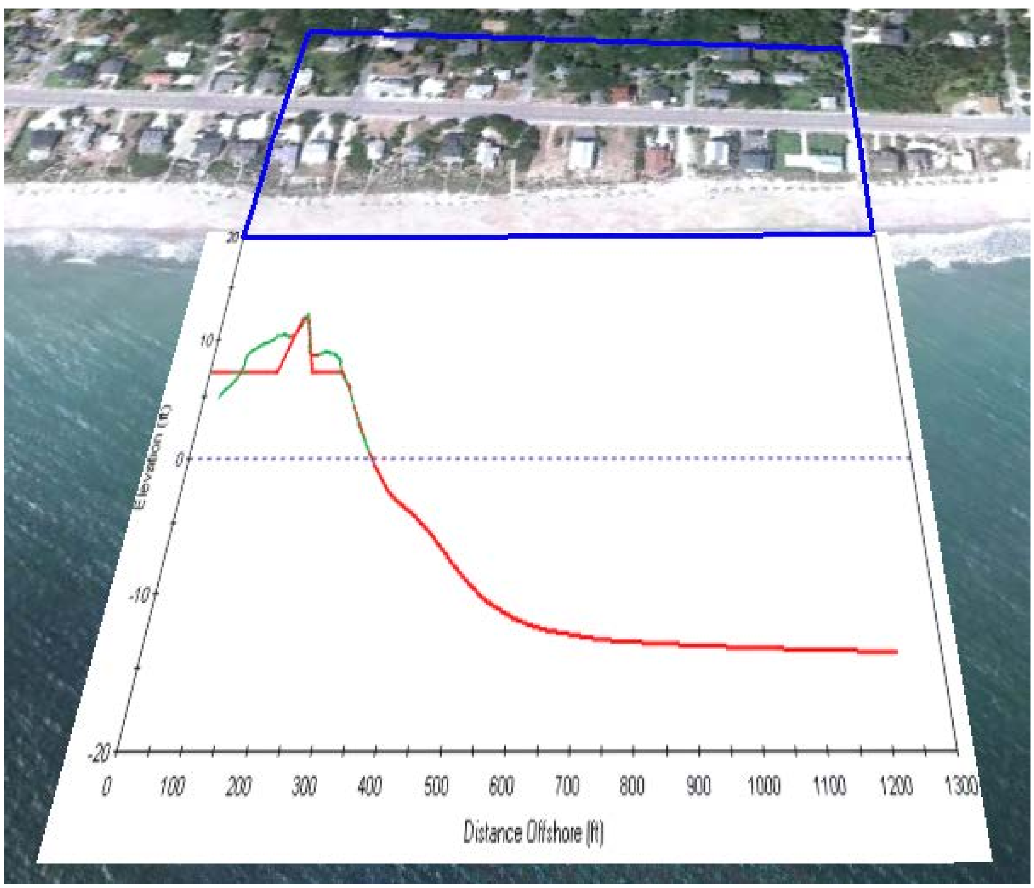


Figure 19: Representative and idealized beach profile for Reach E6.

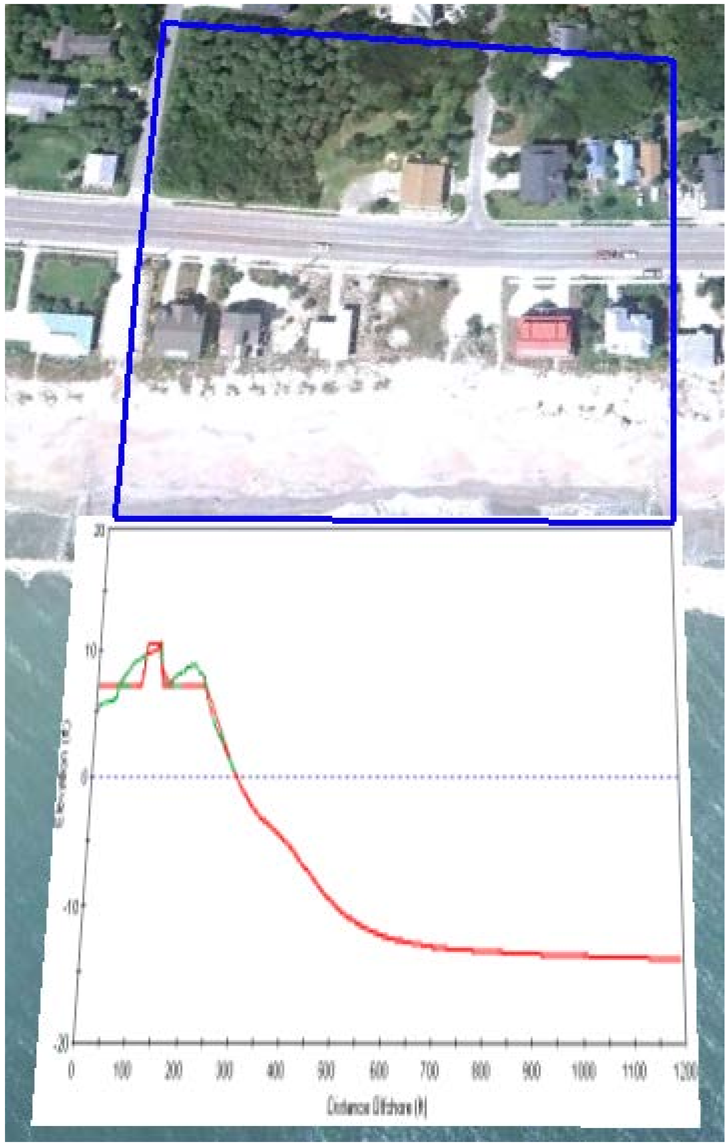


Figure 20: Representative and idealized beach profile for Reach E7.

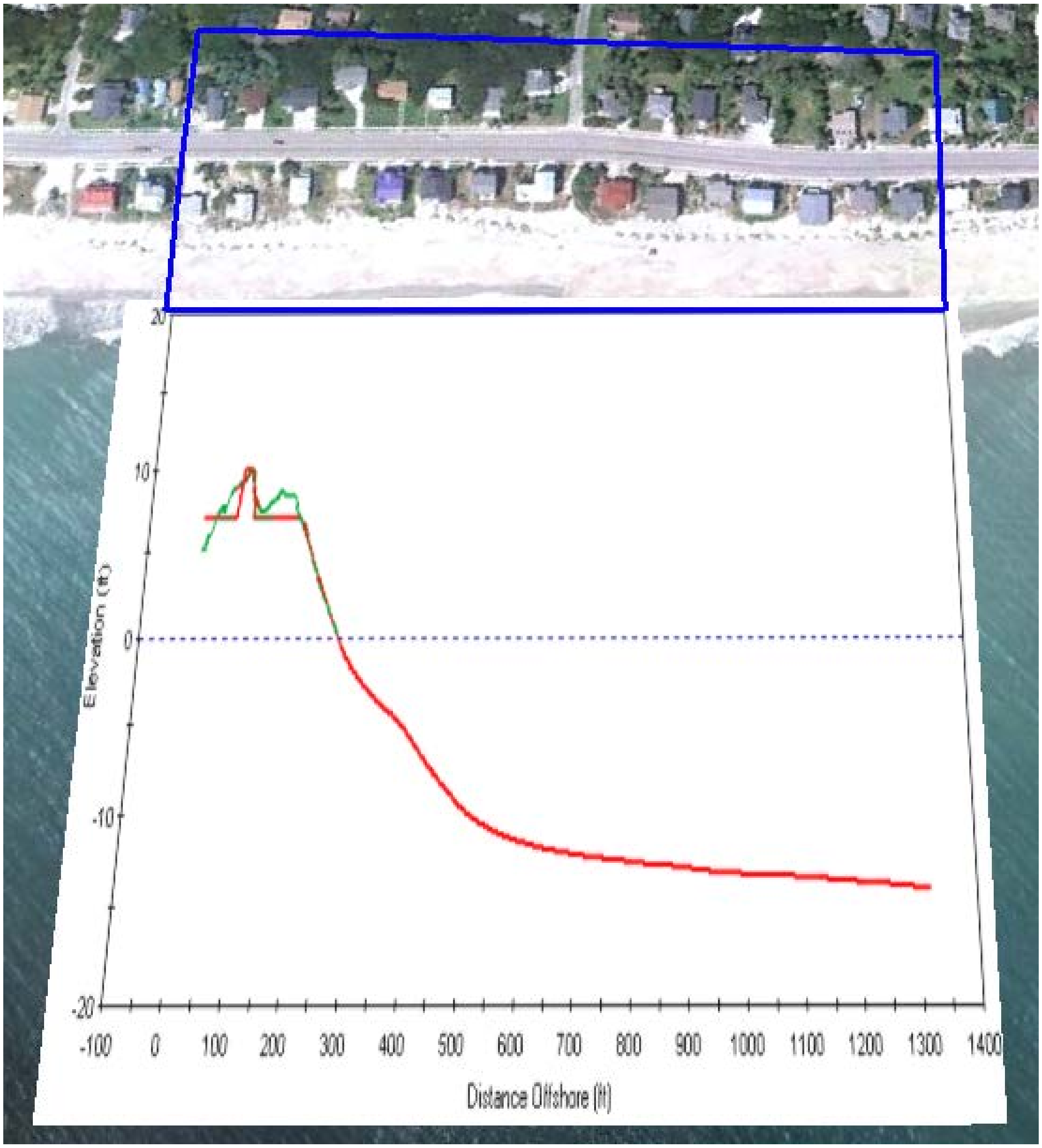


Figure 21: Representative and idealized beach profile for Reach E8.

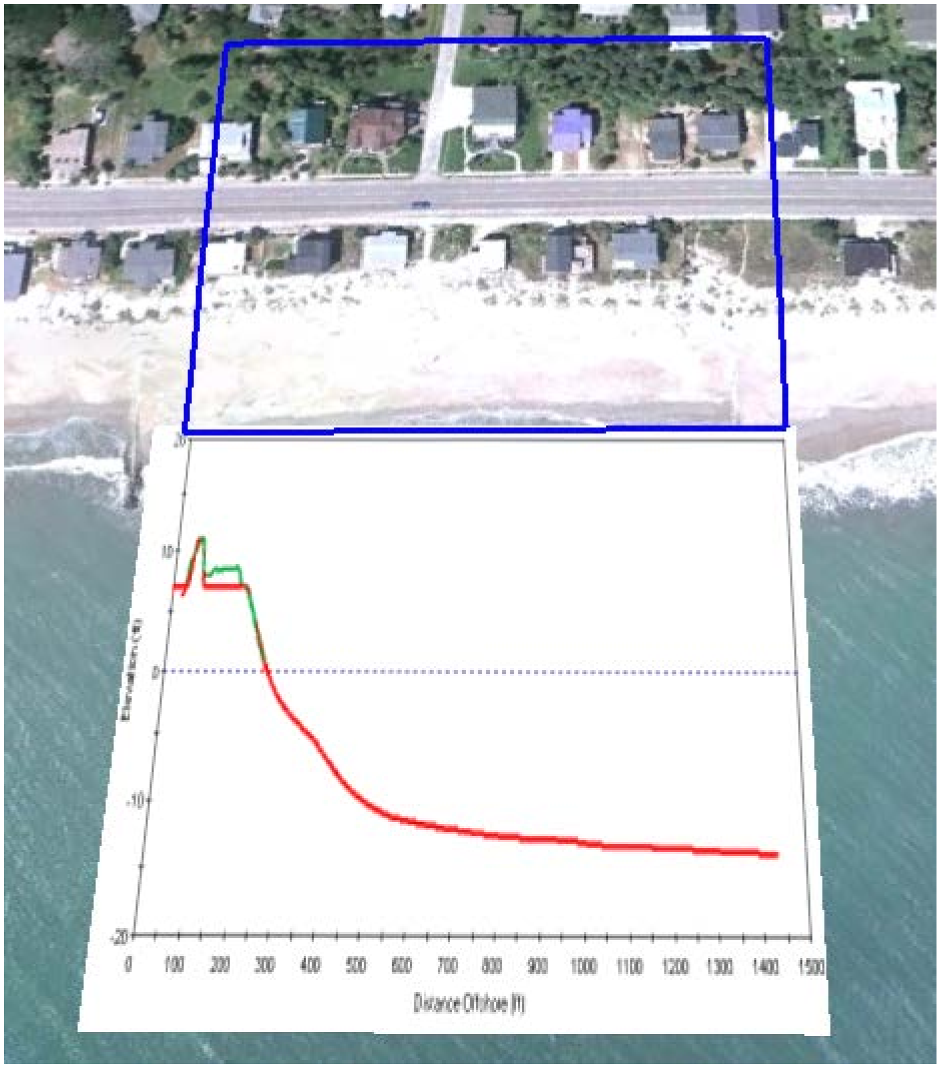


Figure 22: Representative and idealized beach profile for Reach E9.

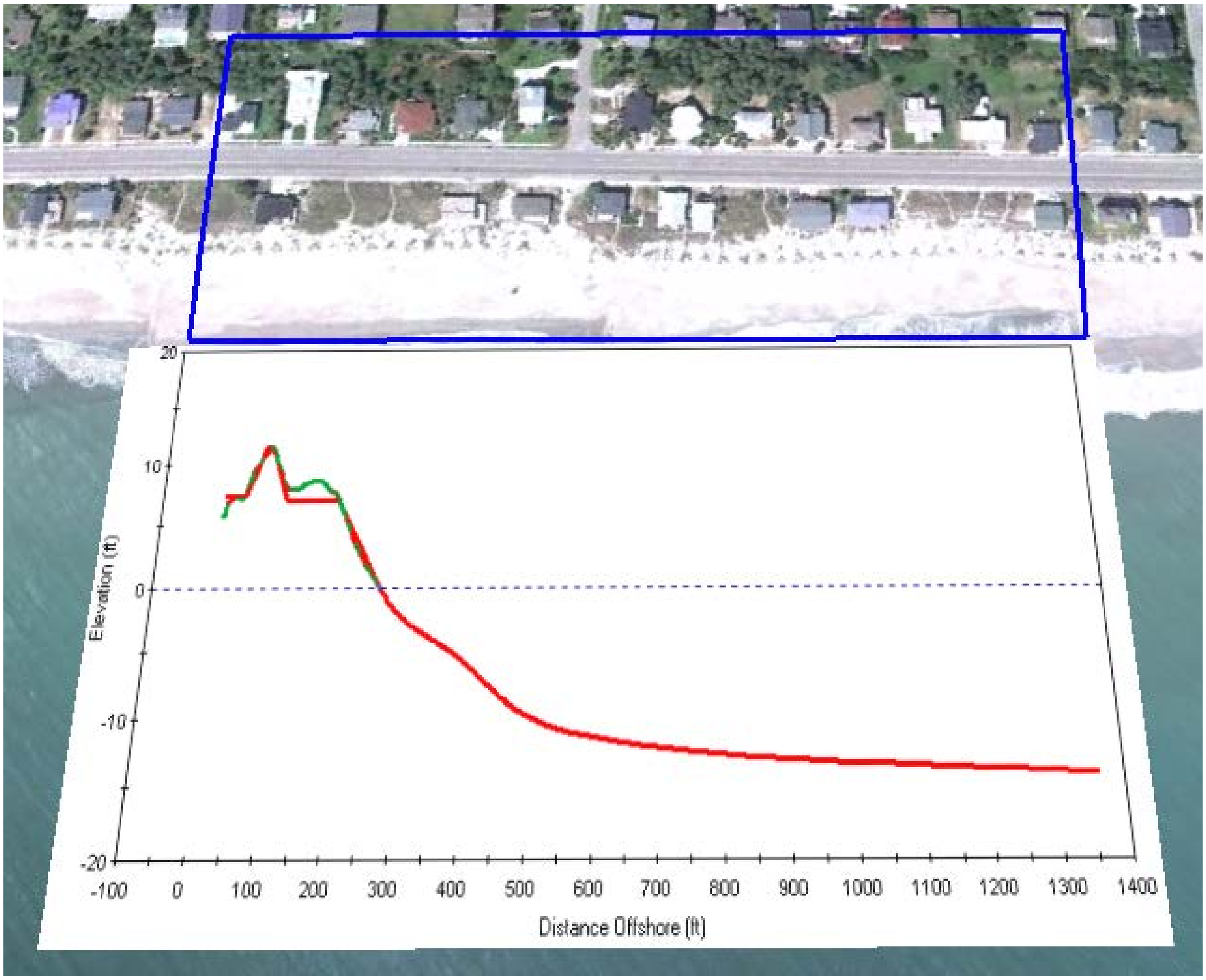


Figure 23: Representative and idealized beach profile for Reach E10.

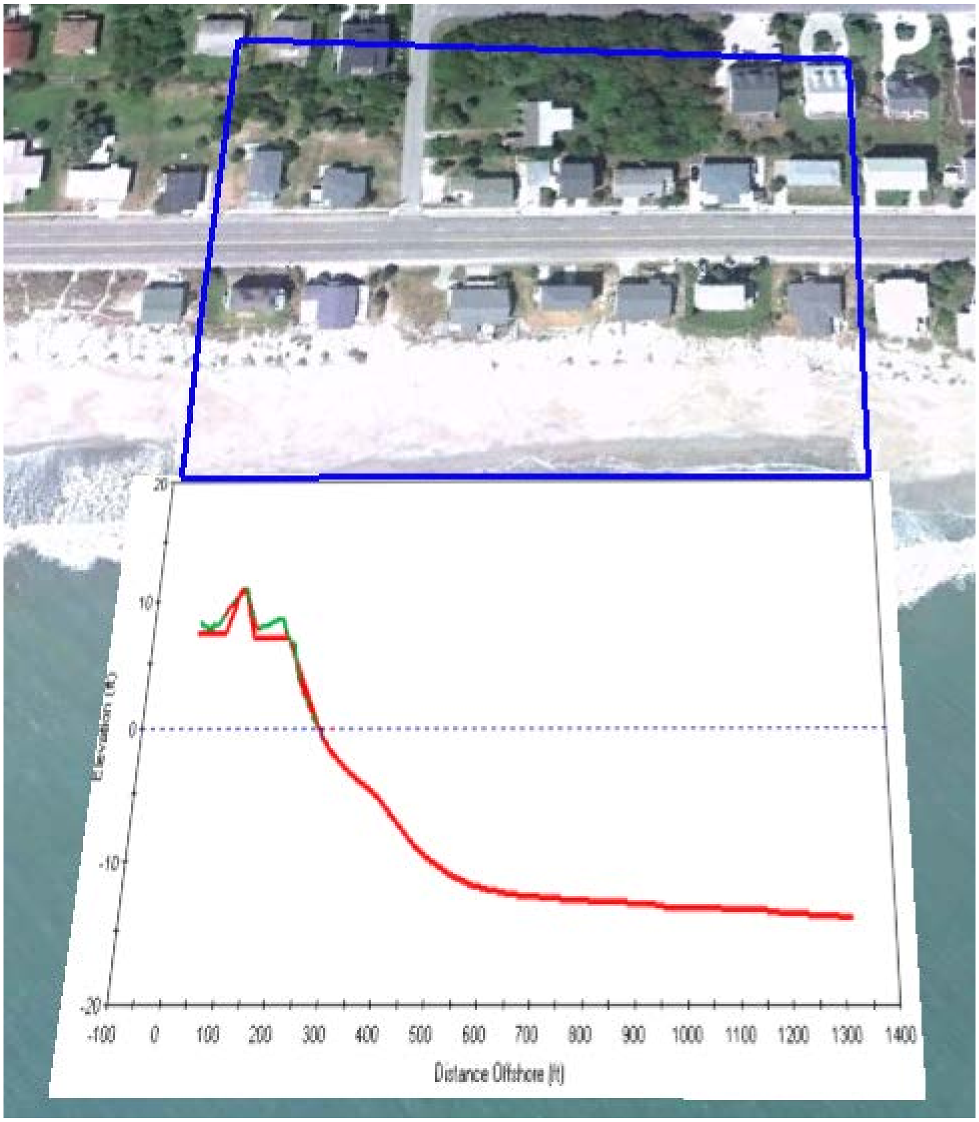


Figure 24: Representative and idealized beach profile for Reach E11.

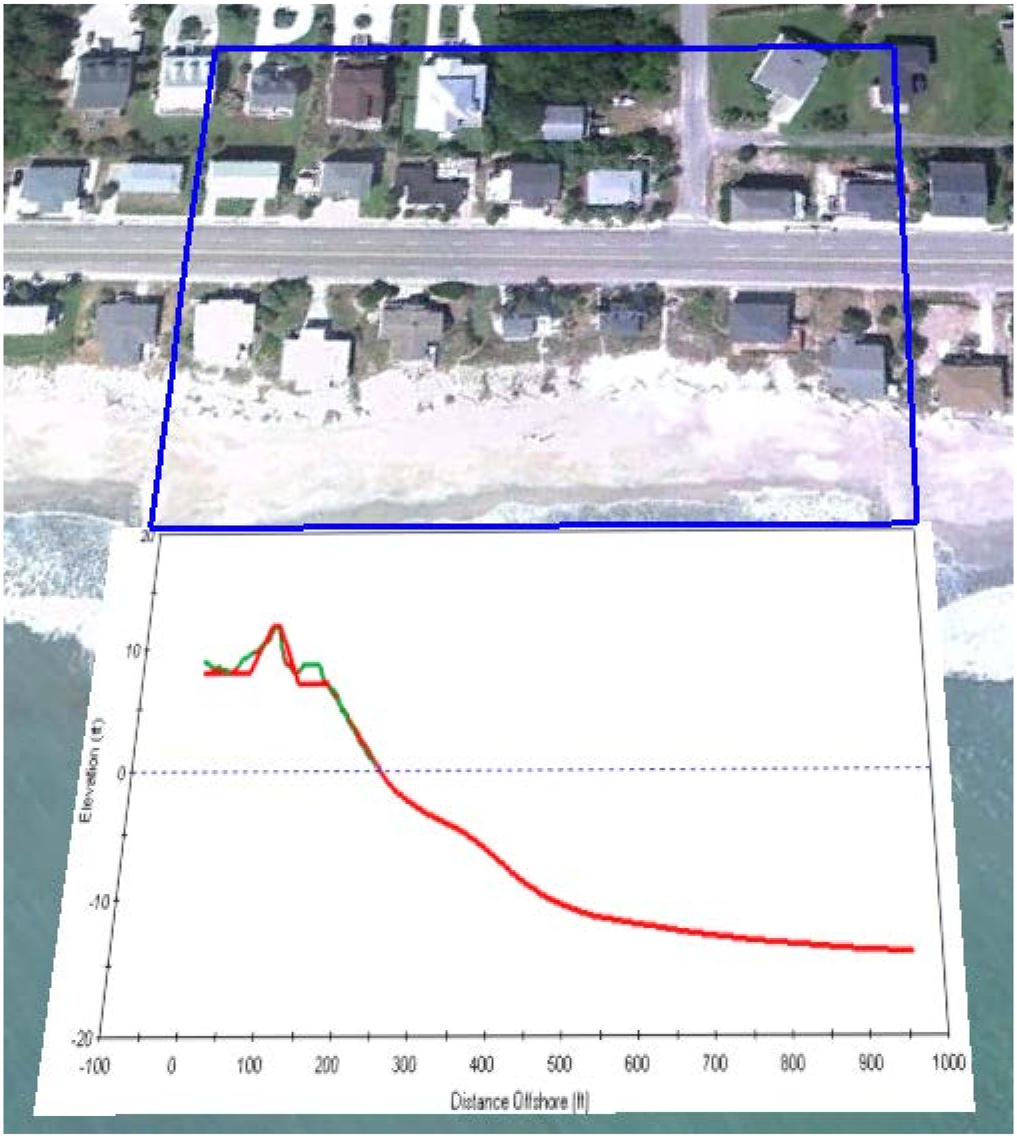


Figure 25: Representative and idealized beach profile for Reach E12.

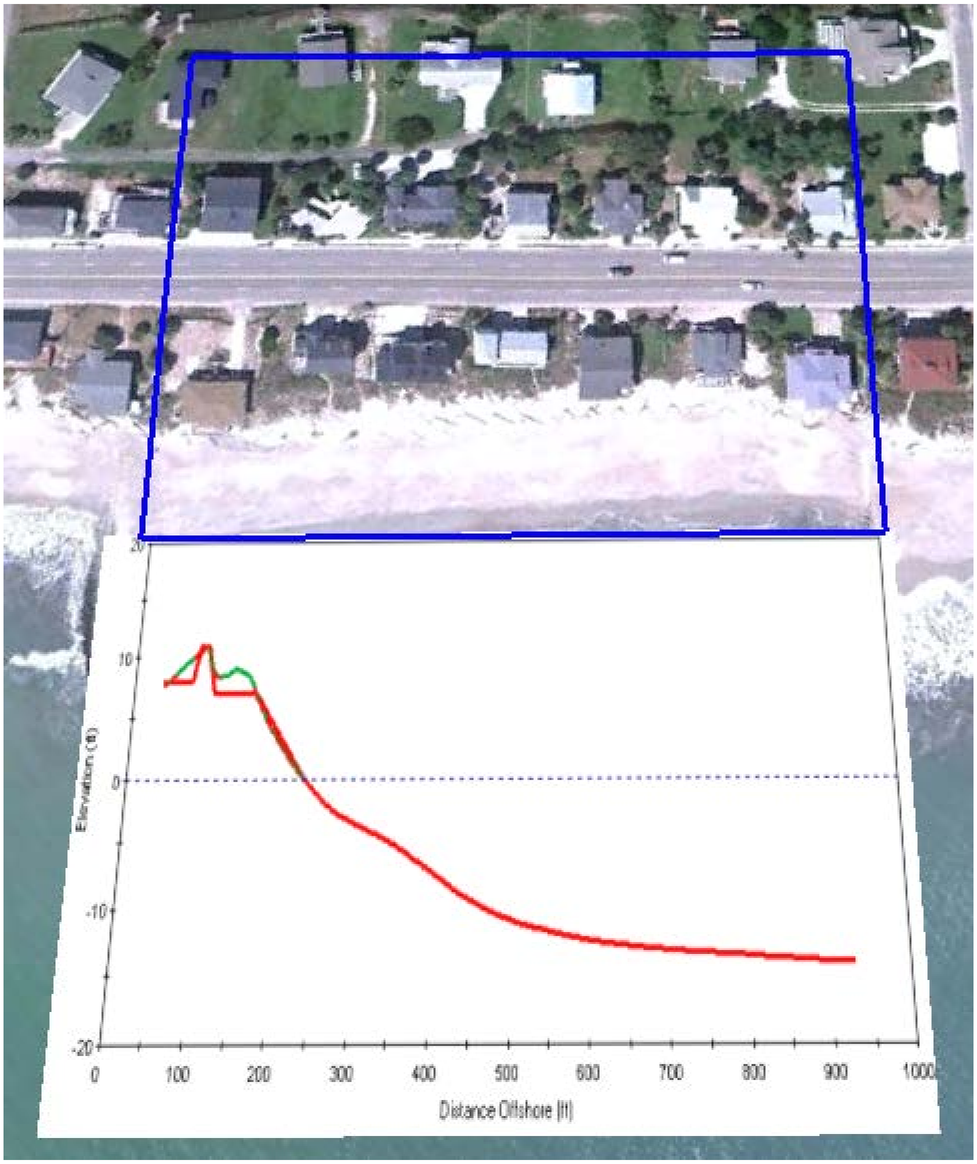


Figure 26: Representative and idealized beach profile for Reach E13.

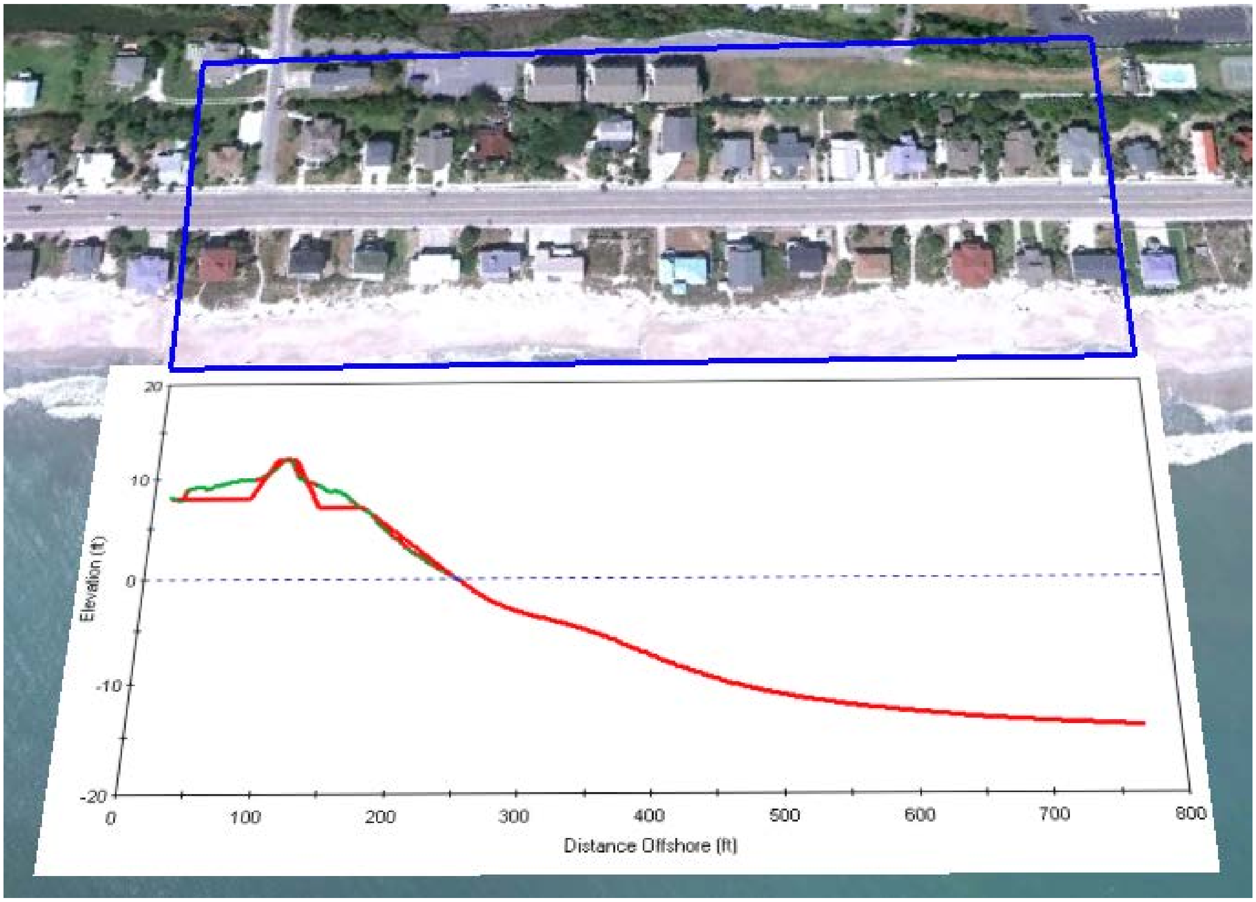


Figure 27: Representative and idealized beach profile for Reach E14.

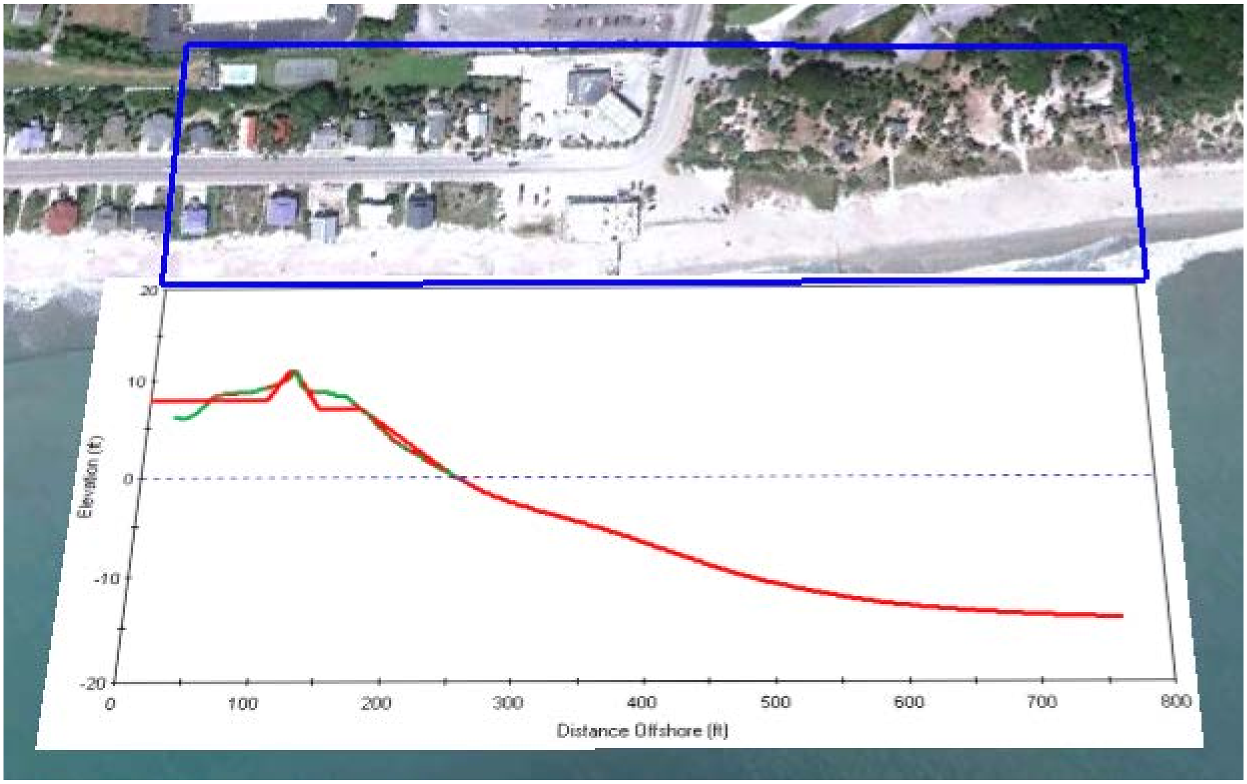


Figure 28: Representative and idealized beach profile for Reach E15.

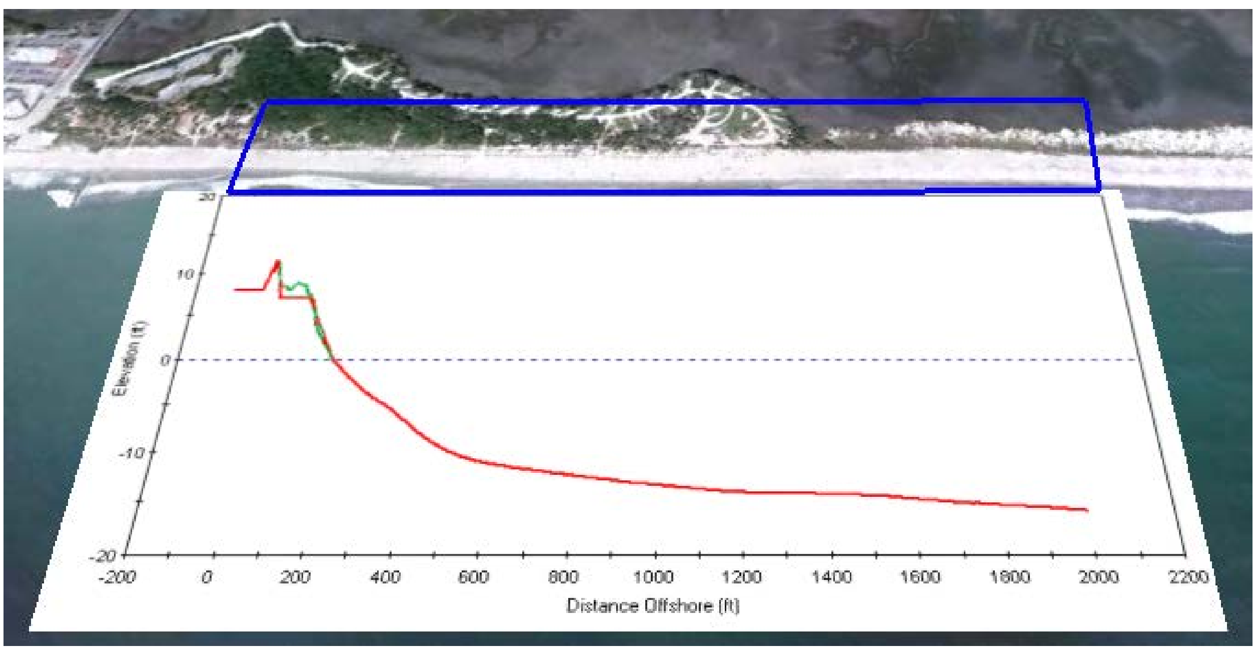


Figure 29: Representative and idealized beach profile for Reach SP1.

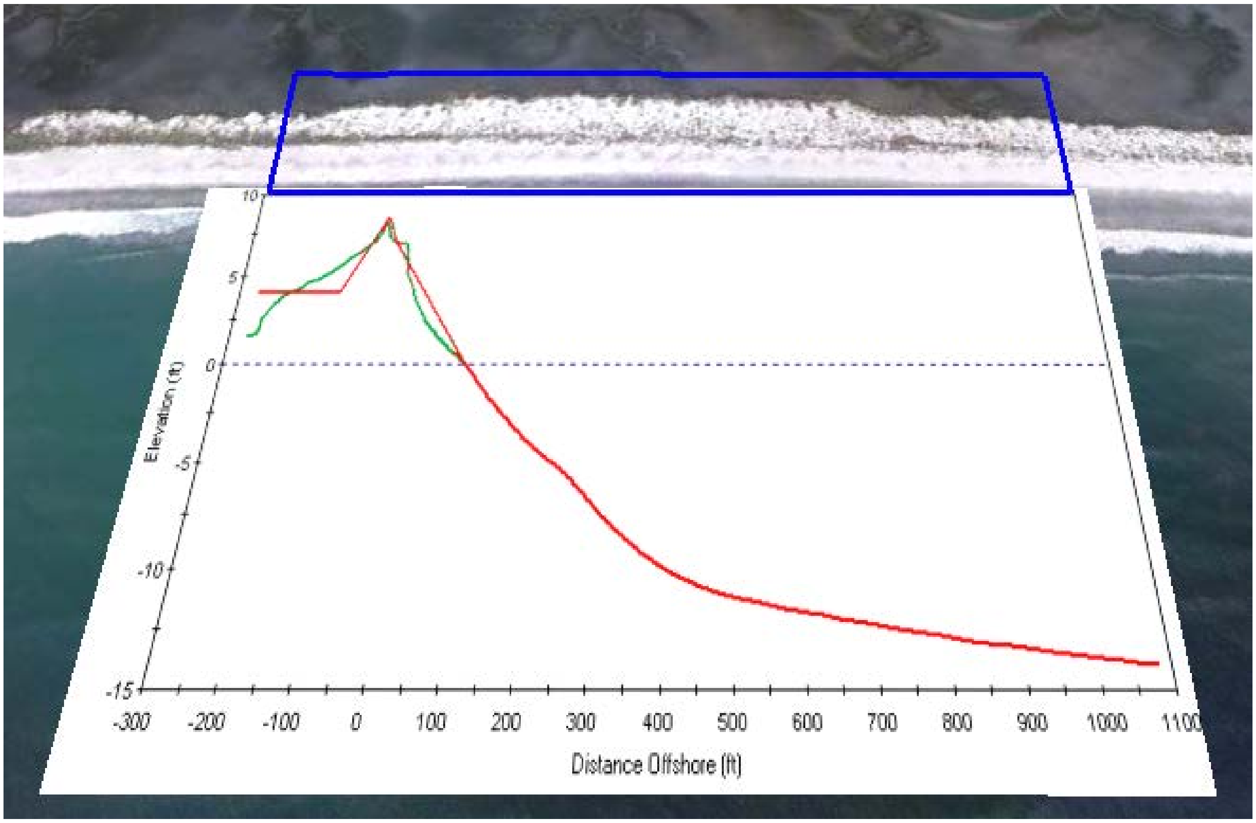


Figure 30: Representative and idealized beach profile for Reach SP2.

5.0 Reach Determination

The Beach-*fx* analysis reaches are largely defined by the morphologically driven development of representative profiles discussed in the previous section. Due to subtle shoreline orientation differences and the requirement to simulate different upland widths to capture the first row of damage elements on the landward side Palmetto Blvd. further subdivision of the Beach-*fx* analysis reaches was necessary. Specifically, Beach-*fx* reaches I2, I3 and I4, were defined based on the same representative beach profile to account for differing shoreline orientations and upland width. Likewise, Beach-*fx* reaches E2 and E3 as well as E4 and E5 were defined from common representative beach profiles. Figure 31 shows the lay-out of the Beach-*fx* analysis reaches for the Edisto project. The blue polygons denote the reach boundaries and the purple lines are the SBEACH reference lines that define the shoreline orientation within each reach. The SBEACH reference line which is defined by cartographic coordinates is required to establish a common cross-shore frame of reference between the one-dimensional SBEACH coastal process model and Beach-fx. Damage elements within each reach are projected on to the SBEACH reference line to obtain the damage element's cross-shore position which is subsequently used to determine the magnitude of the damage driving parameters (erosion, water depth, and wave crest elevation) which are all tied to the SBEACH cross-shore coordinate system.

Figure 31: Beach-fx reaches and SBEACH reference lines.

6.0 Beach-fx Coastal Processes Input Data Development

Storm-Induced Beach Profile Responses

The availability of a large database of beach profile response to the each storm in plausible storm suite is central to the operation of Beach-*fx*. This database is known to Beach-*fx* modelers as the *shore response database* (SDB). Two kinds of data are stored in the SDB for each storm/profile simulation: changes in berm width, dune width, dune height and upland width, and cross-shore profiles of erosion, maximum wave height, and total water elevation. The morphology changes (berm width, dune width, dune height and upland width) are used to modify the pre-storm beach profile to obtain the post-storm profile. The damage driving parameters (cross-shore profile of erosion, maximum wave height, and total water elevation) are used in the estimation of damages to damage elements within reaches associated with that representative profile. The SDB is a pre-generated set of beach profile responses to storms comprising the plausible storm suite, for a range of profile configurations that are expected to exist for different sequences of storm events and management action scenarios. The numerical model for simulating storm-induced beach change (SBEACH), (Larson and Kraus, 1990) was used to estimate beach profile responses to each of the storms contained in the plausible storm suite. As discussed in section 3.0 the historically-based storm suite includes 24 historical tropical storm events, 6 hypothetical tropical storm events, and 9 extratropical storm events. When combined with the statistical representation of astronomical tides the number of storms increased by a factor of 12, resulting in a plausible storm suite involving 360 tropical storm events and 108 extratropical storm events. A companion range of beach profile configurations were developed to encompass all expected beach configurations encountered under each of the evaluated without-project scenarios. The most robust end of beach profile configurations considered was defined by the existing condition representative beach profile (see section 4.0). The most vulnerable end of the beach profile configurations assumed that the dune feature was entirely removed and the upland was fronted with a zero berm width and foreshore slope down to the water's edge. Profiles were developed at 10 ft increments on berm width, 5 ft increments on dune width, and 1 ft increments on dune height between the most robust and most vulnerable beach profiles. This procedure generated a total of 2,335 unique beach profiles. The response of each of these beach profiles to the entire storm suite consisting of 468 plausible storm events was simulated using the SBEACH model. A total of 1,092,780 SBEACH simulations were performed and the results were imported to populate the SDB used as input to the Beach-fx model. Because of the large size of the resulting SDB the Edisto project was divided into three project domains:

1. Edisto South covering reaches I1, I2, I3, I4, P1, P2, E1, E2, E3, E4, and E5.
2. Edisto Central covering reaches E6, E7, E8 and E9.
3. Edisto North covering reaches E10, E11, E12, E13, E14, E15, SP1, and SP2.

Profile Shoreline Position Changes

The next step required to fully implement the Edisto Beach project in Beach-*fx* is calibration of Beach-*fx* such that the model reproduces, on average over multiple lifecycle simulations, the historical shoreline rate of change. To do this one must first develop an estimate of the historical shoreline rate of change. The available beach profile information as outlined in Table 4 was employed as input to make this required estimate. Because the beach profile data consists of distance and elevation pairs across the dune, berm, foreshore, and portions of the offshore and are collected at constant positions (monuments) along the length of the island it is possible to use the profile data to analyze the evolution of the beach over time. The most common, easily understood, and useful shoreline positions are defined by the intersection of the sandy beach with the mean high water tidal datum.

In general, a datum is a base elevation used as a reference from which to determine heights or depths. A tidal datum is a standard elevation defined by a certain phase of the tide and is applicable for a specific time period. The National Tidal Datum Epoch is the specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values for tidal datums.

This analysis utilizes shoreline positions defined by mean high water in order to calculate shoreline change (erosion/accretion) amounts and rates. Mean High Water (MHW) is defined as the average of all the high water heights observed over the National Tidal Datum Epoch. According to the bench mark sheet for Edisto Beach (ID 8667630), published by the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS), the elevation of the MHW tidal datum is +2.48 feet (+0.756 meters) relative to the North American Vertical Datum of 1988 (NAVD88).

The magnitude of shoreline position change from one year to the next and the rate of change over longer periods are extremely important pieces of information for engineers, scientists, economists, etc.

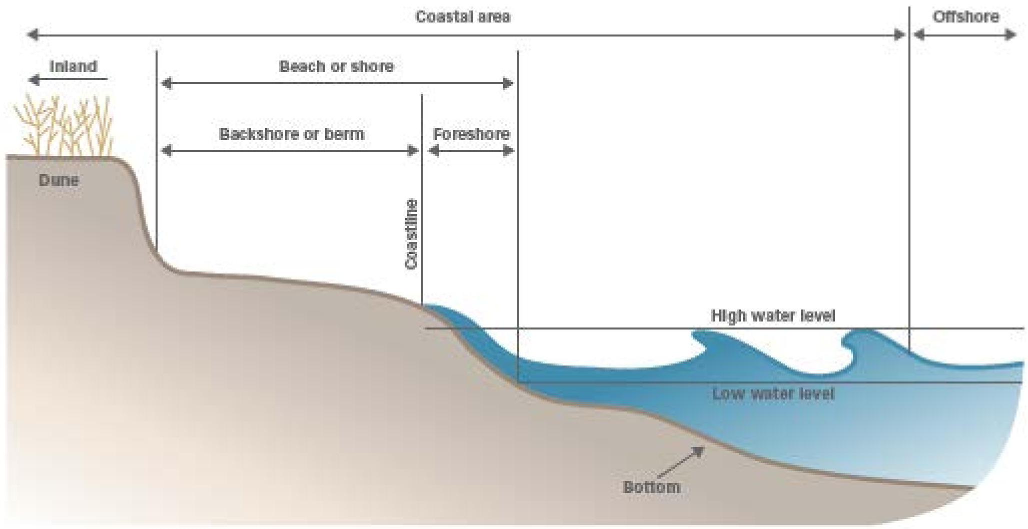


Figure 32: Diagram of the features of a typical sandy beach (from How Beach Nourishment Works, USACE 2007).

South Carolina OCRM is very interested in the condition of the state's beaches and issues an annual report summarizing the changes to the beaches during the previous year. The 2008 Annual State of the Beaches Report states that Edisto Island has a low long-term erosion rate, but an extreme lack of sand. The report does not quantify the long-term erosion rate, but does contend that the low erosion rate is due to the presence of the extensive groin field. According to the report, the southern half of the developed portion of Edisto Beach has the widest oceanfront beach on the island, while the northern half was one of the most critically eroded sections of beach anywhere in the state until the 2006 renourishment.

This analysis of shoreline change used the Corps' RMAP software package to calculate the changes to the MHW and MLW contours between consecutive yearly beach profiles for each profile in the CSE and OCRM datasets. The OCRM dataset contains fewer monuments than the CSE dataset, but it does have a much longer period of record. The analysis benefited from having both the spatial detail provided by the CSE dataset and the historical perspective of the OCRM dataset.

Table 6 provides the results of the MHW shoreline change analysis for the CSE dataset. Results are provided for the yearly changes between 2004 and 2008 and the change rates. The MHW shoreline change rates were determined for the entire time period, identified as "With Fill", and for the period not affected by the 2006 renourishment project, identified as "Without Fill". One can see from the "2005-2006" and "With Fill" columns, that the 2006 renourishment project had significant influence on the position of the MHW shoreline. More specifically, the 2006 renourishment was sufficient enough to counteract the short- and long-term erosion rates and result in positive (accretional) shoreline change rates at all but 9 of the 90 CSE beach profiles. In addition, of the 9 profiles with negative "With Fill" MHW change rates, 7 of these are immediately downdrift of a groin. The MHW shoreline change rates from Table 6 are also presented graphically, in three dimensions (3D), in Figure 33. In order to provide the rates enough separation from the zero value and make them more easily seen and interpreted, the magnitude of the rates were multiplied by a factor of fifty (50). It is clear from the sawtooth shape of the change rates that the magnitudes are affected by the groin field. The magnitudes of the "With Fill" MHW change rates are larger at those profile locations immediately south of a groin and decrease while moving to the south within the same groin cell. Likewise, the magnitudes of the "Without Fill" MHW change rates are larger immediately south of a groin and decrease while moving south within the same groin cell.

Table 6: Mean High Water (MHW) Shoreline Change for CSE Profile Data

	MHW Shoreline Change (ft)				MHW Shoreline Change Rate (ft/yr)	
Benchmark	(2004-2005)	(2005-2006)	(2006-2007)	(2007-2008)	**With Fill**	**Without Fill**
SCCC 2270	-36.58	43.37	4.26	-6.72	1.09	-18.78
SCCC 2250	-50.09	39.56	0.04	12.78	0.58	-14.73
SCCC 2230	-44.17	137.96	-23.11	-3.96	16.81	-20.60
SCCC 2210	-38.21	154.10	-38.95	-14.03	15.85	-23.12
1+75	-8.22	125.43	-55.00	17.12	19.98	5.09
1+300	-19.34	98.43	-38.17	-9.94	7.80	-13.12
1+525	-12.19	48.52	-14.10	-36.07	-3.49	-23.17
2+75	-1.07	129.40	-55.94	22.19	23.82	10.64
2+300	-1.76	99.23	-35.71	-7.51	13.66	-4.50
2+525	-4.97	52.68	-8.36	-37.32	0.51	-20.76
3+75	-6.07	116.49	-51.98	19.87	19.73	7.38
3+300	-4.80	70.94	-26.00	-12.15	7.05	-8.10
3+525	-17.47	28.46	-0.32	-40.21	-7.44	-27.47
4+75	-0.45	105.99	-53.72	17.43	17.44	8.53
4+300	-0.52	62.25	-27.35	-12.29	5.56	-6.36
4+525	-6.86	16.35	-3.78	-39.48	-8.51	-22.63
5+75	2.49	129.99	-54.41	9.74	22.12	5.92
5+300	0.22	94.64	-33.36	-21.86	9.98	-10.84
5+525	-5.46	48.14	-14.82	-47.16	-4.86	-25.88
6+75	4.27	132.97	-42.57	-1.01	23.59	1.30
6+300	-0.72	112.11	-29.12	-20.54	15.55	-10.57
6+525	2.88	63.17	-6.56	-47.86	2.93	-22.72
7+75	-0.60	146.38	-29.65	-1.00	29.00	-0.75
7+300	-1.73	118.17	-12.68	-23.25	20.28	-12.35
7+525	-2.86	71.02	15.49	-38.67	11.33	-20.54
8+75	-5.86	145.87	-27.45	11.89	31.35	3.47
8+300	-10.42	108.10	-1.91	-16.41	19.99	-12.60
8+525	-13.06	55.13	22.83	-37.64	6.87	-24.33
9+75	4.93	127.64	-14.90	8.13	31.69	6.14
9+300	-0.38	88.64	3.22	-11.28	20.20	-5.80
9+525	-6.91	42.31	30.05	-31.04	8.67	-18.43
10+75	-6.93	149.40	-16.88	13.97	35.15	4.06
10+300	-2.82	112.18	5.13	-7.52	26.94	-4.95
10+525	-4.77	67.52	27.73	-29.62	15.33	-16.82
11+75	-16.43	159.20	-26.22	13.34	32.72	-0.26
11+300	-17.94	132.93	-16.20	-10.84	22.15	-12.98
11+525	-23.62	100.37	-4.31	-29.85	10.73	-24.88
12+75	-19.54	166.25	-30.37	11.52	32.21	-2.48
12+300	-9.47	136.70	-19.74	-12.54	23.92	-10.26
12+525	-5.26	106.91	-14.30	-31.61	14.04	-18.02
13+75	-10.22	135.84	-25.27	11.90	28.27	1.64

	MHW Shoreline Change (ft)				MHW Shoreline Change Rate (ft/yr)	
Benchmark	(2004-2005)	(2005-2006)	(2006-2007)	(2007-2008)	**With Fill**	**Without Fill**
13+300	-15.08	117.42	-16.36	-12.73	18.45	-12.72
13+525	-25.24	90.88	-5.69	-31.32	7.21	-26.30
14+00	-12.64	135.37	-25.47	10.31	27.10	-0.17
14+350	-15.61	98.93	-9.24	-7.80	16.70	-10.48
14+600	-29.00	54.34	12.19	-26.58	2.76	-25.52
15+65	-0.73	95.76	-31.33	20.33	21.17	9.86
15+245	-11.62	83.14	-27.30	1.98	11.64	-3.91
15+450	-26.66	55.65	-15.63	-16.72	-0.85	-19.60
16+75	-5.20	105.14	-22.07	10.58	22.28	3.10
16+300	-14.95	95.74	-26.62	-4.96	12.40	-8.78
16+525	-31.85	70.04	-24.74	-21.69	-2.08	-24.27
17+75	-13.70	144.20	-49.35	9.11	22.74	-1.22
17+300	-17.97	121.72	-21.25	-21.71	15.31	-18.43
17+525	-32.08	84.85	-16.37	-19.73	4.20	-23.39
18+75	-10.98	137.91	-32.70	4.30	24.82	-2.48
18+300	-7.64	117.30	-24.88	-8.86	19.12	-7.65
18+525	-21.28	94.73	-15.43	-19.94	9.59	-18.94
19+100	-14.27	137.34	-26.74	2.00	24.77	-5.02
19+525	-7.83	101.92	-1.37	-11.63	20.43	-9.12
19+955	-3.39	38.22	27.55	-24.19	9.62	-13.52
20+100	11.69	90.87	-29.49	2.15	18.95	6.00
20+350	-2.61	76.07	-3.07	-20.26	12.63	-11.23
20+600	-14.93	29.46	33.24	-39.78	2.01	-26.18
21+75	-2.16	76.44	-21.67	6.73	14.95	2.45
21+265	-8.33	64.89	-14.31	-8.69	8.45	-7.86
21+430	-28.96	47.16	3.17	-28.96	-1.91	-26.69
22+75	5.15	75.01	-17.91	14.43	19.31	9.39
22+268	0.28	68.85	-5.81	-10.06	13.42	-4.91
22+460	-18.06	41.78	10.80	-33.44	0.27	-24.33
23+100	1.95	48.24	-12.48	8.28	11.58	4.96
23+220	1.41	41.07	-2.46	-13.54	6.67	-6.18
24+100	1.57	48.17	-1.63	-10.07	9.58	-4.37
24+190	-0.18	39.56	-1.07	-21.86	4.14	-11.01
25+100	-9.45	70.01	-23.57	7.59	11.23	-0.19
25+200	-13.89	58.72	-18.47	-6.65	4.96	-9.18
26+115	-6.77	95.54	-54.72	1.22	8.88	-2.24
26+235	-12.30	86.10	-43.19	-13.58	4.29	-11.98
27+145	6.31	110.55	-26.73	-53.27	9.28	-23.97
27+290	8.92	69.15	13.74	-59.63	8.11	-26.05
28+130	-7.21	75.16	33.48	-28.94	18.26	-17.51
28+277	-8.59	47.83	32.39	-20.72	12.82	-13.98
SCCC 2135	46.56	-20.98	83.76	-59.06	12.66	-9.90
CSE 2130B	49.54	1.07	117.29	40.31	52.45	41.04
CSE 2130A	7.00	11.90	155.93	23.71	50.01	14.81
SCCC 2130	-13.01	-57.78	134.10	3.91	16.93	-3.53
SCCC 2120	30.19	-28.01	-30.62	52.89	6.16	39.17
SCCC 2115	21.11	-26.25	4.79	-15.58	-4.01	1.11
SCCC 2113	-19.80	-0.57	-68.11	44.94	-10.97	14.12
SCCC 2110	25.21	-24.93	65.20	12.61	19.67	16.93

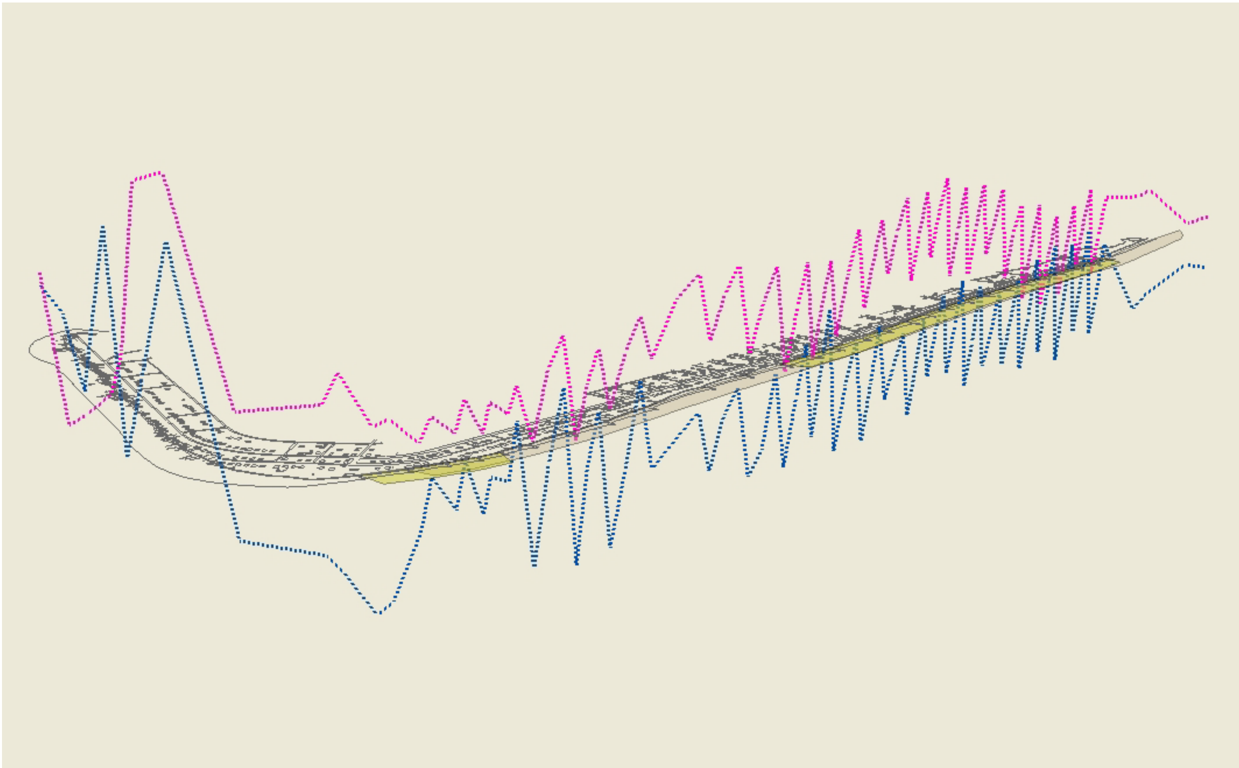


Figure 33: Three dimensional representation of MHW shoreline change rates (ft/yr) for CSE beach profiles along Edisto Island (pink represents rates including the 2006 nourishment, blue represents rates excluding the 2006 nourishment).

The length of record of the OCRM beach profiles was too long to present all of the MHW shoreline change magnitudes, so only the shoreline change rates are presented in Table 7. The shoreline change rates in Table 7 are listed from north to south along the coastline of Edisto Island, from the County Park to the South Edisto River. Because the beach profile records begin in 1988, the "With Fill" rates in Table 7 include two beach nourishment projects, the first in April 1995 and the second in 2006. The "Without Fill" rates neglect the influence of these beach fill projects by excluding the shoreline changes directly attributable to the fill and the subsequent changes as the beach equilibrates. The "With Fill" change rates are missing from SCCC 2198 because no beach profile data exists for the periods surrounding the nourishment projects. Likewise, the "Without Fill" change rates for SCCC 2150 through 2113 are missing because at the time of this analysis OCRM beach profile data was only available for 2006 and 2007. With the exception of SCCC 2198 (only 5 years of data), the shoreline change rates for SCCC 2230 through SCCC 2155, which represent the overwhelming majority of the Atlantic facing shoreline, are calculated from at least 17 years worth of beach profiles. Such a long period of record results in a high level of confidence that the change rates being calculated capture the long-term morphologic processes affecting the island.

Examining the MHW "With Fill" rates versus the "Without Fill" rates reveals that the two beach nourishment projects, in 1995 and 2006, have performed well in offsetting the normal erosion rate and stabilizing the recreational beach. The long-term MHW shoreline change rate without the fill projects is uniformly erosional, but is not uniform in the magnitude of erosion, as it varies from -0.21 to -10.1 feet per year.

The MHW shoreline change rates from Table 7 are also presented graphically, in three dimensions (3D), in Figure 34. The large peaks of the “With Fill” change rates along the South Edisto River inlet shoreline, green in Figure 34, at SCCC 2130 are only based on two years of profile data.

Table 7: Shoreline Change Summary for OCRM Beach Profile Data

OCRM	MHW Shoreline Change Rate (ft/yr)	
Benchmark	With Fill	Without Fill
SCCC 2230	-0.16	-3.94
SCCC 2200	1.52	-2.13
SCCC 2198	N/A	-10.10
SCCC 2195	2.44	-0.21
SCCC 2193	3.36	-2.25
SCCC 2190	4.09	-1.58
SCCC 2185	5.52	-3.41
SCCC 2180	3.48	-4.18
SCCC 2178	-0.15	-8.49
SCCC 2173	2.92	-6.93
SCCC 2170	3.74	-1.77
SCCC 2165	3.11	-0.95
SCCC 2160	1.33	-3.20
SCCC 2155	3.38	-2.04
SCCC 2150	-14.79	N/A
SCCC 2145	-0.64	N/A
SCCC 2135	17.24	N/A
SCCC 2130	121.85	N/A
SCCC 2120	15.58	N/A
SCCC 2113	27.03	N/A
SCCC 2110	4.23	-10.56

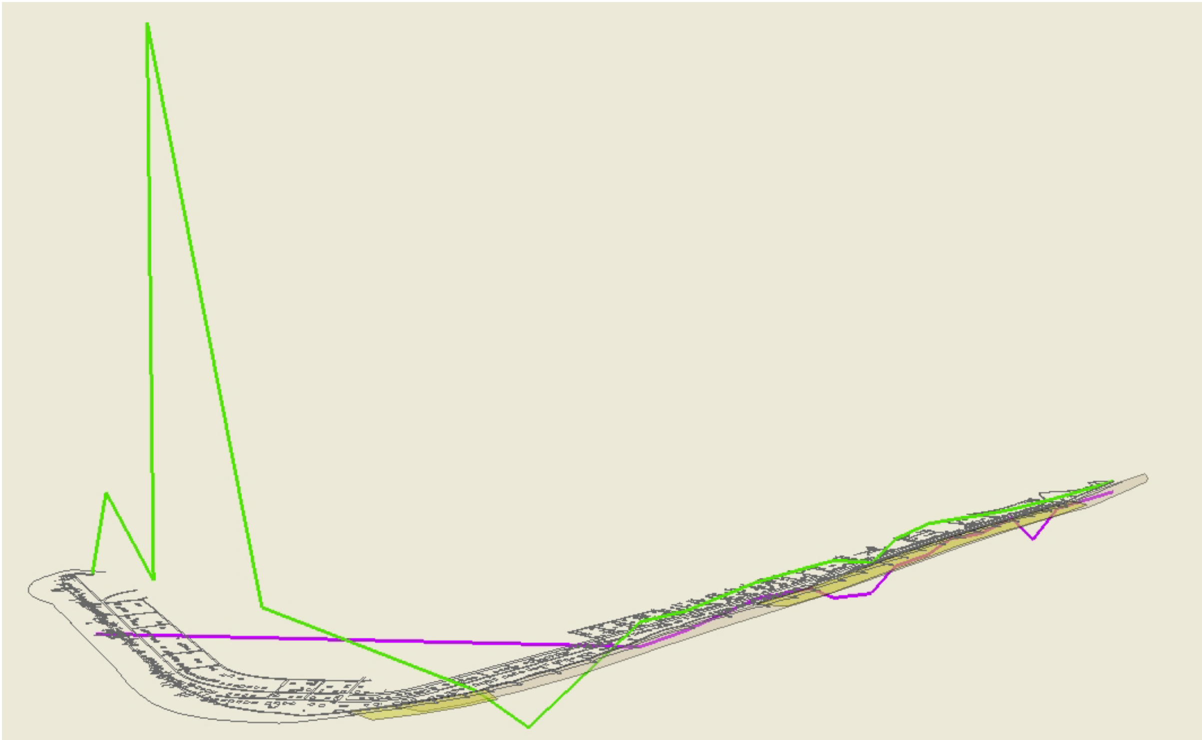


Figure 34: Three dimensional representation of MHW shoreline change rates (ft/yr) for OCRM beach profiles along Edisto Island (green represents rates including the 1995 & 2006 nourishments, purple represents rates excluding the 1995 & 2006 nourishments).

Historical Shoreline Rate of Change

Based on the annual rates of shoreline change presented in the previous section and interpolation to the established Beach-*fx* analysis reaches the long-term historical rate of change corresponding to each of the Beach-*fx* reaches was estimated and plotted as the red line in Figure 35. As seen in the figure, there are extreme discontinuities in the estimated long-term shoreline change rates, frequently greater than 2 ft/year and exceeding 6 ft/year between reaches E7 and E8. These discontinuities are not sustainable over the long-term in that if they were to persist over a long time period large discontinuities in shoreline orientation would develop and the shoreline would evolve to a highly irregular form. However, we know from experience and observation that the shoreline at Edisto Beach is expected to maintain its present general form and orientation over the foreseeable future. To resolve this issue, smoothing was applied to the historical shoreline change rate data and the shoreline rates of change as depicted by the blue line were derived as a reasonable expectation of the future rate of shoreline change in the absence of shoreline management activities. Table 8 provides a listing of the target shoreline rate of change values for each of the Beach-fx reaches.

Table 8: Target Historical Shoreline Rate of Change (SRC) for Edisto Beach by Beach-*fx* Reach

Reach	Target SRC (ft/yr)	Reach	Target SRC (ft/yr)	Reach	Target SRC (ft/yr)
I1	1.37	E3	-1.45	E11	-2.93
I2	0.62	E4	-1.91	E12	-2.85
I3	0.38	E5	-2.21	E13	-2.85
I4	0.16	E6	-2.52	E14	-3.03
P1	0.01	E7	-2.95	E15	-3.56
P2	-0.22	E8	-3.01	SP1	-4.38
E1	-0.43	E9	-3.03	SP2	-5.13
E2	-0.90	E10	-2.98		

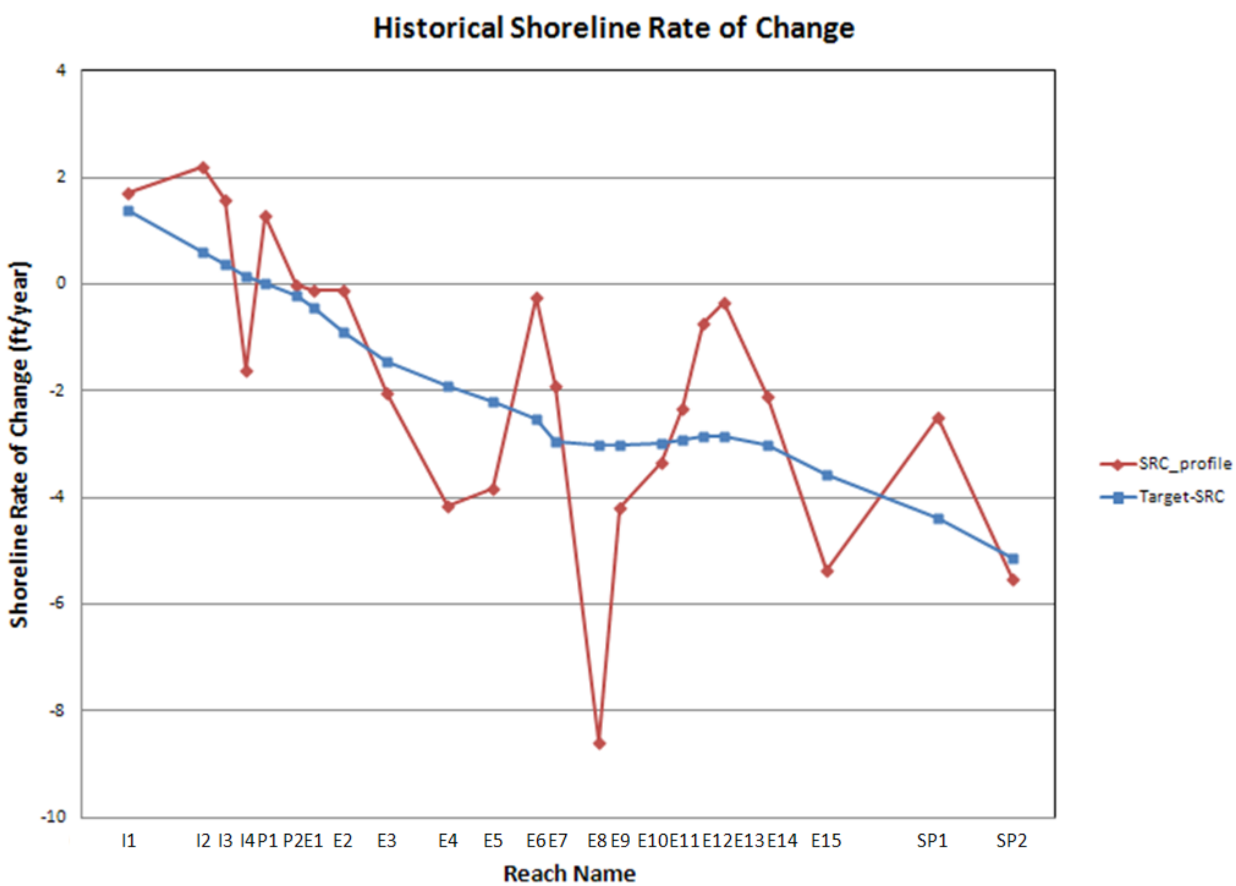


Figure 35: Historical shoreline rate of change based on profile data and synthesized target shoreline rate of change.

Conclusions

Historically the ocean-fronting shoreline within the Edisto Beach study area has been erosional with the rate of erosion generally decreasing from north to south. Near the Point, the shoreline change rate decreases to nearly zero and transitions to accretion along the inlet-fronting shoreline. Of course the natural variability in annual wave energy and storm occurrence can and does produce significant variations in this overall trend of shoreline change. Shore protection measures also have a direct influence on shoreline change rates. For example, following groin construction near the northern end of Edisto Beach erosion accelerated south of the constructed groins which lead to construction of more groins to the south. Likewise, after the nourishment projects in 1995 and 2006 the rate of shoreline accretion along the inlet-fronting increased as nourishment material was transported to the south and around the Point. Overall shoreline change trends within the Edisto Beach study area are well understood and as expected depend to a large degree on sediment supply from the north. If the sediment supply is reduced due to natural processes such as increased overwash into marsh or human intervention such as groin construction, erosion can be expected to the south. Likewise, if new sediment is introduced into the system through beach nourishment, a stabilization of the shoreline or even a transitioning to a prograding shoreline can be expected to the south of the placement area. Both of these scenarios have been observed and recorded in the past within the project study area.

7.0 Beach-fx Calibration

The calibration procedure for Beach-*fx* involves specification and tuning of a reach-level attribute known as the *applied erosion rate*. The applied erosion rate accounts for long-term shoreline change not attributed to storm-induced shoreline changes which are captured within the model by the random sampling of storm events as the model progresses through the lifecycle simulation. The concept employed here is that there are two essentially separable components of beach evolution, the first is cross-shore transport dominated shoreline change due to storm events which is mostly recoverable due to post-storm berm width recovery and the second is longshore transport dominated shoreline change that is driven by longshore sediment transport gradients, underlying geological setting and other factors such as relative sea level change. This second component of beach evolution is considered non-recoverable. The Beach-*fx* calibration concept is that the combination of these two drivers of beach evolution should, on average, over multiple simulated project lifecycles return the long-term average rate of shoreline change. Because the Beach-*fx* simulated life cycle iteration employs a random sequence of storm events the returned shoreline change rate differs for each lifecycle simulated. The Beach-*fx* calibration task is to determine an appropriate applied erosion rate for each reach such that the computed average rate of shoreline change on a reach-by-reach basis is equal to the estimated target historical shoreline change rate over multiple lifecycle simulations.

For the Edisto Beach project, Beach-fx was calibrated across 300 iterations of a 55-year lifecycle using an assigned depth of closure specification of -14 ft NAVD. The depth of closure estimate was developed based on an analysis of the available beach profile data presented in section 6.0 (previous section). The 55-year lifecycle duration stems from the use of the August 2008 beach profile survey to define the initial condition leading to a start year specification of 2009 and the specification of year 2014 as the base year for calculating the economics and an economic analysis horizon corresponding to a 50-year project life. The use of 300 iterations was selected in order to obtain a stabilization of the model results in the context of capturing the expected variability in the environmental forcing. Evidence of the stabilization of results can be gauged by examining the moving average in various model outputs as compared to the individual iteration values. An example of this is shown in Figure 36 where the total number of storms per iteration is plotted along with the moving average number of storms across all iterations. Here it is seen that although the number of storms per iteration varies between a maximum of 63 storms and a minimum of 27 storms the average number of storms stabilizes at approximately 44 storms after about 150 iterations of a 55-year lifecycle.

After a number of calibration iterations Beach-*fx* was calibrated to precisely reproduce the target historical SRC on average over 300 55-year lifecycles. Figure 37 shows the target historical SRC (blue line), the Beach-*fx* calculated average rate of shoreline change over 300 iterations (red stars), together with the calibration determined applied erosion rates on a reach by reach basis (green line).

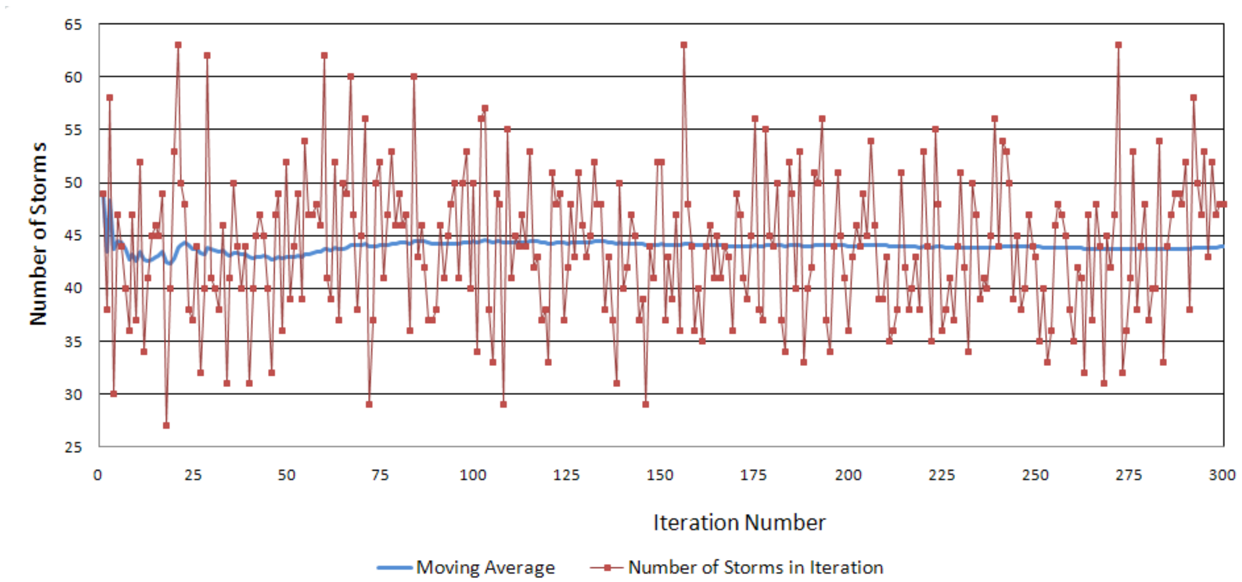


Figure 36: Number of storms per and moving average number of storm per iteration.

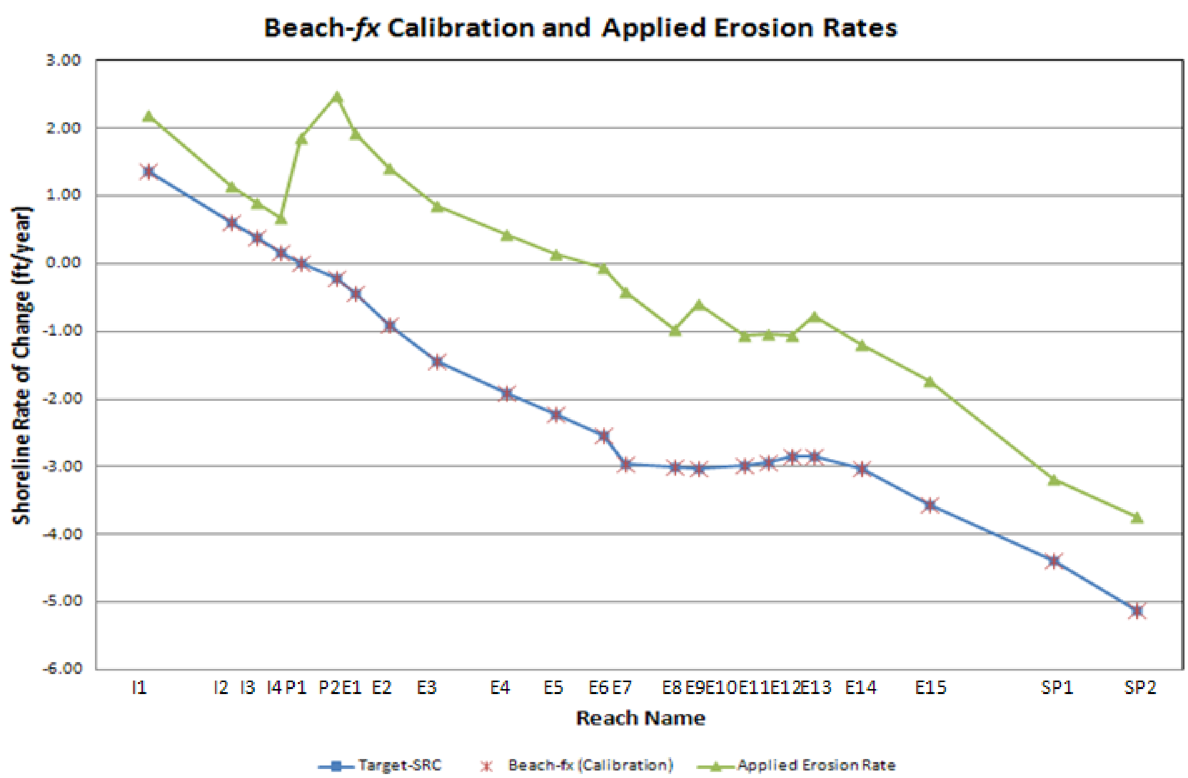


Figure 37: Beach-fx calibration results and applied erosion rates.

8.0 Future Without-Project Beach-fx Simulations

Two future without project scenarios of Edisto Beach evolution were simulated using the calibrated Beach-*fx* model the first scenario involved no action on the part of private land owners or local or state governmental agencies. This scenario illustrates the high vulnerability of developed properties, Palmetto Blvd (Hwy 174), and Edisto Beach State Park to losses due to continued coastal erosion, storm-induced inundation, and direct wave impact. The second future without project scenario includes limited emergency actions including emergency dune reconstruction on an as needed basis as well as armoring of Palmetto Blvd. if the highway becomes vulnerable to loss of function during the simulation. This future without-project is considered the most likely future as it best reflects the proactive shore protection posture of the community of Edisto Beach, the State of South Carolina and the South Carolina Department of Transportation.

No Action Scenario

The calibrated Beach-*fx* model for Edisto Beach was configured for simulation of the *no action* scenario of the without project to estimate beach evolution and economic consequences of a 55-year future that involves no action on the part of private land owners or local or state governmental agencies. This without-project scenario is based on the community of Edisto Beach assertion that in light of current economic circumstances within the State of South Carolina, Colleton County, and the City of Edisto Beach, the resources necessary to sustain historical shore protection measures are not anticipated being available.

The simulation again involved the simulation of 300 55-year lifecycles ending in the year 2064. The average shoreline position at the end of the without project simulation is shown as the brown line in Figures 38 through 41. In Figure 38 which spans the area between Beach-fx reaches I1 and E3 (groin cell 21) it is seen that along the inlet shoreline of Edisto Beach the shoreline is expected to be nearly stable or advance slightly. Slight ongoing erosion is predicted in the vicinity of the Point. Along the ocean-fronting shoreline just north of the Point, erosion begins to increase.

In Figure 39, which covers the area between Beach-*fx* reach E3 (groin cell 20) through reach E8 (groin cell 12), the predicted 2064 shoreline indicates erosion increasing to the north. Based on this prediction it is expected that wave swash will be under the existing homes beginning at approximately groin cell 17. Beginning at about groin cell 14 the homes appear to be highly vulnerable to complete loss. At groin cell 12 the shoreline is predicted to immediately adjacent to Palmetto Blvd. indicating that the developed properties on the ocean side of the highway will likely be destroyed.

In Figure 40, which covers the area between Beach-fx reach E8 (groin cell 11) and reach E15 (groin cell 1), the predicted 2064 shoreline reflects strong erosion indicating complete loss of all developed properties on the ocean side of Palmetto Blvd. Beginning at approximately groin cell 7 the shoreline is predicted to coincide with Palmetto indicating that the Highway will be impassible. To the north, at groin cells 1 though 3 the shoreline is predicted to be at the upland side of Palmetto Blvd. indicating that the Highway will be completely loss and developed properties on the upland side of Palmetto Blvd. will be vulnerable to damages from coastal storms.

Figure 41, which encompasses the Edisto State Park area north of the city of Edisto Beach, shows extreme erosion. The predicted 2064 shoreline indicates that the barrier island will undergo extreme overwash processes and migrate approximately one barrier island width into the upland marsh. The present camping area will be extremely vulnerable and it is likely that necessary infrastructure to support recreational use will be lost.

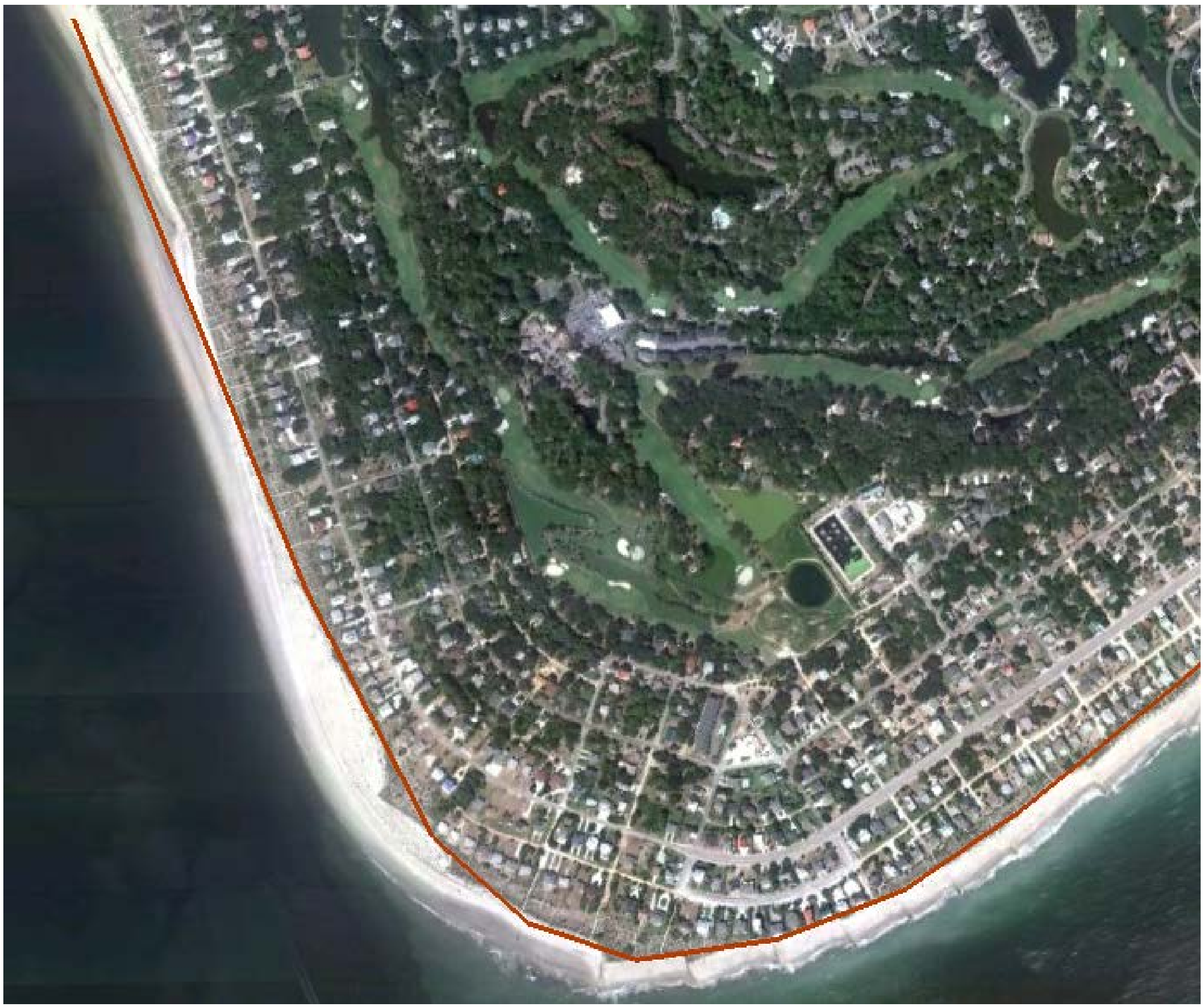


Figure 38: Without-project forecast of average shoreline position in 2064 along the inlet shoreline and around the Point to Groin cell 21.

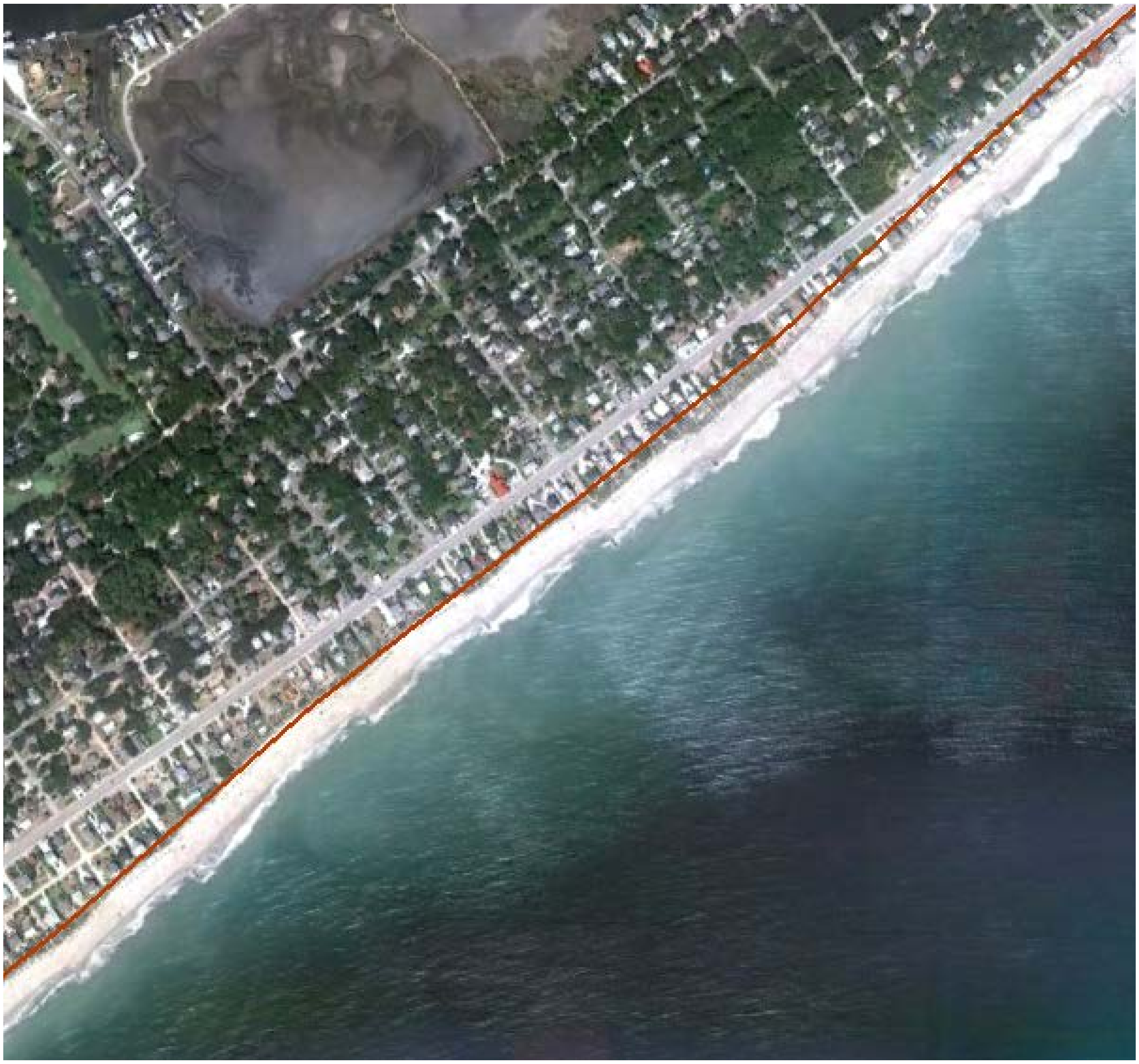


Figure 39: Without-project forecast of average shoreline position in 2064 between groin cells 12 and 20.

Figure 40: Without-project forecast of average shoreline position in 2064 between groin cells 1 and 11.

Figure 41: Without-project forecast of average shoreline position in 2064 at Edisto State Park.

Summary

The results of the *no action* without-project scenario as simulated with Beach-*fx* indicate an unfavorable future within the project study area. Significant losses to privately held developed properties are indicated. Publically held infrastructure will be extensively damaged including loss of the use of Palmetto Blvd. and associated utilities including electrical power lines and water mains. Indications are that Edisto State Park will be subject to extreme losses due to coastal erosion including the inability to support recreational camping within the State Park.

Limited Emergency Action Scenario

The calibrated Beach-*fx* model for Edisto Beach was configured for simulation of the *limited emergency action* scenario of the future without project to estimate beach evolution and economic consequences of a 55-year future that involves emergency dune reconstruction actions on an as needed basis as well as armoring of Palmetto Blvd. if the road becomes vulnerable to loss of function during the simulation. This future without-project scenario is considered the most likely future as it best reflects the proactive shore protection posture of the community of Edisto Beach, the State of South Carolina, and the South Carolina Department of Transportation. The community of Edisto Beach has indicated that they will take whatever shore protection actions that are within their means to protect existing infrastructure and to maintain recreational use of the beaches in their community. Since Palmetto Blvd. is a State highway and the only hurricane evacuation route off the island it is expected that the South Carolina Department of Transportation will take action to maintain the road as an evacuation corridor by armoring the ocean side of the road should coastal erosion threaten the functionality of the highway.

The emergency dune reconstruction action simulated in this future without-project scenario is implemented within the following constraints: On a reach by reach basis, if the simulated dune crest elevation falls below 9 ft NAVD an emergency dune nourishment action will be triggered. When the emergency nourishment action is triggered a nourishment action is scheduled assuming a 30-day mobilization time and the dune is nourished with a fill density of 10 cu yd/ft of beach. The fill material is placed on the dune feature with a target dune elevation of 11 ft NAVD. Any excess fill volume remaining after the target dune crest elevation is achieved is used to increase the dune crest width. Armoring of Palmetto Blvd. is triggered when the seaward edge of the berm erodes to within 10 ft of the road shoulder. Within Beach-fx armoring functions only to prohibit erosion damages, direct wave attack damages and inundation damages are still incurred with armoring in place.

The simulation of this future without-project scenario involved the simulation of 300 55-year lifecycles ending in the year 2064. The results indicate that on average approximately 1.61 million cubic yards of emergency nourishment fill material will be required to maintain the dune feature over the 55 year lifecycle simulation. The standard deviation in the average emergency nourishment fill volume is approximately 445 thousand cubic yards which can be viewed as the uncertainty in the estimated emergency nourishment fill volume over the 55-year lifecycle simulation. Table 9 provides a list of the number of emergency nourishment actions, total average emergency nourishment fill volume and standard deviation.

Table 9: Future Without-Project Emergency Dune Reconstruction Nourishment Summary

Reach	Number of Fill Actions	Fill Volume (yd^3)	Standard Deviation	Reach	Number of Fill Actions	Fill Volume (yd^3)	Standard Deviation
I1	NA	NA	NA	E7	11.0	61,693	15,796
I2	NA	NA	NA	E8	13.1	164,416	36,041
I3	NA	NA	NA	E9	12.1	72,500	18,430
I4	NA	NA	NA	E10	9.3	107,932	29,770
P1	6.1	32,471	10,302	E11	10.6	65,172	16,015
P2	10.9	96,197	26,833	E12	9.4	56,180	12,708
E1	7.4	36,712	14,946	E13	11.4	66,290	13,334
E2	8.0	69,897	27,149	E14	10.1	122,371	26,922
E3	9.1	111,117	38,035	E15	14.1	243,204	44,228
E4	4.8	83,787	42,903	SP1	NA	NA	NA
E5	6.2	77,557	32,723	SP2	NA	NA	NA
E6	11.8	145,509	39,248				

Because this future without project scenario involves emergency dune reconstruction and armoring of Palmetto Blvd. the estimated future without-project shoreline rate of change differs from the target historical rate of shoreline change as indicated in Figure 42.

The average shoreline position at the end of the future without-project simulation is shown as the purple line in Figures 43 through 46. In Figure 43, which spans the area between Beach-fx reaches I1 and E3 (groin cell 21) the shoreline along the inlet is nearly stable. Minor ongoing erosion is predicted along the ocean-fronting shoreline just north of the Point.

In Figure 44, which covers the area between Beach-*fx* reach E3 (groin cell 20) through reach E8 (groin cell 12), the predicted 2064 shoreline indicates erosion increasing to the north albeit slightly less than the *do nothing* without-project scenario due to periodic emergency dune reconstruction. Based on this prediction it is expected that wave swash will be under the existing homes beginning at approximately groin cell 16. At groin cells 13 and 12 the homes appear to be highly vulnerable to complete loss.

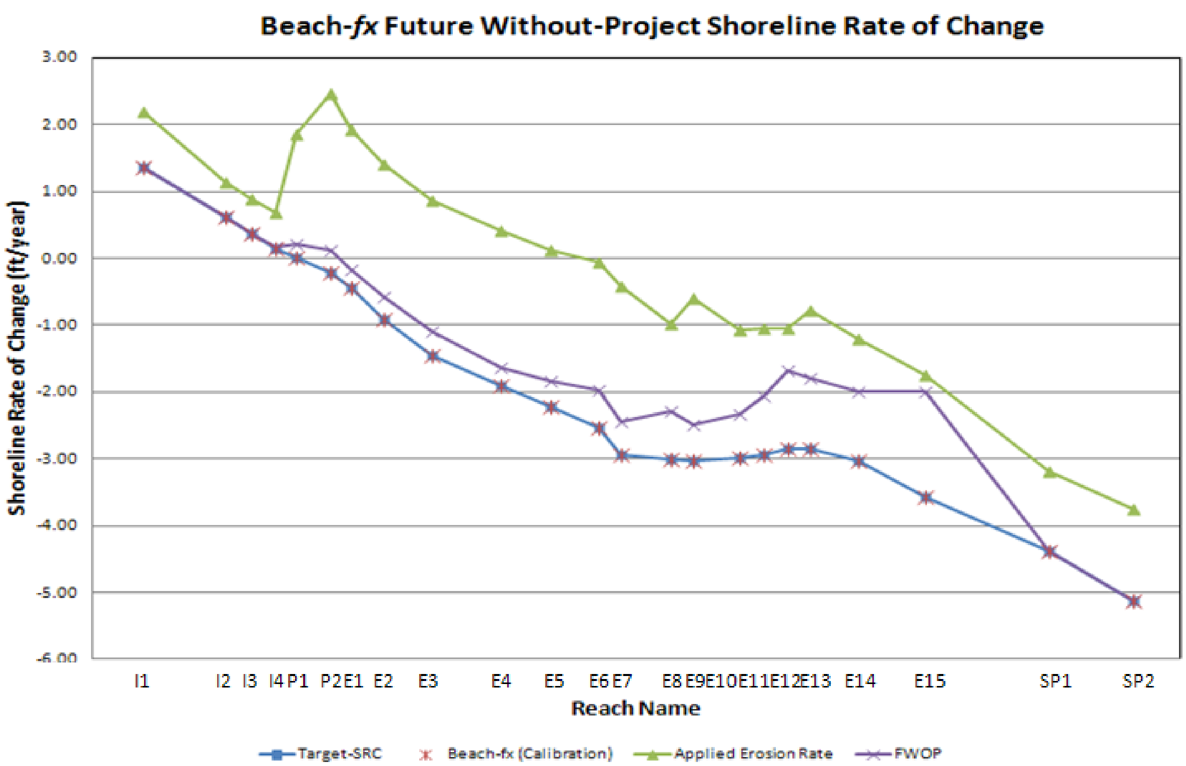


Figure 42: Beach-fx calibration results and applied erosion rates.

Figure 43: Without-project forecast of average shoreline position in 2064 along the inlet shoreline to Groin cell 21.

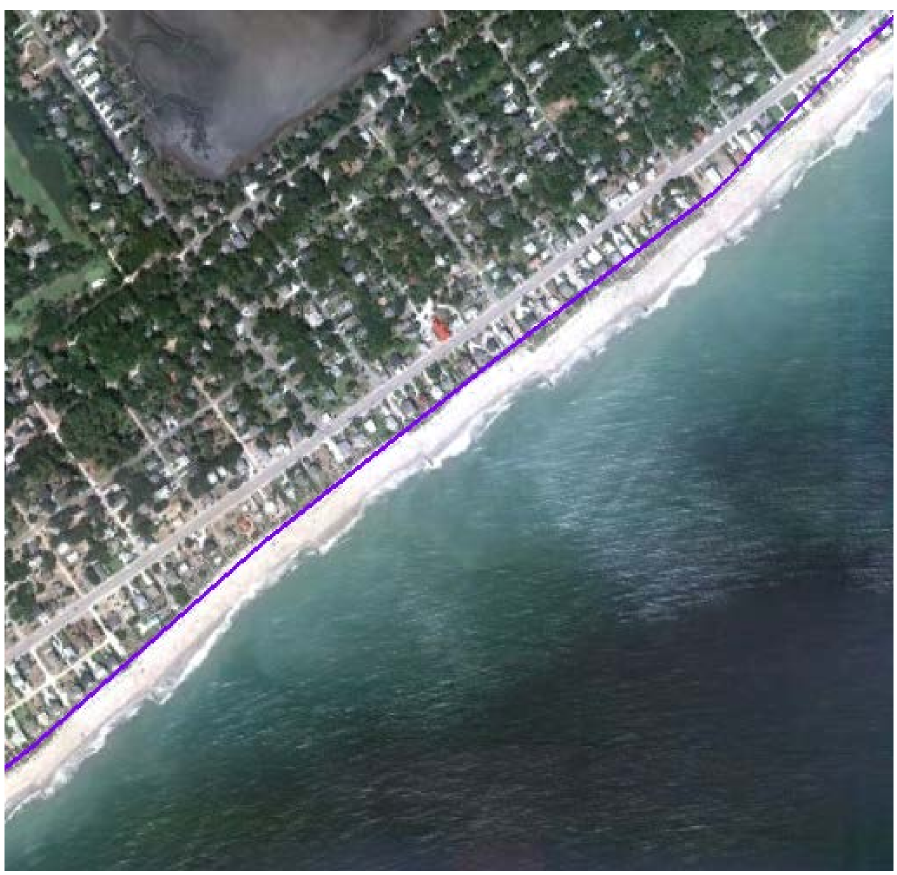


Figure 44: Without-project forecast of average shoreline position in 2064 between groin cells 12 and 20.

In Figure 45, which covers the area between Beach-fx reach E8 (groin cell 11) and reach E15 (groin cell 1), the predicted 2064 shoreline reflects erosion indicating likely a complete loss of all developed properties on the ocean side of Palmetto Blvd. The shoreline is held just seaward of Palmetto Blvd. due to emergency dune reconstruction and armoring of the Highway. However, most if not all developed properties on ocean side of Palmetto Blvd. in this segment of beach are predicted to be destroyed by coastal storms.

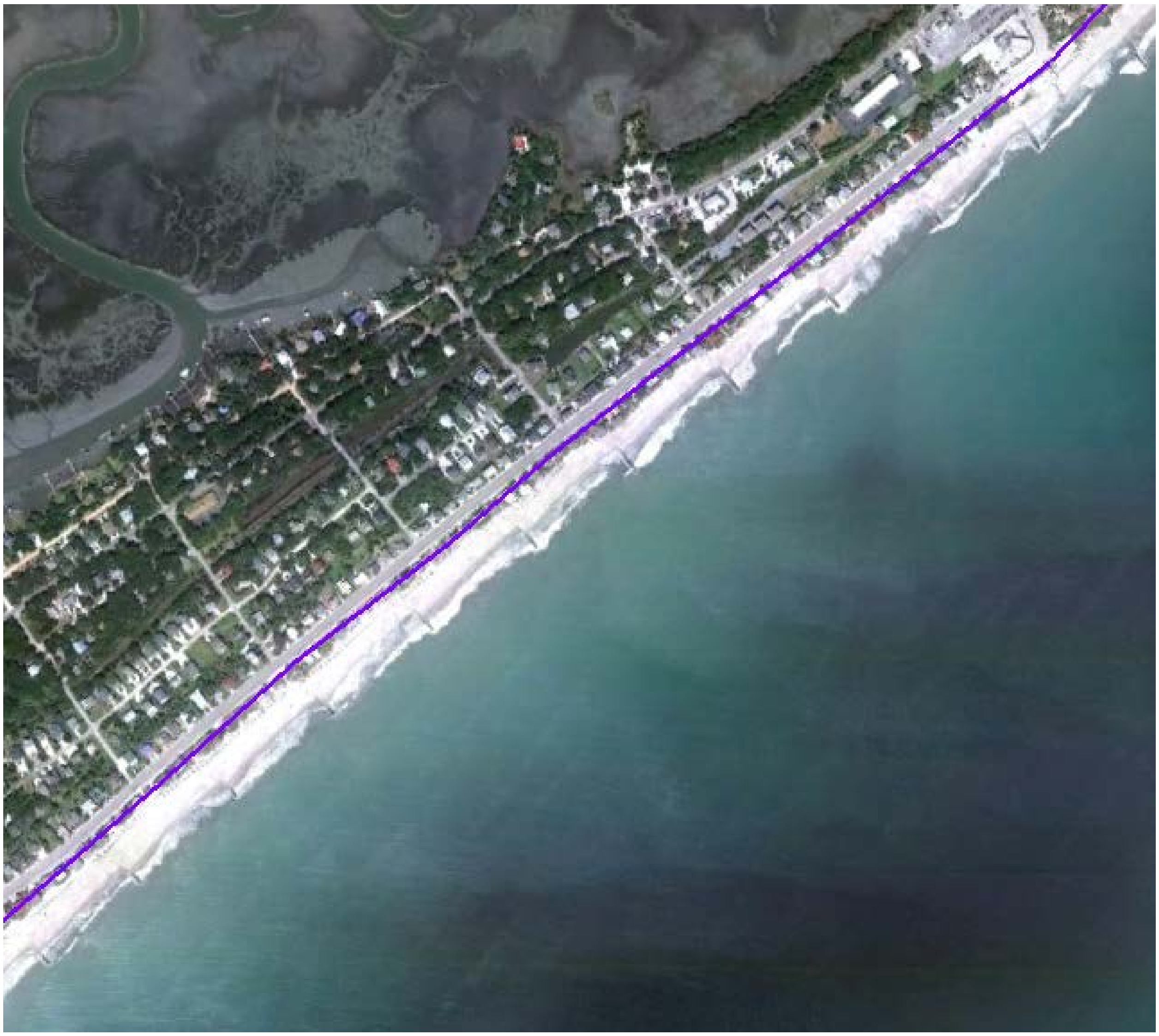


Figure 45: Without-project forecast of average shoreline position in 2064 between groin cells 1 and 11.

Figure 46, which encompasses the Edisto State Park area north of the city of Edisto Beach, shows the same extreme erosion as indicated for the *do nothing* without-project scenario as the emergency dune reconstruction actions are limited to the developed community of Edisto Beach. The predicted 2064 shoreline indicates that the barrier island will migrate approximately one barrier island width into the upland marsh through barrier island overwash processes. The present camping area will be extremely vulnerable and it is likely that necessary infrastructure to support recreational use will be lost.

Figure 46: Without-project forecast of average shoreline position in 2064 at Edisto State Park.

Summary

The results of the *limited emergency action* without-project scenario as simulated with Beach-*fx* indicate that emergency dune reconstruction and armoring of Palmetto Blvd. will reduce erosion along the Atlantic facing shoreline of Edisto Beach and preserve the Palmetto Blvd. as the only hurricane evacuation route off the barrier island. However, considerable loss of privately held developed properties is likely particularly in the north between groin cells 1 and 13. Edisto State Park will be subject to extreme losses due to coastal erosion including the inability to support recreational camping within the State Park.

Total lifecycle without-project damages to structures and contents are estimated at $44.4 million. Costs associated with emergency dune renourishment over the 55-year lifecycle are estimated at $17.5 million and average costs of armoring Palmetto Blvd. are estimated at $2.2 million.

Beach-fx computes damages resulting from erosion, inundation and direct wave impact. The future without-project damages in the Inlet Planning Reach (Beach-fx reaches I1-I4) damages are distributed across the three damage drivers as follows: erosion 9.9%; inundation 12.3%; and wave attack 77.8%. The vast majority of damages in the Inlet Planning Reach are driven by wave attack and inundation indicating that beach elevation and a protective dune system in this planning reach is of primary importance. The future without project damages in the Atlantic South Planning Reach (Beach-fx reaches P1-P2 and E1-E6) are distributed across the three damage drivers as follows: erosion 13.8%; inundation 11.5%; and wave attack 74.6%. Without project damages in the Atlantic South Planning Reach is also dominated by wave attack induced damages with erosion induced damages coming in a distant second. This section of beach will need both a protective dune system and a wider beach to provide storm damage reduction. Future without project damages in the Atlantic North Planning Reach (Beach-fx reaches E7-E15) are distributed across the three damage drivers as follows: erosion 64.5%; inundation 5.1%; and wave attack 30.4%. Without project damages in the Atlantic North Planning reach are dominated by erosion damages followed by wave attack damages. This section of the project will require increased beach width as well as a protective dune system to achieve storm damage reductions.

9.0 Alternative Formulation

Storm damage reduction alternatives were developed based on project site observations and known performance of past beach nourishment projects at Edisto Beach. Apparent during on- site inspection of project beach was the lack of a significant dune feature seaward of the existing infrastructure. Developed properties seaward of Palmetto Blvd. are essentially constructed within the existing dune line. Little if any vegetation is present seaward of the developed properties north of Cheehaw St. (Groin 14, Beach-fx Reach E7) indicating that active swash processes propagate to within close proximity of the structures with such frequency as to preclude the establishment of vegetation. South of this location, a wider vegetated buffer is present between the structures and the active shore face although elevations within the vegetated buffer zone are typically just a few feet higher than the berm elevation. In order to provide meaningful storm damage reduction along the Edisto Beach project shoreline a robust dune feature should be constructed along the entire project shoreline to serve as a barrier to storm surge and waves propagating landward toward developed properties and to provide a reservoir of sand for erosion forces associated with the storms events. To be effective the dune feature should be exposed to active swash processes only during significant storm events and higher than typical water levels. Consequently, the project must also include a constructed berm feature to absorb long-term erosion processes and to ensure that the dune feature is in place at the occurrence of significant storm events. The constructed berm feature will require periodic renourishment to restore its design dimensions and depending on the intensity of the storms encountered since the previous nourishment the dune feature may also require restoration to its design dimensions. A berm feature alone (without an accompanying dune feature) will serve to reduce wave energy and to some extent provide protection against erosion losses but cannot protect against inundation and direct wave impact damages during significant storms and elevated water levels driven by storm surge and wave setup.

The construction and monitoring of the 2006 Edisto Beach restoration project provides valuable site-specific information with respect to beach nourishment design and performance at Edisto Beach. This successful project was used as a guide for the development of alternative beach nourishment the design templates that would be evaluated using Beach-fx to identify the alternative that maximizes net benefits. Three alternatives were initially developed. All alternatives involved the creation of a protective dune along the inlet shoreline (Beach-fx reaches I1 through I4, and P1) and along the Atlantic facing shoreline a design berm feature of varying widths.

Alternative 1, identified as the “Medium” plan, involved a 12 ft dune crest elevation and 15 ft dune crest width along the inlet shoreline (Beach-fx reaches I1 through I4, and P1). Seaward and landward dune slopes were set at one on three. Along the Atlantic facing shoreline the design template involve at 14 ft dune crest elevation and 15 ft dune crest width. The design template berm width transitions from 0 ft at Reach P1 to 50 ft at Reach E1. The design template berm width remains at 50 ft through Reach E6 where it then transitions across Reach E7 to a width of 75 ft at Reach E8. The Alternative 1 design template berm width remains at a 75 ft width through Reach E15 and transitions to a width of 0 ft north of Groin 1. Alternative 1 is referred to as the “Medium” plan because it closely follows the observed added berm widths following the 2006 beach restoration project. The 2006 beach restoration project is viewed as an effective project that has performed well over the 7+ years since construction. Analyses performed by CSE indicated that periodic renourishment would be required at approximate 10 year intervals and based on current conditions this estimate of renourishment interval appears to be reasonably accurate.

Alternative 2, identified as the “Minimum” plan, involved a 15 ft dune crest width at a 10 ft NAVD crest elevation along the inlet shoreline. Along the Atlantic facing shoreline the design dune template involved a 15 ft dune crest width at a 12 ft NAVD crest elevation. The design template berm width transitions from 0 ft at Reach P1 to 25 ft at Reach E1. The design template berm width remains at 25 ft through Reach E6 were it transitions across Reach E7 to a width of 50 ft at Reach E8. The design template berm width remains at a 50 ft width through Reach E15 and transitions to a width of 0 ft north of Groin 1. Alternative 2 is referred to as the “Minimum” plan because it is believed that the dimensions of the Alternative 2 design template represent the minimum beach cross-section that would provide measureable storm damage reduction benefits at Edisto Beach.

Alternative 3, identified as the “Maximum” plan, involved a 15 ft dune crest width at a 14 ft NAVD crest elevation along the inlet shoreline. Along the Atlantic facing shoreline the design dune template involve a 15 ft dune crest width at a 16 ft NAVD crest elevation. The design template berm width transitions from 0 ft at Reach P1 to 75 ft at Reach E1. The design template berm width remains at 75 ft through Reach E6 where it transitions across Reach E7 to a width of 100 ft at Reach E8. The design template berm width remains at 100 ft through Reach E15 and transitions to a width of 0 ft north of Groin 1. Alternative 3 is referred to as the “Maximum” plan because it is believed that the dimensions of the

Alternative 3 design template are the largest that could be justified through storm damage reduction benefits.

Alternatives 1, 2, and 3, were simulated with Beach-fx and based on the results a fourth alternative was developed to optimize the design template to maximize storm damage reduction and minimize project costs. The Alternative 4 design template is smaller than the Alternative 3 (Maximum plan) but slightly larger than the Alternative 1 (Medium plan) design template. Dune crest elevation along the inlet shoreline is 14 ft NAVD, the same as Alternative 3, whereas the dune crest elevation along the Atlantic facing shoreline is 15 ft NAVD, between Alternative 1 and Alternative 3. The design template berm width for Alternative 4 is identical to Alternative 1 except for a longer transition zone at the southern end. The design template berm width transitions from 0 ft at Reach P1 to 50 ft at Reach E2. Table 10 provides reach-by-reach design template dimensions for each of the design alternatives.

Table 10: Dimensions of the four Beach Fill Alternatives Analyzed.

Reach	Alternative 1: Beach and Dune Fill (medium)			Alternative 2: Beach and Dune Fill (minimum)			Alternative 3: Beach and Dune Fill (maximum)			Alternative 4: Beach and Dune Fill (bracketing)		
	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width
I1		12	15		10	15		14	15		14	15
I2		12	15		10	15		14	15		14	15
I3		12	15		10	15		14	15		14	15
I4		12	15		10	15		14	15		14	15
P1	taper	12	15	taper	10	15	taper	14	15	taper	15	15
P2	25	14	15	13	12	15	38	16	15	13	15	15
E1	50	14	15	25	12	15	75	16	15	25	15	15
E2	50	14	15	25	12	15	75	16	15	50	15	15
E3	50	14	15	25	12	15	75	16	15	50	15	15
E4	50	14	15	25	12	15	75	16	15	50	15	15
E5	50	14	15	25	12	15	75	16	15	50	15	15
E6	50	14	15	25	12	15	75	16	15	50	15	15
E7	63	14	15	38	12	15	88	16	15	63	15	15
E8	75	14	15	50	12	15	100	16	15	75	15	15
E9	75	14	15	50	12	15	100	16	15	75	15	15
E10	75	14	15	50	12	15	100	16	15	75	15	15
E11	75	14	15	50	12	15	100	16	15	75	15	15
E12	75	14	15	50	12	15	100	16	15	75	15	15
E13	75	14	15	50	12	15	100	16	15	75	15	15
E14	75	14	15	50	12	15	100	16	15	75	15	15
E15	75	14	15	50	12	15	100	16	15	75	15	15
SP1	taper			taper			taper			taper		

Upland Construction Baseline

As mentioned previously the developed properties seaward of Palmetto Blvd. are constructed within the existing dune line, as such the project design template must be offset seaward of the existing dune such that the landward toe of the constructed dune intersects the existing condition beach profile is seaward of the existing infrastructure. To accommodate this requirement a construction baseline was established and mapped to ensure the constructability of the proposed project. The location of the construction baseline is shown in Figures 47 through 49). However, because there is an offset between the Beach-fx baseline (defined by the landward toe of the existing condition dune feature) and the construction baseline (located seaward of all habitable structures), the estimates of initial construction volumes calculated in Beach-fx are under estimated because the model has no provision for implementing an upland width offset at the time of project construction. That is, within Beach-fx, construction of a planned nourishment dune feature begins at the landward toe of the existing condition dune and extends seaward from that location according to the specified design template. The additional initial construction volume for each of the alternatives was computed externally from the model and added to the volume estimates generated within Beach-fx. The additional sand volume associated with the offset between the construction baseline and the Beach-fx baseline was estimated as follows:

1. Compute fill volume between the 2009 initial condition representative beach profiles and the design template referenced to the Beach-fx baseline on a reach-by-reach basis.
2. Compute fill volume between the 2009 initial condition representative beach profiles and the design template referenced to the construction baseline on a reach-by-reach basis.
3. The fill volume associated with the offset between the construction baseline and the Beach-fx baseline is estimated as the total volume computed in step 2 less the total volume computed in step 1.

This analysis indicated that the initial construction fill volume associated with the offset between the Beach-fx baseline and the construction baseline is approximately 364,000 cy, 198,000 cy, 443,000 cy and 388,000 cy for Alternatives 1, 2, 3, and 4, respectively. The reach-by-reach fill densities and total construction baseline offset fill volumes for each of the four beach and dune fill alternatives are provided in Tables 11 through 14.

Table 11: Construction Baseline offset fill Volume, Alternative 1.

	Beach-fx Baseline		Construction Baseline		
Reach	Fill Density	Reach Volume	Fill Density	Reach Volume	Offset Volume
	cy/ft	cy	cy/ft	cy	cy
I1	5.6	21280	5.6	21280	0
I2	2.9	6127.7	2.9	6127.7	0
I3	2.9	1870.5	2.9	1870.5	0
I4	2.9	1841.5	2.9	1841.5	0
P1	2.8	1472.8	2.8	1472.8	0
P2	5.1	4498.2	5.1	4498.2	0
E1	23.8	11733.4	28.1	13853.3	2119.9
E2	16.5	14338.5	16.5	14338.5	0
E3	16.6	20351.6	31.8	38986.8	18635.2
E4	2.6	4544.8	2.6	4544.8	0
E5	2.6	3268.2	19.1	24008.7	20740.5
E6	2.4	2952	15.1	18573	15621
E7	4.8	2688	33.2	18592	15904
E8	18.4	23128.8	39.8	50028.6	26899.8
E9	5.4	3245.4	41.3	24821.3	21575.9
E10	2.7	3121.2	41.1	47511.6	44390.4
E11	4.7	2895.2	60.6	37329.6	34434.4
E12	17.2	10320	82.2	49320	39000
E13	41.3	24036.6	86.9	50575.8	26539.2
E14	33.8	40898	82.1	99341	58443
E15	48.3	83172.6	71.4	122950.8	39778.2
Total		287785		651867	364082

Table 12: Construction Baseline offset fill Volume, Alternative 2.

	Beach-fx Baseline		Construction Baseline		
Reach	Fill Density	Reach Volume	Fill Density	Reach Volume	Offset Volume
	cy/ft	cy	cy/ft	cy	cy
I1	2.6	9880	2.6	9880	0
I2	0	0	0	0	0
I3	0	0	0	0	0
I4	0	0	0	0	0
P1	0	0	0	0	0
P2	1.3	1146.6	1.3	1146.6	0
E1	1	493	1.3	640.9	147.9
E2	0.3	260.7	0.3	260.7	0
E3	0.3	367.8	2.4	2942.4	2574.6
E4	0	0	0	0	0
E5	0	0	4.3	5405.1	5405.1
E6	0	0	1.6	1968	1968
E7	1	560	5.6	3136	2576
E8	2.9	3645.3	6.1	7667.7	4022.4
E9	1.6	961.6	7.3	4387.3	3425.7
E10	0	0	7.1	8207.6	8207.6
E11	0.2	123.2	26.6	16385.6	16262.4
E12	0	0	48.1	28860	28860
E13	7.2	4190.4	52.8	30729.6	26539.2
E14	0	0	48.1	58201	58201
E15	14.3	24624.6	37.4	64402.8	39778.2
Total		46253		244221	197968

Table 13: Construction Baseline offset fill Volume, Alternative 3.

	Beach-fx Baseline		Construction Baseline		
Reach	Fill Density	Reach Volume	Fill Density	Reach Volume	Offset Volume
	cy/ft	cy	cy/ft	cy	cy
I1	10.2	38760	10.2	38760	0
I2	7.2	15213.6	7.2	15213.6	0
I3	7.2	4644	7.2	4644	0
I4	7.2	4572	7.2	4572	0
P1	6.6	3471.6	6.6	3471.6	0
P2	22.6	19933.2	22.6	19933.2	0
E1	58.3	28741.9	62.6	30861.8	2119.9
E2	49.9	43363.1	49.9	43363.1	0
E3	50	61300	65.1	79812.6	18512.6
E4	14.4	25171.2	14.4	25171.2	0
E5	14.4	18100.8	53.5	67249.5	49148.7
E6	22.6	27798	49.9	61377	33579
E7	26.9	15064	68.1	38136	23072
E8	52.7	66243.9	74.1	93143.7	26899.8
E9	30.7	18450.7	76.3	45856.3	27405.6
E10	21	24276	76.4	88318.4	64042.4
E11	39.7	24455.2	95.6	58889.6	34434.4
E12	52.2	31320	117.1	70260	38940
E13	76.3	44406.6	121.8	70887.6	26481
E14	68.7	83127	117.1	141691	58564
E15	83	142926	106.1	182704.2	39778.2
Total		741339		1184316	442978

Table 14: Construction Baseline offset fill Volume, Alternative 4.

	Beach-fx Baseline		Construction Baseline		
Reach	Fill Density	Reach Volume	Fill Density	Reach Volume	Offset Volume
	cy/ft	cy	cy/ft	cy	cy
I1	8.9	33820	8.9	33820	0
I2	6.7	14157.1	6.7	14157.1	0
I3	6.7	4321.5	6.7	4321.5	0
I4	6.7	4254.5	6.7	4254.5	0
P1	8.9	4681.4	8.9	4681.4	0
P2	7.3	6438.6	7.3	6438.6	0
E1	10.8	5324.4	14.8	7296.4	1972
E2	23.5	20421.5	23.5	20421.5	0
E3	23.5	28811	38.7	47446.2	18635.2
E4	4.8	8390.4	4.8	8390.4	0
E5	4.8	6033.6	26.2	32933.4	26899.8
E6	4.6	5658	22.2	27306	21648
E7	7	3920	40.4	22624	18704
E8	25.5	32053.5	47	59079	27025.5
E9	7.6	4567.6	48.5	29148.5	24580.9
E10	5	5780	48.3	55834.8	50054.8
E11	11.9	7330.4	67.8	41764.8	34434.4
E12	24.4	14640	89.4	53640	39000
E13	48.5	28227	94.1	54766.2	26539.2
E14	41	49610	89.3	108053	58443
E15	55.4	95398.8	78.6	135349.2	39950.4
Total		383839		771727	387887

Figure 47: Construction baseline, Reaches I1 – I4, P1 – P2 , and E1.

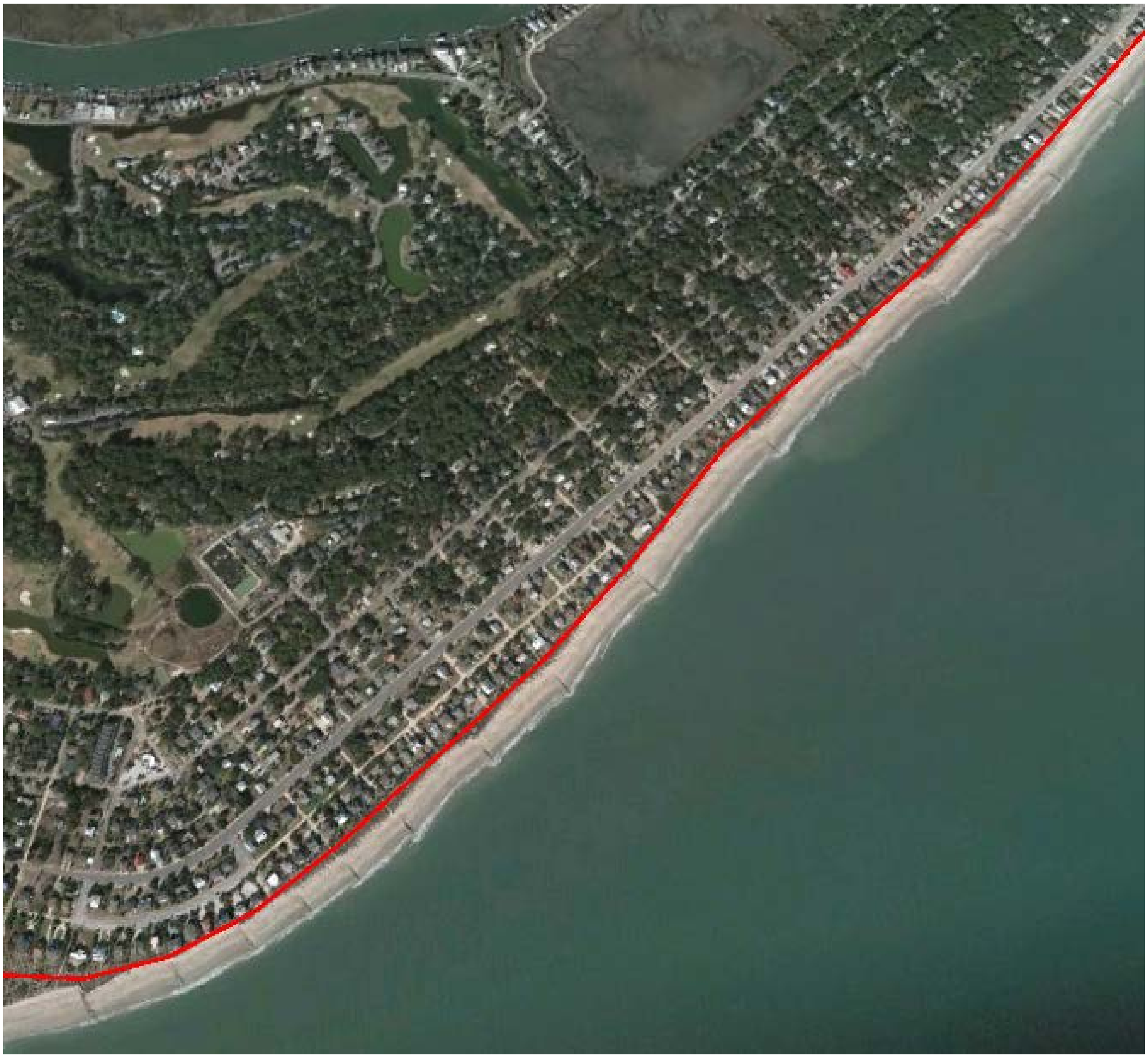


Figure 48: Construction baseline, Reaches P2 and E1 – E6.

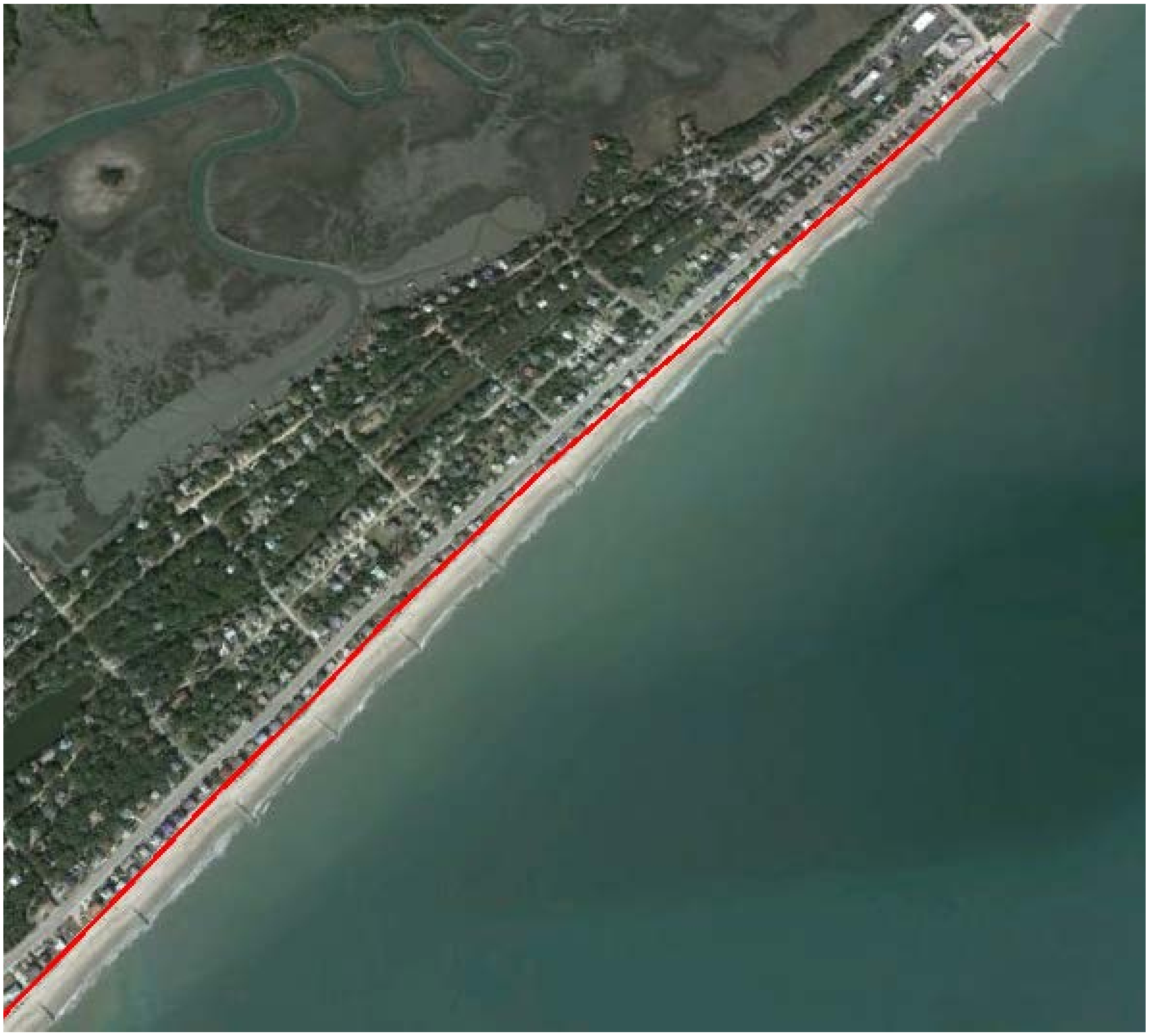


Figure 49: Construction baseline, Reaches E7 – E15.

Methodology and Procedure for Estimating Required Groin Lengthening

This section provides background information related to the importance and function of the groin field at Edisto Beach and document the procedure employed to estimate the amount of groin lengthening necessary to support the proposed project design template.

a. Introduction and Background

Existing coastal processes at Edisto Beach are driven by high energy waves and water levels As discussed in section 1.0 of this appendix the construction of groins at Edisto Beach began in 1948 in an effort to reduce the rate of shoreline erosion and protect upland infrastructure including commercial property (the Pavilion at the north end of Edisto Beach), Palmetto Blvd. (SC 174), and private property. Groins were constructed from north to south along the Atlantic facing shoreline and as erosion continued to move down the beach additional groins were constructed in an attempt to keep pace with the subsequent erosion moving down drift (south). By 1958 a total of 17 groins had been constructed covering approximately 65% of the Atlantic facing shoreline of Edisto Beach. By 1975 17 more groins had been constructed, 29 along the Atlantic facing shoreline and 5 along the inlet shoreline for a total of 34 groins. The chronology of groin construction at Edisto Beach is provided in Table 1 (Section 1.0 of this appendix). This groin field plays a central role in the stabilization of the Edisto Beach shoreline and although long term shoreline erosion persists along the ocean front, the groin field functions to reduce the rate of sand loss. Specifically, periodic beach profile monitoring surveys have shown that the rate of sand loss in groins cells 1 through 27 has been less than 1 cy/ft/yr in recent years compared to an erosion rate of 1.5 cy/ft/yr in the southern part of the State Park reach where there are no groins (CSE 2003). CSE has estimated that without groins 1 through 15, at least two rows of houses and Palmetto Blvd. would be destroyed by natural adjustment of the shoreline within 10 years (CSE 2003). This assertion is supported by observation of the more seaward location of of the shoreline in Edisto Beach as compared to the State Park illustrated in Figure 50. Therefore the groin field at Edisto Beach is viewed as an essential element in the stabilization the beach which in turn provides coastal storm damage protection to the upland infrastructure. The groin field also exerts a critical influence on current and future shoreline position in the Edisto Beach study area.

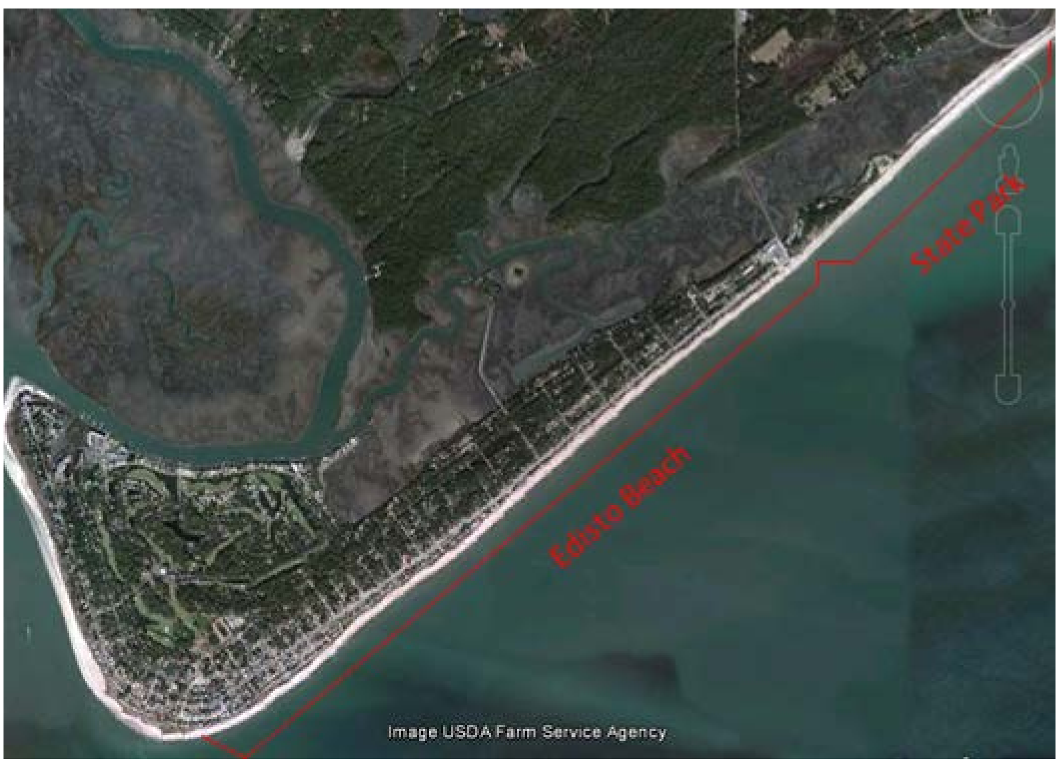


Figure 50: Edisto Beach study area.

Locally funded beach nourishment projects were constructed along the Atlantic facing shoreline in 1995 and 2006. The 1995 project involved the placement of 155,000 cy of beach quality fill material and the 2006 project involved the placement of 850,000 cy of beach quality fill material. The subsequent down drift migration of this fill material has resulted in the burial of the five groins constructed along the inlet facing shoreline. Long term shoreline change rates along the inlet shoreline vary from nearly stable (+0.01 ft/yr) at the point to accretional (+1.36 ft/yr) at the northwest end of the inlet shoreline near Big Bay creek. Along the Atlantic facing shoreline long term shoreline change rates vary from nearly stable (+0.01 ft/yr) at the point to erosive (-3.56 ft/yr) at the northern end of Edisto Beach. Shoreline change rates become even more erosion moving north into the State Park (-4.38 to -5.13 ft/year).

b. Requirement for Groin Lengthening

Existing condition dune heights along the Atlantic facing shoreline at Edisto Beach vary between 10 and 12 ft NAVD and the existing condition berm width varies between 35 and 105 ft. An analysis of the engineering and economic performance of a number of beach nourishment design alternatives has been conducted using Beach-fx and the results of that analysis indicate that a design beach cross-section involving dunes of varying crest elevations and berm widths varying between 25 and 100 ft are needed to provide the desired coastal storm damage reduction. Because the distance between the construction baseline and the seaward edge of the alternative design template berm exceeds the distance between the construction baseline and the seaward edge of the existing condition berm along certain reaches within the project, the effective length of the many of the existing groins will need to be increased in order to create and maintain beach width necessary to support the design template.

The motivation for lengthening groins in the Edisto Beach study area is exclusively for the purpose of providing necessary beach width to accommodate and maintain the alternative design template. Each of the four alternatives require some amount of groin lengthening, the alternatives involving larger cross-sections, those involving higher dune crest elevations and wider berms, require more groin lengthening than those alternatives involving smaller cross-sections. The proposed groin lengthening is not provided as a means for trapping more sand and increasing beach width or significantly changing the rate of sand bypassing the groins. The amount of required groin lengthening was estimated using a technique that employed geometric considerations based on measured beach profile and groin structure survey data as opposed to a numerical simulation-based estimation approach. Use of the described geometric data-based estimation technique is justified and believed to be superior to a numerically-based estimation approach because the available survey data represent actual on-site performance of the existing groin field and measured morphology response to those structures whereas, a numerically-based estimation would rely on theoretical representation of the groin field performance and estimated morphological response to the groin structures. If any amount of groin lengthening was determined to be necessary a minimum increased length of 20 ft was specified, also groin lengthening beyond 20 ft was specified in even 10 ft increments for practical reasons.

c. Estimation of Groin Lengthening Amount

The technique employed to estimate the amount of needed groin lengthening is based on the assumption that the representative existing condition beach profile is in dynamic equilibrium with, and held in place by, the existing groin and the groins intersection with the sea bed. Consequently, the amount of required groin lengthening was taken as approximately equal to the distance between the seaward edge of the existing condition representative beach berm and the seaward edge of the design template beach berm. Figure 51 illustrates the technique for Alternative 4 and Beach-fx Reach E15. In this case the distance between the seaward

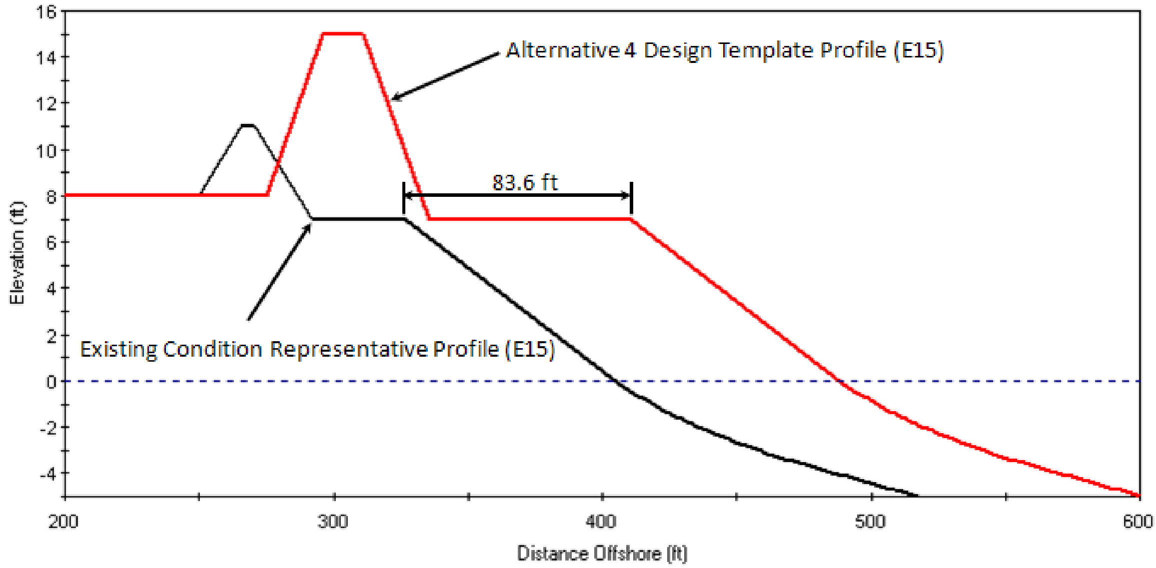


Figure 51: Groin Lengthening Estimation Technique.

edge of the existing condition representative beach berm profile and the seaward edge of the Alternative 4 design template beach berm is 83.6 ft, so, the recommended amount of groin lengthening will be 80 ft, rounding to the nearest 10 ft increment. As result groins 1 and 2 which, are contained within Beach-fx Reach E15, are recommended for lengthening of 80 ft. This approach was applied for all Beach-fx reaches and all evaluated alternative design templates to estimate the amount of required groin lengthening. The resulting recommended amount of groin lengthening for each of the alternatives is listed in Table 15. The total estimated amount of groin lengthening for 1090 ft, 360 ft, 1970 ft and 1130 ft for Alternatives 1, 2, 3, and 4, respectively. As seen in the table amount of required groin lengthening increases from south to north and reflects the greater set back distance between the shoreline and the developed infrastructure in the southern parts of Edisto Beach compared to the northern parts of Edisto Beach.

d. Assessment of Groin Lengthening Influence on Sand Transport and Shoreline Change

The down drift impacts of groins and groin fields depend to a large extent on the effective length of the groin or groins comprising the groin field. The effective length of a groin can be thought of as the length of groin extending beyond the shoreline. Likewise, the sand trapping capacity of a groin depends on the water depth at the seaward tip of the groin. As water depths at the seaward tip of the groin decreases longshore transport rates bypassing the groin increase. The beach and dune fill project alternatives formulated for Edisto Beach are designed to reduce future storm damages to upland infrastructure by: 1) increasing the set back distance between the existing infrastructure and the shoreline which will allow for increased wave energy dissipation; 2) providing a physical barrier to elevated water levels associated with the storm surge; and 3) providing a reservoir of sand to absorb the erosion forces associated with the storm waves and water levels. The design berm provides for the wave energy dissipation component of the protective system and the dune feature provides

Table 15: Recommended Groin Lengthening for all Alternatives.

	Groin Extension Length (ft)			
Groin #	Alt 1	Alt 2	Alt 3	Alt 4
1	80	40	110	80
2	80	40	110	80
3	80	50	120	90
4	90	50	130	90
5	90	60	130	100
6	90	60	130	100
7	80	40	110	80
8	50	20	90	60
9	40		80	50
10	40		80	50
11	40		80	40
12	40		80	40
13	30		70	40
14	20		60	30
15	20		50	20
16	20		50	20
17	20		50	20
18	20		30	20
19			20	
20	20		40	20
21	30		70	30
22	20		60	30
23	20		50	20
24	20		60	20
25	30		70	
26	20		40	
Total	1090	360	1970	1130

the physical barrier component to the elevated water levels and the berm and dune together provide the reservoir of sand need to absorb the storm associated erosion forces. However, construction of the beach and dune fill necessitates a seaward displacement of entire Atlantic facing project shoreline compared to existing conditions. Because the existing shoreline is already being held in place largely by the existing groin field at Edisto Beach any constructed project that further displaces the shoreline in a seaward direction will be short-lived and can be expected to perform poorly without an equivalent seaward displacement of the groin field that holds the shoreline in place. However, because the groin length extensions will be filled to capacity by the fill project and maintained over the life of the project, the delivery of sediment to down drift beaches is expected to largely unaffected by the recommended groin lengthening. That is, the effective length of the groins comprising the Edisto groin field will not increase because not only are the groins being lengthened but the beach is also being renourished causing the shoreline to displaced seaward by the same amount that the groins are being lengthened. The equilibrium water depths at the seaward tips of the extended groins will be the same as the water depths at the seaward tips of the existing condition groins. Consequently, sand bypassing the post-project groin field is expected to remain the same as the existing condition. Overall sand volume delivery to the inlet shoreline of Edisto and the shoal systems and islands of St. Helena Sound are expected to remain constant or to slightly increase due to the introduction of new sediments to the littoral system from the construction and maintenance of the coastal storm damage reduction project at Edisto Beach. The reasonableness of this expectation is supported by observations of increased sand volume and progradation of the shoreline along the Edisto Beach inlet shoreline following nourishment projects in 1995 and 2006.

10.0 Alternative Evaluations

This section describes the results of the Beach-fx lifecycle simulations of the Beach and Dune fill project alternatives formulated in the previous section. The details of each of the four project alternatives were specified in Beach-fx and 300 55-year-long lifecycle simulations were performed for each of the alternatives. Each lifecycle simulation started in the year 2009 and involved emergency dune nourishment and armoring of Palmetto Blvd actions as defined for the “Limited Emergency Action Future Without-Project scenario” between 2009 and 2014. Starting in the year 2014 the alternative beach and dune project was constructed and the physical and economic performance of the project was simulated for a 50-year project life concluding at the end of the year 2063(start of 2064). Each year after initial construction of the fill alternative the need for renourishment of the project was checked within the model simulation. If specific beach morphology and volume requirement thresholds were met then a renourishment was scheduled and constructed. Project costs associated with beach nourishment and nourishment volumes were computed and stored as were storm induced damages to structures and contents. For each alternative net average annual project benefits were computed by comparing Without-Project damages and costs to With-Project alternative damages and costs. For the without project simulation damages are taken as the sum of the computed structure and content damages, without project costs are taken as costs associated with emergency dune nourishment actions and costs associated with armoring and repair of armoring along Palmetto Blvd. Without-project damages and costs were computed on a reach-by-reach basis within Beach-fx. For the with-project alternatives damages were again taken as the sum of the computed structure and content damages. Emergency nourishment and armoring costs accrued during the first 5 years of the simulation were also recorded. With-project benefits were computed as: Without-Project damages less With-Project damages plus Without-Project emergency nourishment costs less With-Project emergency nourishment costs plus Without-Project armoring costs less With-Project armoring costs. In other words, with-project benefits include reductions in computed storm-induced damages plus avoided costs associated emergency nourishment actions and armoring of Palmetto Blvd. With-Project costs included project nourishment placement costs (including cost of sand volume associated with the offset between the Beach-fx baseline and the construction baseline), construction mobilization and demobilization costs, and groin lengthening costs. Total net average annual benefits of each alternative were computed as with-project benefits less with-project costs plus land-loss benefits. Land-loss benefits were computed based on a reduction of shoreline erosion rates on a reach-by-reach basis and apply only to those reaches that are erosional for the without-project condition. The individual damage and cost quantities employed average values computed across the 300 lifecycles simulated. Table 16 lists the net average annual benefits for each of four beach and dune alternatives evaluated. Net benefits are given for each of the Beach-fx reaches as well as for the three larger planning reaches. Table 16 shows that beach and dune Alternative 4 produces the maximum net average annual benefits of all the alternatives evaluated with an average annual benefit of approximately $1,600,000. Alternative 4 is identified as the optimized National Economic Development (NED) plan in that Alternative 4 it is bracketed from the perspective of project size by Alternative 1 (a smaller project) and Alternative 3 (a larger project) and produces net average annual benefits exceeding those produced by Alternatives 1 and 3. Although other Alternatives may generate greater net average annual benefits in specific individual reaches over the entire project and within the three planning reaches Alternative 4 generates the greatest net average annual benefits.

Table 16: Net Average Annual Benefits.

	Net Benefits			
Reach	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
I1	$122,469	$15,882	$222,424	$222,424
I2	$57,558	$7,021	$107,922	$107,922
I3	$14,156	$2,234	$22,820	$22,820
I4	$19,108	$2,416	$33,788	$33,788
P1	$9,658	$9,076	$14,436	$17,528
P2	-$14,101	$22,457	-$1,185	-$5,344
E1	$3,472	$13,017	-$4,736	$9,951
E2	$21,848	$22,470	$11,313	$21,978
E3	$36,315	$46,123	$26,654	$38,632
E4	$81,740	$28,222	$98,315	$93,723
E5	$46,145	$27,247	$43,832	$51,606
E6	$58,933	$66,524	$53,368	$59,216
E7	$18,021	$21,968	$13,804	$16,423
E8	$130,028	$104,432	$121,698	$133,471
E9	$64,325	$21,001	$91,613	$76,090
E10	$135,694	$70,100	$145,367	$151,388
E11	$135,277	$67,594	$142,937	$145,952
E12	$15,223	$14,570	$7,986	$16,015
E13	$60,498	$46,982	$59,520	$61,747
E14	$194,443	$113,188	$207,823	$213,951
E15	$126,759	$120,963	$112,765	$130,192
Inlet Reach (I1-I4)	**$213,290**	**$27,553**	**$386,954**	**$386,954**
AS Reach (P1-2, E1-E6)	**$244,010**	**$235,136**	**$241,996**	**$287,289**
AN Reach (E7-E15)	**$880,268**	**$580,798**	**$903,515**	**$945,230**
Total	**$1,337,568**	**$843,487**	**$1,532,465**	**$1,619,473**

11.0 Renourishment Cycle Optimization

Having identified the NED plan the next step in the analysis was to determine the optimum renourishment cycle. Detailed analyses have shown that the total cumulative volume of fill material place on a nourishment project over a 50-year project life is approximately the same regardless of the length of the renourishment cycle (CEM, Part V, Chapter 4, 2008). As such, optimization of the renourishment cycle effectively reduces to balancing the cost of frequent mobilizations and demobilizations for short duration renourishments against the risk of storm-induced damages in the event the project needs renourishment for a prolonged period before a scheduled renourishment occurs. As stated previously, the initial suite of model simulations were performed in a way that allowed renourishment to occur whenever it was determined to be required. That is, within the simulation the beach morphology was check each year and if certain morphology conditions existed and a specified renourishment mobilization threshold volume was exceeded then a renourishment was scheduled and constructed. The lifecycle results from these simulations were analyzed and the frequency distribution of the computed renouishment cycle was determined to be as shown in Figure 52. From this figure it is seen that required renourishment at Edisto Beach takes on a very broad distribution with renourishment needed in as short as one year and a long 30 plus years. A mean renourishment interval of approximately 16 years was computed from the distribution shown in Figure 52. This broad distribution of renourishment intervals is an indication that the need for renourishment Edisto Beach is primarily driven by the random occurrence of strong storm events as opposed to a persistent background erosion rate.

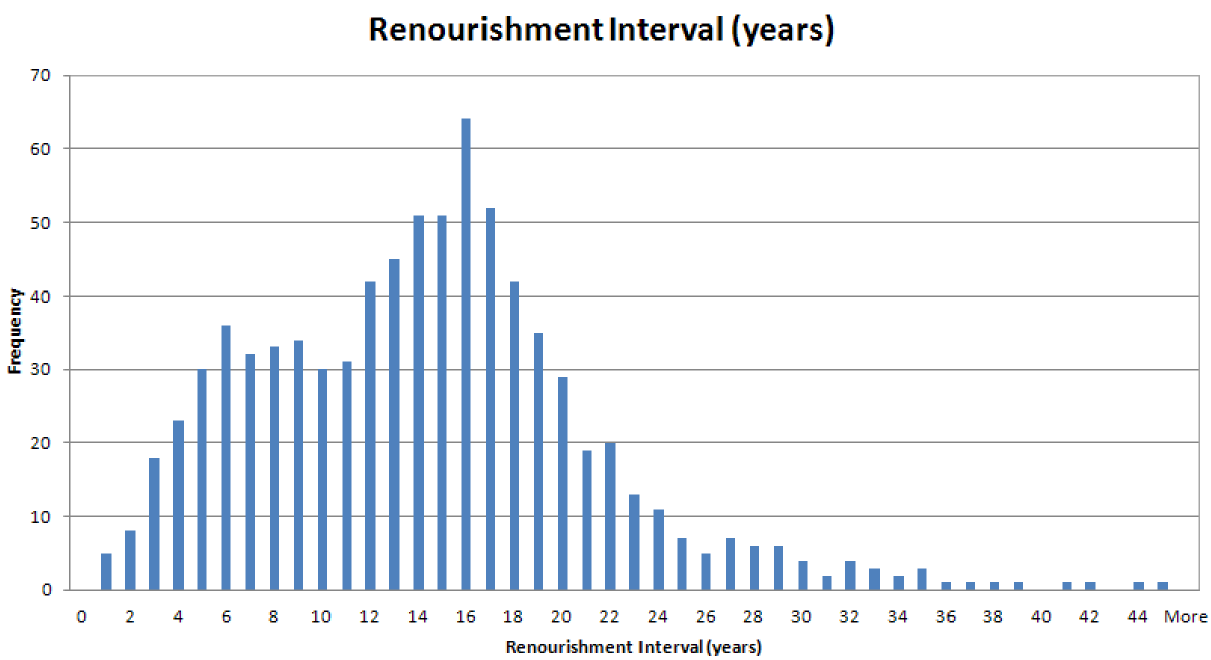


Figure 52: Frequency Distribution of Renourishment Cycle.

A series of additional lifefcycle simulations were performed to determine the optimum renourishment cycle for NED plan (Alternative 4) at Edisto Beach. Simulations were performed for renourishment cycles of 4, 6, 8, 10, 12, and 16 year renourishment cycles. Net average annual benefits were computed for each of the simulated renourishment cycles and the results are shown in Figure 53. This figure shows that net average annual benefits increase substantially between 4 year and 6 year renourishment intervals and again between 6 year and 8 year renourishment intervals. However, the results indicate that renourishment intervals of 8 years and longer produce approximately the same net average annual benefits. Although a notable decrease in net average annual benefits is seen between the 12 year renourishment cycle and the 16 year renourishment cycle. The 12 year renourishment cycle generates net average annual benefits that exceed the 8 year renourishment cycle average annual net benefits by approximately $4500. However, this difference represents an increase of just 0.3% of the total average annual net benefits. Figure 54 shows the cumulative probability distribution function of when renourishment at Edisto Beach is required. This figure shows that there is approximately a 40% probability that renourshment will be required at Edisto at an interval of 12 years or less. Likewise, the plot shows that the

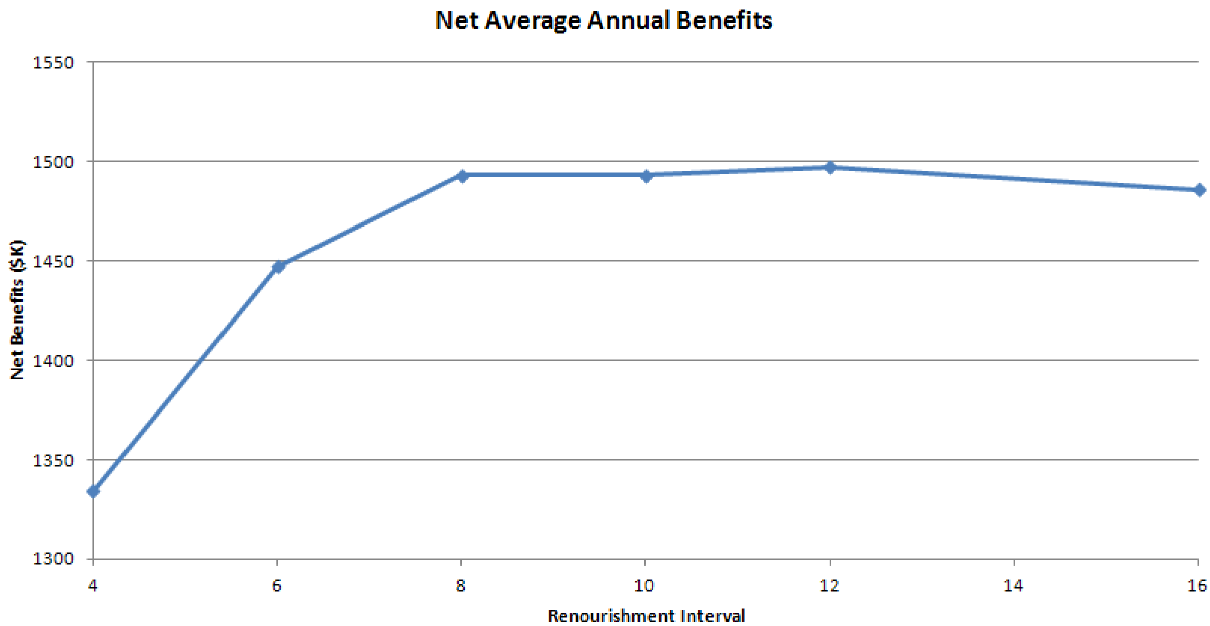


Figure 53: Frequency Distribution of Renourishment Cycle.

probability of a renourishment being required at 8 years or less is approximately 23%. Consequently, the risk of the project requiring renouishment before it is scheduled to occur is reduced by 17% with a 8 year renourishment cycle compared to a 12 renourishment cycle. In light of the 17% risk reduction and the relatively small difference (0.3%) in average annual net benefits nearly an 8 year renourishment cycle for Edisto Beach is identified as the optimum renourishment cycle.

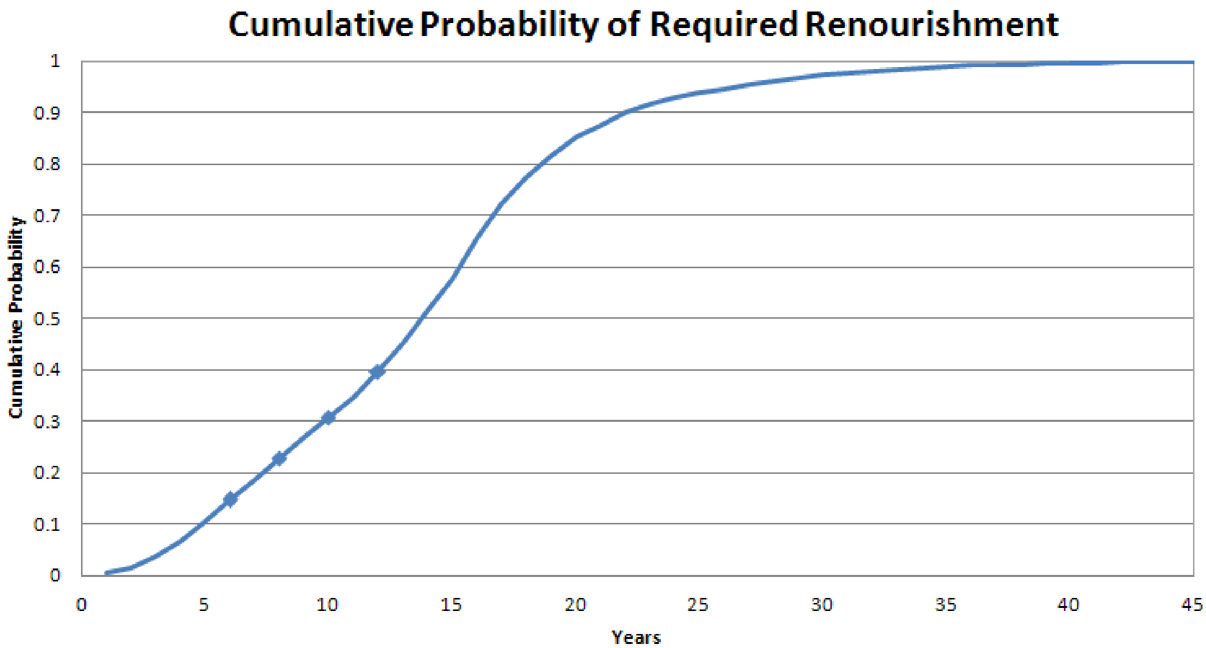


Figure 54: Cumulative Probability Function of Required Renourishment.

12.0 Project Sensitivity to Future Sea Level Change

In accordance with EC 1165-2-212 the direct and indirect effects of future sea level change on the identified NED beach and dune fill alternative (Alternative 4) was evaluated using the Beach-fx model. The engineering and economic performance of the NED plan was evaluated under three scenarios of future sea level change in accordance with official guidance as articulated in EC 1165-2-212. Relative sea level change at Edisto Beach is one of rising sea levels. The historical rate of sea level rise was determined to be 3.19 mm/year (Appendix A, Section 2.0 *d*). The future low rate of sea level change was taken as a linear projection of this historical rate of change. The future intermediate rate of sea level change was computed using modified NRC Curve I and equation 2 and 3 in EC 1165-2-212 Appendix B. The future high rate of sea level change was computed using modified NRC Curve III and equations 2 and 3 in EC 1185-2-212. These relationships for future sealevel change as defined in ED 1165-2-212 are coded within Beach-fx and sea level change is internally computed continuously throughout the simulated project lifecycle. Figure 55 provides a plot of the Beach-fx computed sea level rise for each of the three sea level change scenarios. This figure shows that incremental sea level rise across the simulation period (2009 to 2069) was computed at 0.62 ft, 1.10 ft, and 2.65 ft, for the low, intermediate, and high rates of sea level change, respectively.

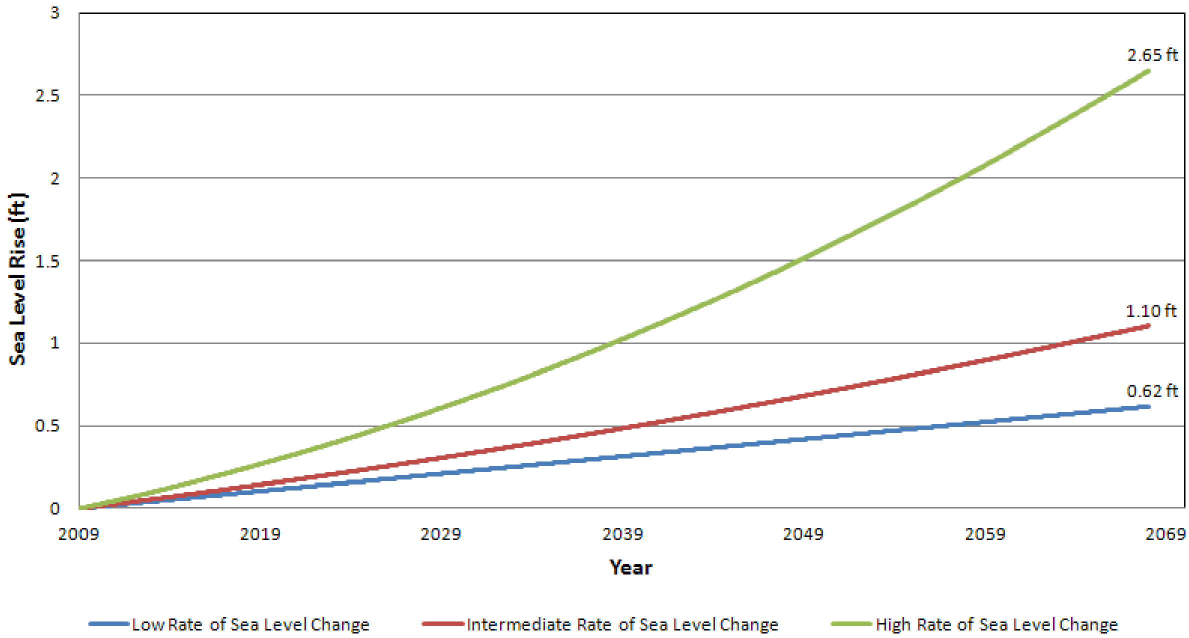


Figure 55: Cumulative Probability Function of Required Renourishment.

The effect of potential future sea level change on the economic performance of the NED alternative (Alternative 4) is illustrated in Figure 56. This plot shows that average annual project costs, average annual project benefits, and net average annual benefits all increase with increasing rates of future sea level rise. However, average annual benefits increase at a faster rate than average annual project costs resulting in net average annual benefits that are greater for higher future rates of sea level rise. These results indicate that from an economic

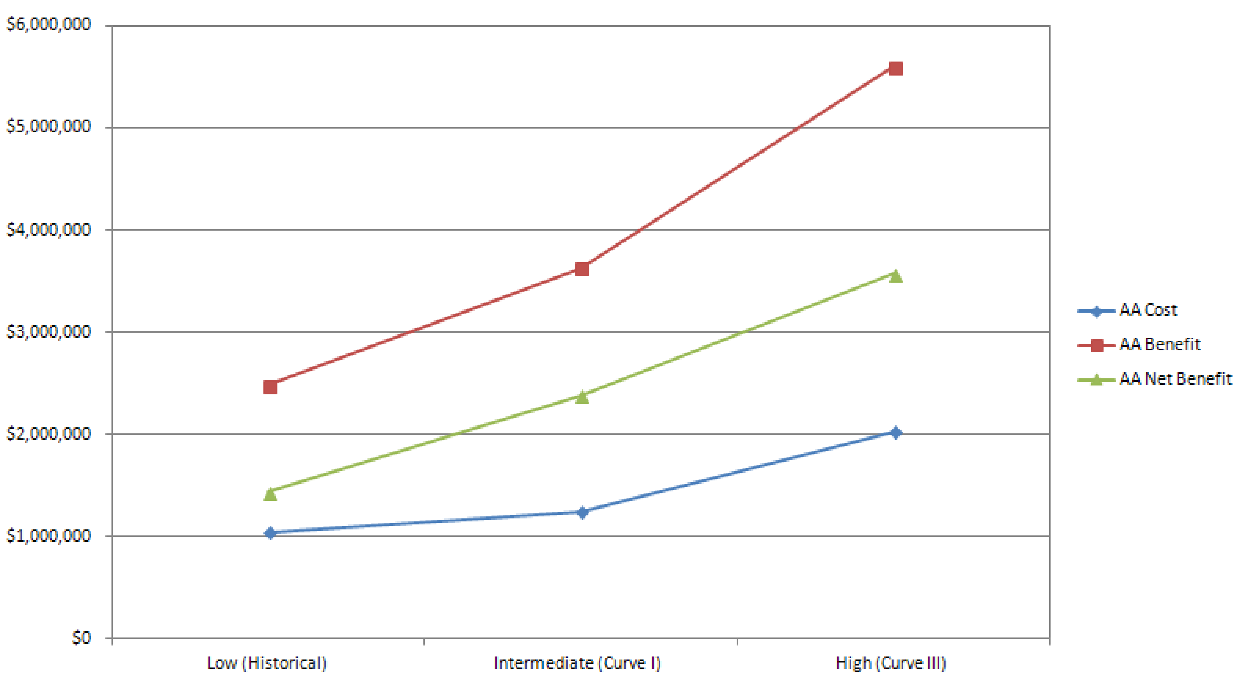
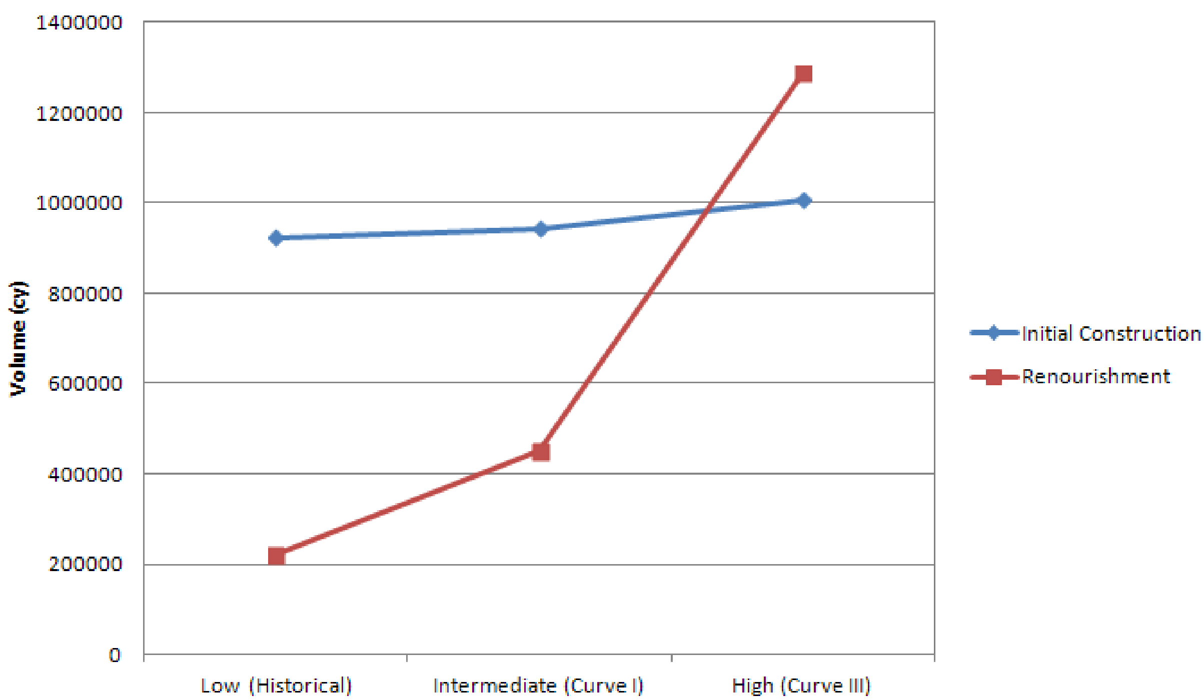


Figure 56: Effect of Future Sea Level Change on Economic Performance of Alternative 4.

perspective a Federal storm damage reduction project at Edisto Beach will remain justified if accelerating rates of future sea level rise occur as some have predicted.

From an engineering perspective, future sea level rise will require more sand volume to maintain the designed project features. Figure 57 shows the estimated fill volume requirements for initial construction and the 8-year interval renourishment for each of the three future sea level change scenarios. Here it is seen that the future sea level rise scenario has little effect on the initial construction volume but a large effect on the average renourishment volume. For the low rate of sea level rise the average 8-year renourishment volume is estimated at 220,400 cy, whereas for the intermediate rate of sea level rise the average 8-year renourishment volume increases by more than double to 450,500 cy, and for the high rate of future sea level rise the average 8-year renourishment volume increase by nearly six-fold to 1,278,300 cy.



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EDISTO BEACH

COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX B

ECONOMICS

Contents

Table of Tables

1. INTRODUCTION

FEDERAL INTEREST

Congress has authorized Federal participation in coastal storm damage reduction (CSDR) projects to prevent or reduce damages caused by wind and tidal generated waves and currents along the Nation's ocean coasts and Great Lake Shores.

STUDY AREA

The Town of Edisto Beach and Edisto Beach State Park are part of Edisto Island located in South Carolina. They are bounded by the South Edisto River and St. Helena Sound to the southwest and the Atlantic Ocean to the southeast. The Town of Edisto Beach occupies the central and southern portions of the island and is generally separated from Edisto Beach State Park by State Highway 174, which provides the only access to the island. Its beachfront extends approximately 4.5 miles between Highway 174 and the South Edisto River/St. Helena Sound. The town has been developed as a permanent and seasonal residential area with limited commercial development. Edisto Beach State Park occupies approximately 1,255 acres of the island and is structured around a dense live oak and maritime forest. It offers ocean and marsh side camping sites, as well as cabins, picnic areas, and nature and hiking trails. Its beachfront extends approximately 1.5 miles between Jeremy Inlet and Highway 174.

ASSUMPTIONS & CONSTRAINTS

The economic analysis is based on the following assumptions and constraints.

Assumptions:

- The FY 2013 Federal Discount rate of 3.75 percent is used in the economic evaluation.
- The period of analysis is 50 years, beginning in 2014 and concludes after the year 2063. There are 5 pre-base years from 2009-2014. The base year is 2014.
- The price level is in constant 2013 dollars.
- Structure values are based on depreciated replacement costs.
- Land use zoning and construction codes will not change during the period of analysis.
- Damaged or destroyed properties will be repaired to pre-storm conditions.
- Lost land will be valued at near shore prices.
- Empirical storm frequencies are based on historical records for the study area and are assumed to be predictive of the probability of future events.
- Existing state and county owned public park limits would remain the same in the future.

Constraints:

- For a project to be economically justified, the benefit to cost ratio needs to be greater than 1 to 1.
- The analysis recognizes the Threatened and Endangered Species Act and the Coastal Barrier Resources Act.
- Adequate Parking and Access

2. SOCIO-ECONOMIC OVERVIEW

DEMOGRAPHICS:

Edisto Island is a barrier island located at the mouth of the Edisto River in Colleton and Charleston Counties, South Carolina. It is approximately 45 miles southwest of Charleston, South Carolina and approximately 20 miles east-northeast of Beaufort, South Carolina. The incorporated Town of Edisto Beach is located on the island, as is Edisto Beach State Park and incorporates 2.3 square miles. Tourism is the largest industry on Edisto Island. Figure 1 is a map of South Carolina showing Colleton County in the southeastern region of the state which is where Edisto Beach can be found. This area of Colleton County is bordered by Beaufort County and Charleston County.

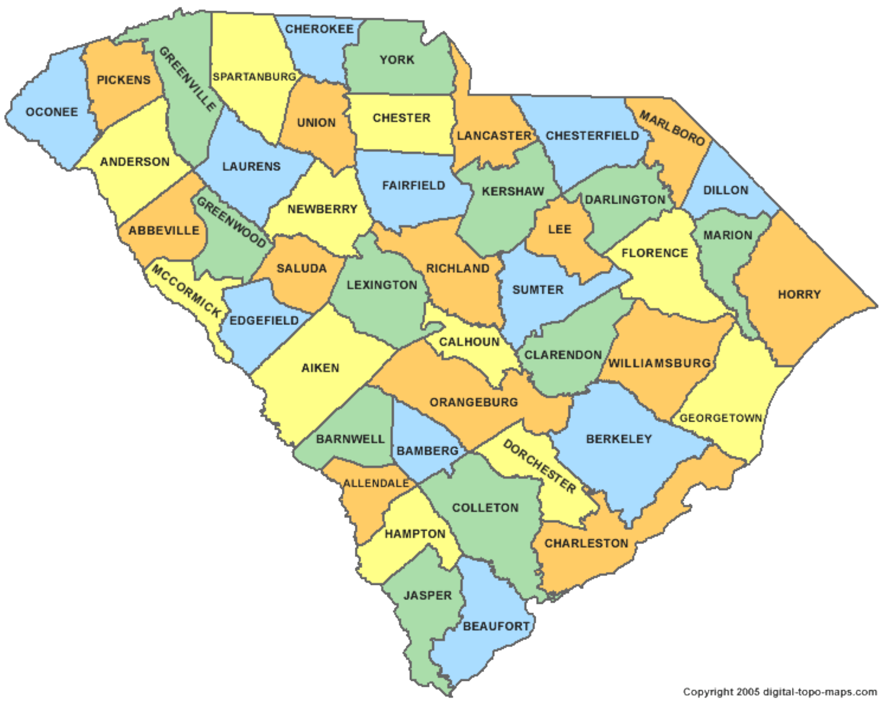

Figure 1
South Carolina Counties

POPULATION: As of the 2010 census data, there were 414 people in the Town of Edisto Beach which is a decrease of 35.4% since the 2000 census of 641 people. There were 2,181 housing units, with 10.6% being occupied and 89.4% being vacant housing units mainly for rent or seasonal use. There were 232 households out of which 3.4% had children under the age of 18 living with them, 62.9% were married couples living together, 1.7% had a female householder with no husband present, and 35.3% were non-families. The average household size was 1.78, and the average family size was 2.13. The population was spread out with approximately 4% under the age of 19, 1% from 19 to 24, 9% from 25 to 44, 41% from 45 to 64, and 45% who were 65 years of age or older. The median age was 64.6 years.

According to the Town of Edisto Beach representative, the 2010 population count of 414 has been challenged because the Town of Edisto Beach did not have a mail out census, just a door to door count during a season when many people are out of town. According to the sponsor, the voter registration is 704 people, a 10 percent increase from the 2000 census.

Table 1 shows the population characteristics for Colleton County and the surrounding southern counties. As a seasonal resort community, population in the Town of Edisto Beach fluctuates significantly during the year.

Table 1: Population Characteristics

	Population			Percent Change		
	1990	2000	2010	1990-2000	2000-2010	1990-2010
South Carolina	3,486,703	4,012,012	4,625,364	33%	15.3%	90%
Colleton County	34,377	38,264	38,892	46%	1.6%	171%
Charleston County	295,039	309,969	350,209	31%	13%	62%
Beaufort County	86,425	120,937	162,233	30%	34.1%	159%
Town of Edisto Beach	340	641	414	89%	-35%	22%

http://quickfacts.census.gov

EMPLOYMENT AND INCOME: In 2010, Edisto Beach had 261 people in the labor force. The occupations in Edisto Beach are as follows: management, business, science and arts (154 people), service occupation (22 people), sales and office (38 people), natural resources, construction and maintenance (12 people), and production, transportation and material moving (20 people). The unemployment rate was 5.7 percent.

In 2010, the per capita income was $51,628. The median income for a household in the town was $64,125, and the median income for a family was $96,250. About 2.9% of families were below the poverty line. Table 2 display the per capita income for Colleton County and the surrounding southern counties and Edisto Beach.

Table 2: Per Capita Income

Counties	Per Capita Income			Percent Change	Percent Change	Percent Persons
	1989	2000	2010	1989-00	2000-2010	Below Poverty Level - 2010
South Carolina	$11,897	$18,795	$23,443	58.0%	24.7%	16.4%
Colleton County	$9,193	$14,831	$17,842	61.3%	20.3%	21.3
Charleston County	$13,068	$21,393	$29,401	63.7%	37.4%	16.5%
Beaufort County	$15,213	$ 25,377	$ 32,731	66.8%	29.0%	10.5%

Edisto Beach	NA	$ 39,400	$51,628	NA	31.0%	2.9%

EDUCATION: According to the 2010 census, the education attainment in Edisto Beach for high school graduates is 20.8 percent. The population that attained an associate's degree is 6.5 percent, and the population percentage that received a bachelor's degree is 35.7, and 19 percent of the population has a graduate or professional degree.

HOUSEHOLDS: A household includes the related family members and all the unrelated people who share the housing unit. A person living alone in a housing unit, or a group of unrelated people sharing a housing unit such as partners or roomers, is also counted as a household. There were a total of 232 households in Edisto Beach in 2010, with an average household size of 1.78 people. Table 3 shows the number of households and the median household income for Colleton and surrounding counties.

Table 3: Select Household Characteristics

Counties	Households			Median Household Income
	1990	2000	2010	2010
South Carolina	1,258,044	5,134,869	2,137,683	$43,939
Colleton County	12,040	14,470	19,901	$33,263
Charleston County	107,069	123,326	137,844	$48,433
Beaufort County	30,712	45,532	93,023	$ 55,286
Edisto Beach	Not Available	329	232	$64,125

TRANSPORTATION & UTILITIES: The Town of Edisto is accessible from Edisto Island and the mainland via SC 174. The William McKinley Jr. Bridge connects Edisto Island to the mainland. Major local roads on the island include Palmetto Boulevard (SC 174), Lybrand Street, Jungle Road, Dock Site Road and Myrtle Street.

There is one company that supplies water to the Town of Edisto Beach from a well source. There is also one sewer plant for the Town of Edisto Beach.

According to the Town of Edisto Beach Local Comprehensive Beach Management Plan, the Town of Edisto is designated by the State Hurricane Plan as a Category 1 evacuation area. The evacuation route for residents and tourists from Edisto Beach is along SC 174 to US 17 South to SC 64 to Walterboro.

3. STUDY METHODOLOGY

EVALUATION FRAMEWORK

Coastal storm damage reduction projects are formulated to provide hurricane and storm damage reduction, with incidental recreation benefits. USACE participation in coastal storm damage reduction projects must produce economic justification from storm damage reduction benefits or a combination of storm damage reduction benefits and recreation benefits not to exceed 50 percent of the total benefits required for justification.

The specific methodologies that will be used for the study are based on the general principles and guidelines (P&G) documented in Engineering Regulation 1105-2-100, 22 April 2000, Planning-Planning Guidance Notebook, Section I – Hurricane and Storm Damage Reduction, and Appendix D – Economic and Social Considerations.

INCORPORATING RISK AND UNCERTAINTY

The P&G recommends a life-cycle approach and risk and uncertainty analysis. The benefits and costs of storm damage reduction measures are highly uncertain. Predicted costs and benefits are dependent upon a variety of engineering and economic assumptions and models. Future damages are dependent on the sequence of storms, their characteristics, property inventory, erosion, wind and wave effects and a multitude of other factors.

In order to provide analytical support for projects involving storm damage reduction, a unified risk-based engineering-economic model called Beach-*fx* is being applied to the Edisto Beach, SC coastal storm damage reduction project for estimation of expected annual benefits. Beach-*fx* incorporates triangular distributions in capturing uncertainty in value of structures and contents, first floor elevations and number of times a structure is rebuilt.

BEACH-FX HURRICANE AND STORM DAMAGE SIMULATION MODEL

The Beach-*fx* model is a USACE Certified engineering-economic event based, Monte Carlo simulation model that relates beach profile change to storms, coastal processes and nourishment programs. Beach-*fx* represents an improvement on previous models in this arena by being strongly based on representation of the coastal and engineering processes, incorporating the impact of multiple storms and incorporating uncertainty in damage functions, physical characteristics of structures and economic valuations. Expected structural damages generated through the simulations are expressed as losses due to flooding, erosion and waves. Beach-*fx* is run for multiple project life-cycles and provides statistics on probable benefits and costs of the evaluated hurricane and storm damage reduction design alternatives, which is used to determine the economic justification of the project.

Beach-*fx* simulates beach response over time as storms, natural recovery, and management methods alter the beach profile. Events of interest (storms, beach nourishment) take place at calculated times. As each event takes place, the model simulates the physical and economic responses associated with that event. A set of simplified beach profiles, as defined by key data points, are tracked by the simulation model as the beach profile evolves over time.

As each storm is processed, the shoreline response is determined, and a post-storm beach configuration is calculated, as well as profiles of maximum water level, wave height, and erosion during the storm. This information is used to determine economic damages, based on empirical curves (damage functions) relating the percentage loss of value of structure and contents to "damage-driving parameters" calculated from the aforementioned profiles and characteristics of the structure.

4. EXISTING CONDITION

The 2003 South Carolina Annual State of Beaches Report by South Carolina Department of Health and Environmental Control Ocean & Coastal Resource Management (SCDHEC- OCRM) categorizes Edisto Beach as "very vulnerable to beach erosion", with areas that "are among the most critical in the state."

In 1948, construction of timber groins began along Edisto's beachfront. Throughout the years, the groin field has been eroded and modified. In 1995, the town of Edisto maintained and repaired the existing groins and widened the beach for recreational use and increased the buffer zone between existing structures and the ocean. After project completion, monitoring was conducted from 1995-2001 and concluded that the project was successful. The groin field along Edisto Beach had reduced the long-term erosion rate to a fraction of the pre-groin rate in the area encompassed by most of the groin field. However, groin maintenance is an ongoing issue. Sand fencing is also used as a precaution; however erosion continues to be an ongoing problem with sand fencing as well.

LAND USE AND FUTURE DEVELOPMENT

Land use on Edisto Beach is primarily residential in the form of single and multiple family dwelling units. The west end of the island has been developed as a planned gated community. The Edisto Beach State Park occupies approximately one third of Edisto Beach at the northern end and offers numerous scheduled activities and educational opportunities. Edisto Beach has relatively few commercial units, and commercial development is limited. Approximately 34 acres, 2 percent, of the 1,531 acres on the beach is zoned for commercial use, excluding resort amenities within the gated section of Wyndham Resort. There are 4.67 miles of walking/biking trails that provide recreational activities to the public throughout the town.

Development is ongoing and continuous at Edisto Beach and likely to continue into the immediate and near future until the remaining limited beach front, except for the State Park, is developed. There are public structures on Edisto Island such as the Town Hall and other parks that have facilities. However, the public structures are not in the Edisto Beach Study Area.

STRUCTURE INVENTORY

The structure inventory is a collection of information for the structures that may be potentially impacted by flooding, waves and/or erosion. The existing condition structure inventory is the basis for estimating the expected annual damages to the study area. Beach front development is predominantly single family dwellings. A complete structure inventory was completed in 2010 of existing structures that may benefit from a storm damage reduction project. The depreciated replacement cost for the structure values were used to estimate damages. The purpose was to gather data required for Beach-*fx* inputs and to obtain a database that would facilitate the gathering of critical metrics that locate the structure spatially in relation to the shoreline as well as its elevation. Beach-*fx* considers the inventory of structures (damage elements) as items that are containerized in 'lots'. Lots form boundaries that contain damage elements. An aggregation of lots that are for the most part contiguous composes a reach. All reaches taken in aggregate compose the study area. The Beach-*fx* model currently has 23 reaches, largely based on the morphologically driven development of the representative profiles of Edisto Beach. Four planning reaches were identified to aggregate the Beach-*fx* reaches; Inlet Reach (Beach-fx reaches I1-I4), Atlantic Reach South (Beach-*fx* Reaches P1, P2, E1-E6), Atlantic Reach North (Beach-*fx* reaches E7-E15) and the State Park Reach.

Photos of structures along with pertinent information of construction and foundation type, number of floors, and accompanying detached structures that may benefit from a project were also collected. A summary of inventory is shown in Table 4. The 'SFR1' represents a single family residence, 'Walk' represents walkovers, 'Commercial' represents commercial structures and 'MFR' represent multi-family structures. The 'Road' damage element is Palmetto Boulevard. It has been divided based on reaches and modeled as a linear damage element. The 'Utility' damage element refers to the underground water pipes that run along the side of the road that have potential to be damaged. There are twice as many utilities as roads because the utilities run along both sides of the road.

Table 4: Structure Inventory Count by Beach-*fx* Reach

Reach	Beach-*fx* Reach	SFR1	Walk	Road & Utilities	Commercial	MFR
1	I1	68	33			16
2	I2	43	16			
3	I3	13	2			
4	I4	20	4			
5	P1	12	2			
6	P2	21	1			
7	E1	13				
8	E2	24	2			
9	E3	35	6			
10	E4	38	4			
11	E5	25	10			
12	E6	21	2			
13	E7	10				
14	E8	28	1	2		
15	E9	13		1		
16	E10	22		2		
17	E11	14		1		

Reach	Beach-*fx* Reach	SFR1	Walk	Road & Utilities	Commercial	MFR
18	E12	14		1		
19	E13	14		1		
20	E14	35	1	2	8	
21	E15	13		2	7	
22	S1					
23	S2	112	1	9	15	
	Total	**608**	**85**	**21**	**30**	**16**
	Grand Total	**760**				

VALUE OF COASTAL INVENTORY

Structure Value

The value of structures in the study area required for economic analysis to determine NED benefits should be expressed in terms of depreciated replacement costs. Staff from the Army Corps of Engineers Savannah District prepared the Edisto Beach Structure Inventory Analysis that determined the depreciated replacement cost for the structures using the Cost Approach. Tax Assessor's records were examined and analyzed on the current inventory to determine depreciated replacement cost using variables of interest relating to assessed value, date of construction, type of construction, number of floors, square footage, recent sales and selling prices, along with other information. Appendix C – Edisto Beach Structure Inventory Analysis gives further detail of the Cost Approach used to determine depreciated replacement cost. Walkovers were valued at an average of $100 per linear feet for the wood boardwalks also according to staff from the Army Corps of Engineers Savannah District.

Content Value

Content value was taken at 50% of the structure value. A web search of trade associations of homeowner casualty underwriters revealed that insurers generally use a content to structure ratio between 50 and 75 percent of replacement cost. For this analysis, the more conservative number of 50% was used. Table 5 presents the structure and content value of damageable property value based on depreciated replacement cost.

In conducting a sensitivity analysis for the content value, 40% and 60% were used to determine the range of content damages. The values are $50,403,000 and $75,604,000 respectively for all reaches.

Table 5: Edisto Beach Structure and Content Value by Reach

Reach	Beach-*fx* Reach	Structure	Content
1	I1	$ 30,533,000	$ 15,133,000

Reach	Beach-*fx* Reach	Structure	Content
2	I2	$ 10,142,000	$ 4,988,000
3	I3	$ 2,597,000	$ 1,287,000
4	I4	$ 4,897,000	$ 2,421,000
5	P1	$ 3,188,000	$ 1,585,000
6	P2	$ 5,962,000	$ 2,976,000
7	E1	$ 3,134,000	$ 1,567,000
8	E2	$ 5,321,000	$ 2,653,000
9	E3	$ 8,529,000	$ 4,241,000
10	E4	$ 5,272,000	$ 2,615,000
11	E5	$ 6,174,000	$ 3,060,000
12	E6	$ 4,590,000	$ 2,290,000
13	E7	$ 2,537,000	$ 1,268,000
14	E8	$ 6,456,000	$ 3,214,000
15	E9	$ 2,817,000	$ 1,402,000
16	E10	$ 3,359,000	$ 1,666,000
17	E11	$ 2,370,000	$ 1,179,000
18	E12	$ 2,443,000	$ 1,215,000
19	E13	$ 2,603,000	$ 1,295,000
20	E14	$ 9,393,000	$ 4,644,000
21	E15	$ 3,690,000	$ 1,832,000
22	S1	$ -	$ -
23	S2	$ -	$ -
	Total	$126,007,000	$62,531,000
	Grand Total	$188,537,900	

5. ECONOMIC BENEFIT EVALUATION

STORM DAMAGE REDUCTION

Beach-*fx* calculates the storm damage reduction from inundation, storm-induced erosion, long-term erosion and wave attack on a damage element-by-damage element basis for each storm event for the study period.

Damage Element

Damages are estimated based on the concept of a "damage element". A damage element represents any structure that can incur an economic loss such as structures, walkways, pools, etc. In Beach-*fx*'s system hierarchy reaches contain lots, and lots contain damage elements. For each storm, damages are estimated by examining the reach, lots, and damage elements within the lots. Thus, the basic unit on which damages are calculated at present is the damage element. Damage elements have attributes relating to type, geographic location, and value. Each damage element has information relating to structure and content value (treated as a three-parameter distribution for purposes of incorporating uncertainty). For location information, a structure's center point is referenced, as well as its width and length. A single value of ground elevation is specified, which also includes a three-parameter distribution for describing the first floor elevation and uncertainty.

Damage Functions

The damage functions used in Beach-*fx* were those developed for the Institute for Water Resources (IWR) – Coastal Storm Damage Relationships Based on Expert Opinion Elicitation. However, the expert opinion elicitation did not capture all damage element types and the additional curves were based on best professional judgment by the Project Delivery Team.

Damage functions for each damage type (erosion, inundation, and wave) are currently associated with damage element type (single family residential, multi-family residential, walkway, etc.) foundation type (shallow piles, deep piles, slab, etc.) construction type (wood frame concrete, masonry, etc.) and armor type (No armor, sheet pile, etc.) are used to select the appropriate damage function.

Damages are calculated at the damage element level, following each storm. For each damage type, a damage driving parameter is calculated for each damage element, and used as a lookup into stored damage functions.

LOST LAND REDUCTION

The land lost reduction benefit was determined for eroding reaches by calculating the amount of land that would be lost during the study period times the value of near shore upland.

LOSS OF LAND BENEFIT

With a project in place, land that would be lost in the without project future condition would be preserved by a project. The design template that represents the project that always provides full benefits to protected properties would be in place for the period of analysis preserved through the process of periodic renourishment. This benefit is based on the value of near shore lands. Normally, determination of the market value of the land losses is based on the value of near shore upland. Near shore upland is sufficiently removed from the shore to lose its significant increment of value because of its proximity to the shore, when compared to adjacent parcels that are more distant from the shore. These parcels have no gulf frontage or access point to the water as part of any deeded subdivision rights. For this project, near shore land values were estimated by the Army Corps of Engineers Savannah District from samples taken from recent land sales and calculated on cost per square foot and the above criteria applied. Appendix C – Edisto Beach Structure Inventory Analysis has further explanation and clarification on how the value per square foot was calculated for near shore land values. The near shore land value per square foot was determined to be $19.76.

RECREATION

To determine the recreation benefits of a plan, an economic value must be placed on the recreation experience at Edisto Beach. This value can be applied to the visitation which results from the project to determine the NED recreation benefits. For this report, unit day values (UDV's) are used to determine the economic value of recreation using a point system that takes into account the following factors: recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental (esthetics) quality. Parking at Edisto Beach is sufficient to support recreation for the general public and is reasonably near and accessible to the project beaches. Along with designated parking areas for beach access, public parking along the rights of ways of the Town's streets is permitted. The Town of Edisto Beach has 38 public beach access points that lie along Palmetto Boulevard, Point Street and Yacht Club Road. Each access point is identified with a reflective "Beach Access" sign. The longest distance between the access points is 1,425 feet, still less than one half mile.

REBUILDING

In Beach-*fx*, a triangular distribution (minimum, most likely and maximum) is defined for the number of days required for rebuilding at the damage element (DE) level, meaning that the distribution can be changed for each damage element. At the start of each iteration a value is drawn from the sample, setting the rebuilding time for the damage element for that iteration. The number of times rebuilding could occur was unlimited if there was sufficient room on the lot.

If a DE is damaged to any degree, and has not been "rebuilt" more times than the maximum allowable, then a "rebuilding event" is set at a time in the future corresponding to the random rebuilding time. When the simulation reaches that time the lot on which the DE exists is checked to see if it is buildable. At present, the model makes a simple check based on whether or not the landward toe of the dune has retreated past the center point of the lot. If so, the lot is not buildable, and rebuilding does not take place.

If the lot is rebuildable at the time of rebuilding, then structure and contents values are restored to their initial values at the start of the simulation, such that they are able to be taken as damages again at the next storm event, and the number of times the damage element is rebuilt is incremented by one.

COMBINING DAMAGES – COMPOSITE DAMAGE FUNCTION

Total damage element damages are calculated using a composite damage function that takes into account damages for all damage mechanisms present while avoiding double counting. Because a structure may be damaged by more than one storm damage hazard, a methodology was developed for combining the damages. This methodology was defined during the IWR workshop and is included in Attachment 1 – Coastal Storm Damage Relationships Based on Expert Opinion Elicitation.

6. FUTURE WITHOUT PROJECT CONDITION

In the future without project condition, it has been indicated by the local sponsor that the action taken would be to armor State Road 174 as it becomes increasingly threatened as it is the primary evacuation route, and perform emergency nourishment as necessary. Within Beach-*fx*, a trigger distance was specified at 20 feet from the road, meaning that when the seaward edge of the berm gets within 20 feet of the road, armoring will occur on an as needed basis. The economic consequences are measured as a range of average annual equivalent damages.

DAMAGES

In determining the future without project damages, Beach-*fx* was simulated for 300 iterations over a 50 year period of analysis to capture the variability of estimated damages with a discount rate of 4%. Table 6 displays the summary statistics of damages from Beach-*fx* showing existing average total damages and average annual (AA) damages to structure and content by model reach. Table 6 also shows the average emergency nourishment (EN) cost associated with each reach in the future condition. All alternatives will be compared and measured to the without project values. The benefits for plan comparison will be the reduction in other negative impacts or increases in positive impacts.

Table 6: Without Project Structure and Content Damage Summary Values

Reach	Beach-*fx* Reach	Avg Structure Damage	Avg Content Damage	Avg Total Damage	AA Damages	Avg Emergency Nourishment	AA Emergency Nourishment	Armor Cost	AA Armor Cost
1	I1	$6,318,000	$2,990,000	$9,308,000	$433,000	$0	$0	$0	$0
2	I2	$3,063,000	$1,115,000	$4,177,000	$194,000	$0	$0	$0	$0
3	I3	$718,000	$297,000	$1,015,000	$47,000	$0	$0	$0	$0
4	I4	$1,043,000	$417,000	$1,460,000	$68,000	$0	$0	$0	$0
5	P1	$370,000	$141,000	$511,000	$24,000	$437,000	$20,342	$0	$0
6	P2	$636,000	$272,000	$908,000	$42,000	$1,350,000	$62,843	$0	$0
7	E1	$253,000	$127,000	$379,000	$18,000	$507,000	$23,601	$0	$0
8	E2	$703,000	$289,000	$991,000	$46,000	$854,000	$39,754	$0	$0
9	E3	$848,000	$280,000	$1,129,000	$53,000	$1,320,000	$61,446	$0	$0
10	E4	$1,419,000	$645,000	$2,065,000	$96,000	$727,000	$33,842	$0	$0
11	E5	$1,047,000	$315,000	$1,363,000	$63,000	$665,000	$30,956	$0	$0
12	E6	$336,000	$145,000	$481,000	$22,000	$1,552,000	$72,246	$0	$0
13	E7	$123,000	$55,000	$178,000	$8,000	$645,000	$30,025	$0	$0
14	E8	$1,311,000	$641,000	$1,952,000	$91,000	$1,835,000	$85,420	$383,000	$17,829
15	E9	$1,444,000	$714,000	$2,158,000	$100,000	$743,000	$34,587	$182,000	$8,472
16	E10	$2,151,000	$1,058,000	$3,209,000	$149,000	$951,000	$44,269	$455,000	$21,180
17	E11	$2,196,000	$1,088,000	$3,284,000	$153,000	$626,000	$29,140	$210,000	$9,776
18	E12	$388,000	$184,000	$572,000	$27,000	$504,000	$23,461	$160,000	$7,448
19	E13	$1,113,000	$544,000	$1,656,000	$77,000	$738,000	$34,354	$183,000	$8,519
20	E14	$3,637,000	$1,791,000	$5,428,000	$253,000	$1,284,000	$59,770	$414,000	$19,272
21	E15	$1,482,000	$722,000	$2,204,000	$103,000	$2,757,000	$128,339	$224,000	$10,427
Total		$30,598,000	$13,830,000	$44,429,000	$2,068,000	$17,495,000	$814,396	$2,211,000	$102,922

7. WITH PROJECT CONDITION

NON-STRUCTURAL ALTERNATIVE

A non-structural measure, property acquisition, was considered as a hurricane and storm damage reduction measure. Property acquisition would involve the purchase of the damageable property and relocating the residents. Property acquisition would take place in the northern most reaches only because they are the most erosion- and damage-prone reaches in the study area. The reaches evaluated were E14 and E15, it was determined that additional reaches would be evaluated if these two reaches yielded the highest net benefits.

There were 19 shorefront houses located within reaches E14 and E15. The assumptions made for the non-structural alternative were compliance by the property owners and implementation of the plan at the start of the project. The benefits of the non-structural plan were calculated based on the assumption that the average future without project condition structure and content damages from the future without project condition Beach-*fx* runs as well as emergency renourishment cost avoidance.

Costs for the non-structural plan were based on an acquisition cost using the actual land and structure value taken from the Structure Inventory Analysis (Appendix C) for each structure, and a demolition cost for each structure. For simplification, an identical demolition/removal and land value acquisition cost was used for every structure and lot. Based on the average costs of some demolition/removal activities that took place recently at a similar beach project, a $100,000 per lot demolition/removal cost was used in this analysis.

NOURISHMENT ALTERNATIVES

Beach nourishment and periodic renourishment will meet the study objectives for shoreline erosion protection in the most economically efficient and environmentally acceptable manner. Hard structures would have negative impact on the environment and are forbidden by laws and regulations of the study area.

For the Edisto Beach with project condition, four alternatives were evaluated to compare against the future without project condition. The alternatives were formulated and evaluated on the basis of the most likely conditions expected to exist with implementation of each of the plans identified for analysis. The alternatives were formulated based on past knowledge and performance of what has been determined as the best with project plan. During formulation, alternative measures considered involved soft structures, hard structures and non-structural measures.

Alternative 1 was designed to resemble the dimensions of the 2006 local beach renourishment effort. Alternative 2 was considered to be the smallest practicable beachfill plan. Alternative 3 was considered to be the largest practicable plan. Therefore the minimum and maximum plan was captured in the analysis. Based on the results of the three alternatives, an Alternative 4 was analyzed to bracket the economic benefits. Table 7 shows the dimensions of each alternative.

Table 7: Alternative Dimensions

Reach	Alternative 1			Alternative 2 (Minimum)			Alternative 3 (Maximum)			Alternative 4		
	Beach & Dune Fill			Beach & Dune Fill			Beach & Dune Fill			Beach & Dune Fill		
	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width	Berm Width	Dune Height	Dune Width
I1		12	15		10	15		14	15		14	15
I2		12	15		10	15		14	15		14	15
I3		12	15		10	15		14	15		14	15
I4		12	15		10	15		14	15		14	15
P1	Taper	12	15	Taper	10	15	Taper	14	15	Taper	15	15
P2	25	14	15	13	12	15	38	16	15	13	15	15
E1	50	14	15	25	12	15	75	16	15	25	15	15
E2	50	14	15	25	12	15	75	16	15	50	15	15
E3	50	14	15	25	12	15	75	16	15	50	15	15
E4	50	14	15	25	12	15	75	16	15	50	15	15
E5	50	14	15	25	12	15	75	16	15	50	15	15
E6	50	14	15	25	12	15	75	16	15	50	15	15
E7	63	14	15	38	12	15	88	16	15	63	15	15
E8	75	14	15	50	12	15	100	16	15	75	15	15
E9	75	14	15	50	12	15	100	16	15	75	15	15
E10	75	14	15	50	12	15	100	16	15	75	15	15
E11	75	14	15	50	12	15	100	16	15	75	15	15
E12	75	14	15	50	12	15	100	16	15	75	15	15
E13	75	14	15	50	12	15	100	16	15	75	15	15
E14	75	14	15	50	12	15	100	16	15	75	15	15
E15	75	14	15	50	12	15	100	16	15	75	15	15
SP	Taper			Taper			Taper			Taper		

PHYSICAL DAMAGES

Physical damages are expected to occur in the future on Edisto Beach, including structural damages, loss of contents and damages to the street and utility lines. Physical damages are evaluated separately for residential, commercial and road and utilities using different damage curves to estimate damages over the period of analysis. Depreciated replacements cost of the structure and contents are the basis for determining damages. The structure and content values are input as a minimum, maximum and most likely to address uncertainty. The cumulative damage for all the years from life-cycle modeling is presented as average damages and average annual damages equivalent values. Additional structural damages are also captured and include walkovers, pools and gazebos in the structure inventory of the study area. These structures are included in the total damage values.

For comparative analysis of the plans formulated, Beach-*fx* simulated 300 iterations for each alternative to determine the NED plan. Tables 8-11 show the structure and content damage for Alternatives 1-4. Land loss benefits are included in physical damage.

Table 8: Alternative 1 Physical Damage Benefits

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
1	I-1	$4,213,296	$1,993,071	$6,206,366	$288,908	$144,386	$0	$144,386
2	I-2	$1,756,450	$682,710	$2,439,160	$113,543	$80,917	$0	$80,917
3	I-3	$385,767	$171,584	$557,350	$25,945	$21,308	$0	$21,308
4	I-4	$624,051	$273,808	$897,859	$41,795	$26,184	$0	$26,184
5	P-1	$382,121	$138,457	$520,577	$24,233	-$456	$0	-$456
6	P-2	$1,313,875	$627,005	$1,940,880	$90,348	-$48,080	$0	-$48,080
7	E-1	$215,112	$107,761	$322,873	$15,030	$2,630	$1,656	$4,286
8	E-2	$610,672	$276,748	$887,420	$41,310	$4,839	$10,028	$14,867
9	E-3	$661,016	$264,636	$925,652	$43,089	$9,447	$26,358	$35,805
10	E-4	$715,402	$339,438	$1,054,840	$49,103	$47,001	$32,641	$79,641
11	E-5	$564,382	$229,762	$794,144	$36,968	$26,472	$26,950	$53,421
12	E-6	$247,466	$113,815	$361,281	$16,818	$5,566	$34,416	$39,981
13	E-7	$108,938	$54,617	$163,555	$7,614	$685	$20,383	$21,068
14	E-8	$446,931	$214,059	$660,991	$30,769	$60,084	$54,744	$114,828
15	E-9	$828,343	$408,040	$1,236,383	$57,554	$42,910	$23,146	$66,055
16	E-10	$551,284	$269,144	$820,428	$38,191	$111,182	$36,617	$147,799
17	E-11	$379,549	$186,560	$566,109	$26,352	$126,526	$21,289	$147,815
18	E-12	$87,051	$41,836	$128,887	$6,000	$20,636	$19,788	$40,424
19	E-13	$298,210	$144,637	$442,847	$20,615	$56,492	$20,678	$77,169
20	E-14	$945,209	$464,214	$1,409,424	$65,609	$187,073	$47,437	$234,509
21	E-15	$323,046	$155,389	$478,435	$22,271	$80,303	$67,577	$147,880
Total		**$15,658,169**	**$7,157,291**	**$22,815,460**	**$1,062,064**	**$1,006,104**	**$443,705**	**$1,449,809**

Table 9: Alternative 2 Physical Damage Benefits

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
1	I-1	$5,995,901	$2,842,965	$8,838,866	$411,451	$21,843	$0	$21,843
2	I-2	$2,847,417	$1,038,815	$3,886,233	$180,905	$13,556	$0	$13,556
3	I-3	$652,608	$271,770	$924,377	$43,030	$4,223	$0	$4,223
4	I-4	$968,426	$397,319	$1,365,745	$63,576	$4,404	$0	$4,404
5	P-1	$448,470	$153,493	$601,963	$28,022	-$4,244	$0	-$4,244
6	P-2	$930,185	$409,709	$1,339,894	$62,372	-$20,104	$0	-$20,104
7	E-1	$278,564	$139,478	$418,042	$19,460	-$1,801	$653	-$1,148

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
8	E-2	$807,645	$331,313	$1,138,958	$53,019	-$6,870	$3,606	-$3,264
9	E-3	$941,259	$297,382	$1,238,641	$57,659	-$5,123	$15,286	$10,164
10	E-4	$1,474,577	$668,464	$2,143,040	$99,759	-$3,655	$11,847	$8,192
11	E-5	$1,073,400	$316,885	$1,390,285	$64,718	-$1,279	$12,270	$10,991
12	E-6	$360,267	$151,766	$512,033	$23,835	-$1,452	$19,055	$17,603
13	E-7	$129,427	$64,835	$194,262	$9,043	-$745	$13,799	$13,054
14	E-8	$1,016,986	$493,482	$1,510,467	$70,313	$20,541	$40,313	$60,853
15	E-9	$1,527,956	$755,919	$2,283,875	$106,315	-$5,851	$16,234	$10,383
16	E-10	$1,595,008	$783,372	$2,378,380	$110,714	$38,659	$23,231	$61,890
17	E-11	$1,408,339	$695,509	$2,103,848	$97,935	$54,944	$14,095	$69,040
18	E-12	$211,806	$98,942	$310,748	$14,465	$12,171	$13,089	$25,260
19	E-13	$617,182	$298,040	$915,222	$42,604	$34,502	$19,194	$53,696
20	E-14	$2,309,518	$1,138,758	$3,448,276	$160,518	$92,164	$41,603	$133,766
21	E-15	$773,392	$375,404	$1,148,796	$53,477	$49,097	$59,921	$109,019
Total		**$26,368,334**	**$11,723,619**	**$38,091,953**	**$1,773,188**	**$294,980**	**$304,196**	**$599,176**

Table 10: Alternative 3 Physical Damages Benefits

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
1	I-1	$2,753,155	$1,310,263	$4,063,418	$189,153	$244,141	$0	$244,141
2	I-2	$983,528	$395,531	$1,379,059	$64,195	$130,265	$0	$130,265
3	I-3	$259,064	$118,341	$377,405	$17,568	$29,684	$0	$29,684
4	I-4	$406,137	$182,193	$588,330	$27,387	$40,593	$0	$40,593
5	P-1	$308,260	$114,313	$422,573	$19,671	$4,106	$0	$4,106
6	P-2	$1,043,389	$512,424	$1,555,813	$72,423	-$30,155	$0	-$30,155
7	E-1	$147,054	$73,781	$220,835	$10,280	$7,379	$1,656	$9,036
8	E-2	$501,977	$239,441	$741,417	$34,513	$11,636	$10,028	$21,664
9	E-3	$478,463	$211,003	$689,466	$32,095	$20,441	$26,358	$46,799
10	E-4	$490,933	$234,809	$725,742	$33,783	$62,320	$51,603	$113,924
11	E-5	$349,645	$147,926	$497,571	$23,162	$40,277	$40,238	$80,515
12	E-6	$141,468	$67,347	$208,815	$9,720	$12,663	$47,637	$60,300
13	E-7	$76,315	$38,259	$114,575	$5,333	$2,965	$26,369	$29,334
14	E-8	$288,301	$139,945	$428,246	$19,935	$70,918	$56,582	$127,500
15	E-9	$405,613	$200,172	$605,785	$28,199	$72,264	$29,428	$101,692
16	E-10	$264,071	$127,316	$391,387	$18,219	$131,154	$49,568	$180,722
17	E-11	$198,282	$96,548	$294,830	$13,724	$139,154	$25,196	$164,351
18	E-12	$47,976	$22,660	$70,635	$3,288	$23,348	$19,788	$43,136

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
19	E-13	$171,675	$83,364	$255,039	$11,872	$65,234	$20,678	$85,912
20	E-14	$465,053	$228,568	$693,621	$32,288	$220,393	$47,437	$267,830
21	E-15	$165,638	$79,997	$245,635	$11,434	$91,140	$67,577	$158,717
Total		**$9,945,997**	**$4,624,200**	**$14,570,197**	**$678,246**	**$1,389,922**	**$520,144**	**$1,910,066**

Table 11: Alternative 4 Physical Damage Summary

Reach	Beach-*fx*Reach	Structure Damage	Content Damage	Total Damages	AA Damages	AA Damage Reduction	Land Loss Benefits	Total Physical Damages
1	I-1	$2,753,155	$1,310,263	$4,063,418	$189,153	$244,141	$0	$244,141
2	I-2	$983,528	$395,531	$1,379,059	$64,195	$130,265	$0	$130,265
3	I-3	$259,064	$118,341	$377,405	$17,568	$29,684	$0	$29,684
4	I-4	$406,137	$182,193	$588,330	$27,387	$40,593	$0	$40,593
5	P-1	$230,876	$93,296	$324,171	$15,090	$8,687	$0	$8,687
6	P-2	$1,219,561	$593,141	$1,812,702	$84,382	-$42,113	$0	-$42,113
7	E-1	$231,907	$116,181	$348,088	$16,204	$1,456	$1,656	$3,112
8	E-2	$586,254	$270,364	$856,618	$39,876	$6,273	$10,028	$16,301
9	E-3	$604,129	$248,879	$853,008	$39,708	$12,829	$26,358	$39,186
10	E-4	$593,652	$283,899	$877,550	$40,850	$55,254	$35,266	$90,519
11	E-5	$468,267	$201,008	$669,276	$31,155	$32,284	$28,663	$60,948
12	E-6	$207,411	$98,009	$305,420	$14,217	$8,166	$36,409	$44,575
13	E-7	$96,035	$48,160	$144,195	$6,712	$1,586	$21,124	$22,710
14	E-8	$371,020	$178,778	$549,798	$25,593	$65,260	$56,209	$121,469
15	E-9	$648,160	$319,640	$967,800	$45,051	$55,412	$23,847	$79,259
16	E-10	$341,413	$165,789	$507,202	$23,610	$125,763	$38,535	$164,298
17	E-11	$239,574	$117,099	$356,672	$16,603	$136,276	$22,324	$158,599
18	E-12	$60,464	$28,795	$89,260	$4,155	$22,481	$19,788	$42,269
19	E-13	$255,023	$123,910	$378,933	$17,639	$59,467	$20,678	$80,144
20	E-14	$631,156	$310,547	$941,702	$43,836	$208,845	$47,437	$256,282
21	E-15	$241,714	$117,632	$359,346	$16,728	$85,847	$67,577	$153,424
Total		**$11,428,499**	**$5,321,454**	**$16,749,953**	**$779,714**	**$1,288,454**	**$455,898**	**$1,744,352**

EMERGENCY AND ARMOR COST

In the with project condition, the emergency nourishment and armoring cost avoided with the placement of planned nourishment become a benefit. Table 12 shows the emergency cost and armoring cost avoidance benefits.

Table 12: Emergency Cost and Armor Cost Avoidance Benefits

Reach	Alt 1	Alt 2	Alt 3	Alt 4
I-1	$0	$ -	$ -	$ -
I-2	$0	$ -	$ -	$ -
I-3	$0	$ -	$ -	$ -
I-4	$0	$ -	$ -	$ -
P-1	$14,593	$ 14,593	$ 14,593	$ 14,593
P-2	$46,174	$ 46,174	$ 46,174	$ 46,174
E-1	$17,182	$ 17,182	$ 17,182	$ 17,182
E-2	$32,006	$ 32,006	$ 32,006	$ 32,006
E-3	$49,960	$ 49,960	$ 49,960	$ 49,960
E-4	$31,705	$ 31,705	$ 31,705	$ 31,705
E-5	$29,403	$ 29,403	$ 29,403	$ 29,403
E-6	$64,126	$ 64,126	$ 64,126	$ 64,126
E-7	$25,955	$ 25,955	$ 25,955	$ 25,955
E-8	$89,139	$ 73,492	$ 90,060	$ 89,668
E-9	$34,008	$ 29,545	$ 38,005	$ 35,491
E-10	$55,867	$ 41,944	$ 61,238	$ 59,743
E-11	$36,237	$ 28,224	$ 36,882	$ 36,679
E-12	$30,270	$ 28,825	$ 30,308	$ 30,308
E-13	$38,819	$ 37,429	$ 38,819	$ 38,819
E-14	$74,563	$ 70,293	$ 74,563	$ 74,445
E-15	$124,954	$ 124,396	$ 124,954	$ 124,954
Total	**$794,960**	**$ 745,251**	**$ 805,933**	**$ 801,210**

NET BENEFITS

To determine the NED plan, the benefits were reduced by the cost to determine the plan that maximizes net benefits. Tables 13-16 show the net benefits of each alternative. For purposes of plan comparison, the cost included is the placement of planned nourishment, mobilization and demobilization cost and in some alternatives groin lengthening cost are associated with implementation of the plan.

Alternative 1 has average annual benefits of $2,244,770 and average annual cost of $907,200 resulting in net benefits of $1,337,570. The alternative requires a total of 1,090 feet of groin lengthening. The cost for the groin lengthening is included in the average annual cost.

Table 13: Alternative 1 Benefits and Costs

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
I-1	$144,386	$0	$144,386	$21,918	$122,469
I-2	$80,917	$0	$80,917	$23,359	$57,558
I-3	$21,308	$0	$21,308	$7,152	$14,156
I-4	$26,184	$0	$26,184	$7,077	$19,108
P-1	-$456	$14,593	$14,137	$4,480	$9,658
P-2	-$48,080	$46,174	-$1,906	$12,195	-$14,101
E-1	$4,286	$17,182	$21,467	$17,995	$3,472
E-2	$14,867	$32,006	$46,874	$25,025	$21,848
E-3	$35,805	$49,960	$85,765	$49,450	$36,315
E-4	$79,641	$31,705	$111,346	$29,606	$81,740
E-5	$53,421	$29,403	$82,824	$36,680	$46,145
E-6	$39,981	$64,126	$104,108	$45,175	$58,933
E-7	$21,068	$25,955	$47,023	$29,002	$18,021
E-8	$114,828	$89,139	$203,966	$73,938	$130,028
E-9	$66,055	$34,008	$100,063	$35,738	$64,325
E-10	$147,799	$55,867	$203,666	$67,971	$135,694
E-11	$147,815	$36,237	$184,052	$48,775	$135,277
E-12	$40,424	$30,270	$70,694	$55,471	$15,223
E-13	$77,169	$38,819	$115,988	$55,490	$60,498
E-14	$234,509	$74,563	$309,072	$114,629	$194,443
E-15	$147,880	$124,954	$272,834	$146,075	$126,759
Total	**$1,449,809**	**$794,960**	**$2,244,769**	**$907,201**	**$1,337,568**

Alternative 2 has average annual benefits of $1,344,430 and annual cost of $500,940 resulting in net benefits of $843,490. This alternative requires groin lengthening of 360 feet which is included in the average annual cost.

Table 14: Alternative 2 Benefits and Costs

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
I-1	$21,843	$ -	$21,843	$5,961	$15,882
I-2	$13,556	$ -	$13,556	$6,534	$7,021
I-3	$4,223	$ -	$4,223	$1,989	$2,234
I-4	$4,404	$ -	$4,404	$1,988	$2,416

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
P-1	-$4,244	$ 14,593	$10,349	$1,273	$9,076
P-2	-$20,104	$ 46,174	$26,070	$3,612	$22,457
E-1	-$1,148	$ 17,182	$16,034	$3,017	$13,017
E-2	-$3,264	$ 32,006	$28,742	$6,272	$22,470
E-3	$10,164	$ 49,960	$60,124	$14,001	$46,123
E-4	$8,192	$ 31,705	$39,897	$11,675	$28,222
E-5	$10,991	$ 29,403	$40,395	$13,147	$27,247
E-6	$17,603	$ 64,126	$81,730	$15,206	$66,524
E-7	$13,054	$ 25,955	$39,009	$17,041	$21,968
E-8	$60,853	$ 73,492	$134,345	$29,912	$104,432
E-9	$10,383	$ 29,545	$39,928	$18,927	$21,001
E-10	$61,890	$ 41,944	$103,834	$33,734	$70,100
E-11	$69,040	$ 28,224	$97,263	$29,669	$67,594
E-12	$25,260	$ 28,825	$54,085	$39,515	$14,570
E-13	$53,696	$ 37,429	$91,125	$44,143	$46,982
E-14	$133,766	$ 70,293	$204,060	$90,872	$113,188
E-15	$109,019	$ 124,396	$233,414	$112,451	$120,963
Total	**$599,176**	**$ 745,251**	**$1,344,427**	**$500,940**	**$843,487**

Alternative 3 requires 1,970 feet of groin lengthening. The length is much greater for Alternative 3 because the berm width is greater for Alternative 3 and a higher dune width. The total average annual benefits are $2,716,000 and average annual cost of $1,183,500 resulting in net benefits of $1,532,500.

Table 15: Alternative 3 Benefits and Costs

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
I-1	$244,141	$ -	$244,141	$21,717	$222,424
I-2	$130,265	$ -	$130,265	$22,343	$107,922
I-3	$29,684	$ -	$29,684	$6,864	$22,820
I-4	$40,593	$ -	$40,593	$6,805	$33,788
P-1	$4,106	$ 14,593	$18,699	$4,263	$14,436
P-2	-$30,155	$ 46,174	$16,018	$17,203	-$1,185
E-1	$9,036	$ 17,182	$26,217	$30,953	-$4,736
E-2	$21,664	$ 32,006	$53,670	$42,357	$11,313

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
E-3	$46,799	$ 49,960	$96,759	$70,105	$26,654
E-4	$113,924	$ 31,705	$145,629	$47,313	$98,315
E-5	$80,515	$ 29,403	$109,919	$66,087	$43,832
E-6	$60,300	$ 64,126	$124,427	$71,059	$53,368
E-7	$29,334	$ 25,955	$55,289	$41,485	$13,804
E-8	$127,500	$ 90,060	$217,559	$95,861	$121,698
E-9	$101,692	$ 38,005	$139,697	$48,084	$91,613
E-10	$180,722	$ 61,238	$241,961	$96,594	$145,367
E-11	$164,351	$ 36,882	$201,233	$58,296	$142,937
E-12	$43,136	$ 30,308	$73,443	$65,457	$7,986
E-13	$85,912	$ 38,819	$124,730	$65,210	$59,520
E-14	$267,830	$ 74,563	$342,393	$134,569	$207,823
E-15	$158,717	$ 124,954	$283,671	$170,906	$112,765
Total	**$1,910,066**	**$ 805,933**	**$2,715,999**	**$1,183,534**	**$1,532,465**

Alternative 4 requires a total of 1,130 ft of groin lengthening and the cost included in average annual cost. The average annual benefits of Alternative 4 are $2,545,560, the average annual cost are $926,000 resulting in net benefits of $1,619,500.

Table 16: Alternative 4 Benefits and Costs

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
I-1	$244,141	$ -	$244,141	$21,717	$222,424
I-2	$130,265	$ -	$130,265	$22,343	$107,922
I-3	$29,684	$ -	$29,684	$6,864	$22,820
I-4	$40,593	$ -	$40,593	$6,805	$33,788
P-1	$8,687	$ 14,593	$23,280	$5,752	$17,528
P-2	-$42,113	$ 46,174	$4,060	$9,405	-$5,344
E-1	$3,112	$ 17,182	$20,294	$10,342	$9,951
E-2	$16,301	$ 32,006	$48,307	$26,330	$21,978
E-3	$39,186	$ 49,960	$89,146	$50,514	$38,632
E-4	$90,519	$ 31,705	$122,224	$28,502	$93,723
E-5	$60,948	$ 29,403	$90,351	$38,745	$51,606
E-6	$44,575	$ 64,126	$108,701	$49,485	$59,216
E-7	$22,710	$ 25,955	$48,665	$32,242	$16,423

Reach	Damage Reduction Benefits	Cost Avoidance Benefits	Total Benefits	AA Costs	Net Benefits
E-8	$121,469	$ 89,668	$211,137	$77,666	$133,471
E-9	$79,259	$ 35,491	$114,749	$38,659	$76,090
E-10	$164,298	$ 59,743	$224,042	$72,653	$151,388
E-11	$158,599	$ 36,679	$195,278	$49,326	$145,952
E-12	$42,269	$ 30,308	$72,576	$56,561	$16,015
E-13	$80,144	$ 38,819	$118,963	$57,217	$61,747
E-14	$256,282	$ 74,445	$330,727	$116,776	$213,951
E-15	$153,424	$ 124,954	$278,378	$148,185	$130,192
Total	**$1,744,352**	**$ 801,210**	**$2,545,562**	**$926,089**	**$1,619,473**

Table 17 shows the summary of net benefit comparison between all the alternatives. As shown, the plan that maximizes net benefits is Alternative 4. Alternative 4 is also bracketed by the net benefits of Alternative 1 which is a smaller plan and Alternative 3 which is a larger plan than Alternative 4. Alternative 5 is sand fencing and Alternative 6 is the non-structural property acquisition.

Table 17: Net Benefits for Plan Comparison

Reach	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
I-1	$122,469	$15,882	$222,424	$222,424	$126,686	
I-2	$57,558	$7,021	$107,922	$107,922	$69,198	
I-3	$14,156	$2,234	$22,820	$22,820	$18,070	
I-4	$19,108	$2,416	$33,788	$33,788	$22,476	
P-1	$9,658	$9,076	$14,436	$17,528		
P-2	-$14,101	$22,457	-$1,185	-$5,344		
E-1	$3,472	$13,017	-$4,736	$9,951		
E-2	$21,848	$22,470	$11,313	$21,978		
E-3	$36,315	$46,123	$26,654	$38,632		
E-4	$81,740	$28,222	$98,315	$93,723		
E-5	$46,145	$27,247	$43,832	$51,606		
E-6	$58,933	$66,524	$53,368	$59,216		
E-7	$18,021	$21,968	$13,804	$16,423		
E-8	$130,028	$104,432	$121,698	$133,471		
E-9	$64,325	$21,001	$91,613	$76,090		
E-10	$135,694	$70,100	$145,367	$151,388		
E-11	$135,277	$67,594	$142,937	$145,952		
E-12	$15,223	$14,570	$7,986	$16,015		
E-13	$60,498	$46,982	$59,520	$61,747		
E-14	$194,443	$113,188	$207,823	$213,951		($226,906)
E-15	$126,759	$120,963	$112,765	$130,192		($17,935)

Reach	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Total	**$1,337,568**	**$843,487**	**$1,532,465**	**$1,619,473**	**$236,430**	

Periodic nourishment is placement of suitable material on a beach at appropriate intervals of time to maintain the design template. Beach-*fx* examines all reaches to be nourished to determine if mobilization is warranted. The existing reach profile is compared to the design template, and a nourishment volume is determined. If the total nourishment volume for all reaches exceeds a user-defined threshold, then mobilization and nourishment take place. If nourishment is required, then nourishment time is determined based on placement rates. The cost of nourishment, including mobilization and placement costs, is calculated based on nourishment volumes and user-defined cost-related parameters.

Once the NED plan was determined, Beach-*fx* was used to optimize the renourishment cycle for the NED plan. Two year increments were analyzed for 4, 6, 8, 10 and 12 years and then for a 16 year renourishment cycle. Table 18 shows the average annual costs, benefits and net benefits for each of the renourishment cycles for comparison of the optimized renourishment interval. The FY13 discount rate of 3.75% was used over a 50 year period of analysis.

Table 18: Average Annual Net Benefits for Renourishment Cycles

Cycle (yrs)	AA Benefits	AA Placement Cost	AA Mob Cost	AA Groin Cost	Total AA Cost	AA Net Benefits
4	$2,529,665	$643,132	$ 448,070	$104,592	$1,195,794	$1,333,871
6	$2,502,654	$637,736	$ 313,366	$104,592	$1,055,694	$1,446,960
8	$2,478,624	$635,223	$ 246,196	$104,592	$986,011	$1,492,613
10	$2,406,228	$612,080	$ 196,579	$104,592	$913,251	$1,492,977
12	$2,402,784	$621,710	$ 179,388	$104,592	$905,690	$1,497,094
16	$2,351,070	$614,499	$ 146,343	$104,592	$865,434	$1,485,638

There is minimal difference in net benefits between the eight and 12 year renourishment cycle. Although the net benefits are maximized at the 12 year cycle, the average annual difference between the eight and 12 year cycle is only about $4,500, or 0.025% and the difference between the eight and ten year cycles are even less. From a risk based perspective, a shorter renourishment cycle reduces the likelihood that beach fill would be needed (based on the mobilization threshold) and substantial damages being incurred prior to a scheduled renourishment. Therefore, based on the consideration of risk and the minimal differences in the net benefits between the eight, ten and 12 year cycles, an average renourishment cycle of eight years was identified for the NED plan.

The NED plan was then updated to the FY13 discount rate of 3.75% using the eight year optimized renourishment interval. Table 19 shows the summary benefit analysis for the constructible NED plan presented by planning reach.

Table 19: NED Plan Benefits and Costs

NED Plan - Alternative 4			
Reach	**Total AA Benefits**	**AA Costs**	**Net Benefits**
Inlet Reach (I1-I4)	$459,455	$74,890	$384,564
Atlantic Reach South (P1, P2, E1-E6)	$534,116	$254,506	$279,610
Atlantic Reach North (E7-E15)	$1,489,028	$712,852	$776,177
All Reaches Total	**$2,482,599**	**$1,042,248**	**$1,440,351**

8. PROJECT COST

Once the NED plan was determined a more detailed project cost was conducted. The total project cost summary was prepared for Edisto Beach and the first cost of the project for initial construction and the renourishment cost were used to compare to project benefits to compute final net benefits and the benefit to cost ratio. The renourishment cost for each eight year interval was discounted to the present value. The initial construction cost of the project is $21,424,000 and the renourishment cost that is expected to occur every eight years is $7,058,000, with the present value totaling $17,088,400. The interest during construction is approximately $118,400 and operations and maintenance approximately $83,000. The total average annual cost is presented in Table 20.

Table 20: NED Cost

Initial Construction	$ 21,424,000
2026 Renourishment	$ 5,257,470
2034 Renourishment	$ 3,916,260
2042 Renourishment	$ 2,917,200
2050 Renourishment	$ 2,173,010
2058 Renourishment	$ 1,618,670
2066 Renourishment	$ 1,205,740
Total First Cost	$ 38,512,360
Interest During Construction	$ 118,450
Total Project Cost	$ 38,630,810
Average Annual First Cost	$ 1,721,940
O&M	$ 83,000
Total Average Annual Cost	**$ 1,804,940**

9. CONSTRUCTIBLE NED PLAN

The FY13 initial construction costs are $21,424,000 and a single renourishment cost is $7,058,000. Renourishment costs are discounted using the FY13 discount rate of 3.75% to present worth each renourishment. Total project first cost including Interest During Construction

(IDC) for this plan is $38,512,400. The annualized cost of Operation and Maintenance (O&M) is $83,000. The annualized benefits are $2,482,600 for coastal storm damage reduction benefits. The benefit-to-cost ratio (BCR) is 1.38 to 1 which yields net benefits of about $677,700.

Table 21 summarizes the costs, benefits and other pertinent information on project justification for the NED Plan without recreation benefits.

Table 21: NED Summary of Benefits without Recreation Benefits

Average Annual CSDR Benefits	$ 2,482,600
Total Average Annual Cost	$ 1,804,940
Benefit-to-Cost Ratio	1.4
Net Benefits	$ 677,660

10. RECREATION BENEFITS

The evaluation procedure used for this report is the Unit Day Value method (UDV). This method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. Unit Day Value (UDV) method was selected as the evaluation procedure because there are no specialized recreation activates for the area and the annual visits expected do not exceed 750,000. The recreational analysis can be found in Attachment 2.

In 2012, the Town of Edisto Beach area had approximately 371,000 beach visitors. Traffic counts combined with estimated rentals determine expected visitors per year. This estimate is based on data provided by the Town of Edisto Beach. Visitation is generally constrained by availability of beach area only during peak days and is not limited at other times of the year. The peak recreation season is Memorial Day through Labor Day. Recreational visitation reaches a peak four times a year. These times are Spring Break, Memorial Day, Independence Day and Labor Day.

PARKING

Edisto Beach provides sufficient parking for the general public. At some access points there are parking lots that provide for up to 150 cars. The other access points have parking along the streets that are permitted by the town. The State of South Carolina recognizes that in order participate in beach nourishment projects public access is a must and therefore protects and promotes public access to the state's beaches. Parking is a reasonable walking distance to the beach.

ACCESS

According to ER1105-2-100, reasonable access is access approximately every one-half mile or less. According to the Town of Edisto Beach Local Comprehensive Beach Management Plan, the Town has 38 public access points that lie along Palmetto Boulevard, Point Street and Yacht Club Road. Each access point is identified with "Beach Access" signs. The 38 access points are exclusive of the State Park. The average width of each access point is approximately 50 feet with an average distance between each access point of 400 ft. Provisions of reasonable public access rights of ways are present in Edisto Beach.

The following table shows the beach access location and facilities at each location.

Table 22: Parking & Access

	PARKING & ACCESS								
Location	Feet Between Access Points	Sign Number	Pedestrian Only	Boardwalk	Walkover	Off-Street Parking	On-Street Parking	Handicapped Access	Signage
Coral St	842	1					x		x
Fenwick St	807	1a	x				x		x
Mary St	829	2	x				x		x
Whaley St	791	3	x				x		x
Matilda St	797	4	x				x		x
Cupid St	787	5	x				x		x
Atlantic St	802	6	x				x		x
Portia St	797	7	x				x		x
Dawhoo St	300	8				6	x		x
Cheehaw St	288	9				11	x		x
Osceola St	290	10				8	x		x
Byrd St	300	11	x				x		x
Nancy St	302	12				5	x		x
Thistle St	317	13				11	x	x	x
Chancellor St	300	14	x				x		x
Dorothy St	300	15	x				x		x
Marianne St	284	16				10	x	x	x
Lybrand St	300	17		x	x	10	x	x	x
Catherine St	300	18	x	x			x		x
Mitchell St	303	19			x	15	x	x	x
Baynard St	300	20	x		x	2	x	x	x
Edings St	300	21		x	x	7	x	x	x
Jenkins St	300	22				4	x	x	x
Seabrook St	300	23				10	x	x	x
Murray St	300	24				10	x	x	x
Holmes St	308	25				10	x	x	x
Loring St	300	26				10	x	x	x
Laroche St	300	27				10	x	x	x
Neptune St	907	28	x				x	x	x
Billow St	300	29	x	x			x		x
White Cap St	350	30				9	x	x	x
Edisto St.	387	31				6	x	x	x
Mikell St.	599	32		x		2	x	x	x
Townsend St.	1249	33	x				x		x
Louise St.	600	34	x	x			x		x
Ebb Tide St.	1425	35		x	x	4	x	x	x
Yacht Club Rd.	865	36	x	x			x		x
Yacht Club Rd.		37		x		2	x		x

WITH AND WITHOUT PROJECT VALUES

To determine the recreation benefits of the tentatively selected plan, an economic value must be placed on the recreation experience at Edisto Beach. The value can then be applied to the expected visitation experience that results from the project to determine NED recreation benefits.

The UDV are determined using a point system that takes into account the following factors: recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental (esthetics) quality. A good deal of judgment is required in the assessment of point values. A group of planning professionals and experts of the study area made independent judgments of the UDV values which were averaged. The differences in the values were applied to the estimated visitation. The difference in the Without and With project values of recreation determine the NED recreation benefits. The source of the value of recreation is obtained from the Economic Guidance Memorandum, 13-03, Unit Day Values for Recreation for Fiscal Year 2013. Table 24 shows the without project and with project points and their associated dollar values.

Table 23: UDV Project Points and Values

Criteria	W/O Project Points	W/ Project Points
Recreation Experience	16	28
Availability of Opportunity	16	18
Carrying Capacity	13	13
Accessibility	13	13
Environment (Esthetics)	4	15
Total Points	62	85
General Recreation Value	$9.02	$10.57

The UDV point totals convert to a recreation value of $9.02 in the Without project condition and the $10.57 in the With project condition. The difference in the Without Project condition and the With Project condition recreation value is $1.55.

Because Edisto Beach is already a public beach, it is not anticipated that public visitation numbers will change as a result of the Federal project. It is assumed that the 2012 visitation is indicative of future visitation given that the Edisto Island beach front is almost fully developed and generally no more room for parking areas. However, it is recognized that visitation could be much higher than reported due to the homes and vacation rentals being in walking distance from the beach and spillover from the State Park. Applying the unit day values of $9.02 in the Without project condition of 62 total points and $10.57 for the With project condition of 85 points results in annual recreation benefits of approximately $573,200.

Table 24 summarizes the costs, benefits and other pertinent information on project justification for the NED plan with recreation benefits.

Table 24: NED Plan Benefits with Recreation Benefits

Average Annual CSDR Benefits	$2,482,600
Average Annual Recreation Benefits	$573,200
Total Average Annual Benefits	$3,055,800
Total Average Annual Cost	$1,804,900
Benefit-to-Cost Ratio	1.7
Net Benefits	$1,250,900

11. TENTATIVELY SELECTED PLAN

The Tentatively Selected Plan was calculated at the Federal discount rate of 3.75% for a 50 year period of analysis. The total expected average annual coastal storm damage reduction benefits for the tentatively selected plan are $2,482,600. The recreation benefits for the TSP are estimated to be $573,200. The average annual cost is $1,804,900. Net benefits are $1,250,900 and the benefit-to-cost ratio is 1.7 to 1.

Attachment 1:

Part 1:

Coastal Storm Damage Relationships

Based on Expert Opinion Elicitation

&

Part 2:

Edisto Beach Damage Functions

Part 1:

Coastal Storm Damage Relationships

Based on Expert Opinion Elicitation

Institute for Water Resources, U.S. Army Corps of Engineers

Version1

Coastal Storm Damage Relationships Based on Expert Opinion Elicitation

(DRAFT)

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Abstract

This report documents the results of the Coastal Storm Damage Workshop on June 5, 6, 2002 in Alexandria, Virginia where expert-opinion was elicited for economic consequence assessment of coastal storm damage. The objectives of this workshop were to discuss and recommend damage relationships needed for predicting structural damage from coastal storms as functions of hazard intensity levels, with associated uncertainties, resulting from erosion, waves, inundation, and their combined effects. Because information on the relationship between residential structural damage and storm parameters is limited, this workshop used expert-opinion as a means of gaining information on these relationships (see Ayyub 2001). This report describes the results of the workshop both in terms of damage relationships and future information needs identified by the experts at the workshop.

This workshop is part of longer-term research effort whose objective is to develop a peer-reviewed, step-by-step methodology for estimating coastal storm damages. The methodology will be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by IWR. The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

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Program Overview

The objective of this research is to develop a peer-reviewed, step-by-step methodology for estimating damages from coastal storms to property and improvements. The methodology will also be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by the Institute for Water Resources (IWR). The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

The objective will be achieved using a two-stage process to elicit opinions from experts to develop damage functions to estimate storm damages. The first stage of this process consisted of developing framework to quantitatively describe the damage done to a structure from storm hazards such as inundation, waves, erosion, and wind. Preliminary damage relationships (curves) were also developed. As a starting point for the first stage, the project core team from IWR proposed a “strawman” framework to be modified by a small group of experts. Inputs for this first stage included the models presently in use by Corps' offices (e.g. Wilmington and Jacksonville) and other agencies around the country, as well as a framework that is being developed for this purpose for the Corps’ Wilmington District. Experts were chosen from within the Corps’, from contractors and academics with experience in coastal storm damage, and from the Federal Emergency Management Authority. Although a focus was on the hurricane-prone southeastern U.S., the workshop also included expertise from the North Atlantic and California.

The second stage will involve additional data collection through a full review of the initial framework and relationships by a review team, by Corps' offices, and by the professional community at-large, and from damage data collected in post-storm surveys. Experts will then be convened in a formal expert elicitation to use this additional information to modify the preliminary depth-damage relationships and develop final estimates of likely economic damages from a coastal storm.

Needs and Existing Storm Damage Information

This study was prompted by a widely-perceived need for better information on coastal storm damage relationships. A December 2000 letter from the Assistant Secretary of the Army to the Wilmington District requested a “Corps-wide-survey of damage functions used for all types of structures and the rationale for using them, for hurricane and storm damage reduction projects". The expectation was that "better guidance can be provided to field offices on the conduct of economic analysis if we have the benefit of … better tools to evaluate hurricane and storm damage projects". This research seeks to provide these better tools.

In investigating storm damage relationships, available sources of information can be divided into two general categories: 1) data on storm damages and on existing structures, and 2) models of the relationships between storm parameters and damage. Whereas the relationships between storm parameters and damage is the ultimate purpose of this investigation, the relationships need to be grounded in the data on actual storm damages. As background for the research and in preparation for the workshop, the project core team from IWR reviewed coastal damage methodologies from various sources including: Corps Districts in Jacksonville, Wilmington, New Orleans, Mobile, New York, Philadelphia; the HAZUS model - a natural hazard loss estimation methodology developed by the Federal Emergency Management Agency in partnership with the National Institute of Building Sciences; FEMA building performance studies; Federal Insurance claims data; USACE reports on Hurricane Fran and on Shoreline Protection and Beach Erosion Control; state data from HurricaneOpal (FL); the Heinz Center's Evaluation of Erosion Hazards, and various articles from the open literature (i.e. Bodge 1991, King et al. 1991, Urlich et al. 1994, Kato and Torii 2002, Thomalla et al. 2002).

Use of Expert Opinions

The primary reason for using expert opinions is provide "data" where little or no data exists about an issue or problem. It can also deal with uncertainty in selected technical issues related to a system of interest. Issues with significant uncertainty, issues that are controversial and/or contentious, issues that are complex, and/or issues that can have a significant effect on risk are most suited for expert-opinion elicitation. Here we used an informal, consensus-based elicitation process to promote creative thinking about potential frameworks and problem definition. The value of any expert-opinion elicitation comes from its initial intended uses as a heuristic tool, not a scientific tool, for exploring vague and unknowable issues that are otherwise inaccessible. It is not a substitute to scientific, rigorous research.

The identification of the need for the information developed during the elicitation process and its communication to experts are essential for the success of the elicitation. The need identification and communication should include the definition of the goal of the study and relevance of issues to this goal. Establishing this relevance would make the experts stakeholders and thereby increase their attention and sincerity levels. Relevance of each issue and/or question to the study needs to be established. This question-to-study relevance is essential to enhancing the reliability of collected data from the experts. Each question or issue needs to be relevant to each expert especially when dealing with subjects with diverse views.

The expert-opinion elicitation process can be defined as a formal, heuristic process of obtaining information or answers to specific questions about certain quantities, called issues, such as failure rates, unsatisfactory-performance consequences and expected service life. This process should not be used in lieu of rigorous reliability and risk analytical methods, but should be used to supplement them and to prepare for them. It should be preferably performed during a face-to-face meeting of members of an expert panel that is developed specifically for the issues under consideration. The meeting of the expert panel should be conducted after communicating to the experts in advance to the meeting background information, objectives, list of issues, and anticipated outcome from the meeting. The different components of the expert-opinion elicitation process are described in Ayyub (2001).

Recent USACE Expert-Opinion Elicitation Studies

Expert-opinion elicitation is a technique for using a panel of individuals with various areas of specialized knowledge for estimating parameters or addressing issues of interest based on their expertise. The March 2002 expert elicitation conducted by IWR on the Economic Consequence Assessment of Residential Flood Damage is a recent example of use of the technique. Expert-opinion elicitation has also been recently applied by the New Orleans District's study of the Lower Atchafalaya Basin and reevaluation of the Morganza to the Gulf of Mexico feasibility studies, by Vicksburg District's Pearl River study, and by the Sacramento District's Feather River flood damage study. Building contractors, insurance adjusters, home decorators, and other individuals with knowledge of construction, prices, and typical home furnishings were used to estimate depth-damage and content-to-structure value ratios. Details on some of these studies are provided in Ayyub (1999 and 2001).

Residential Damage Due to Coastal Storms

The scope of this study consists of structural damage to single-family homes from coastal storms. These economic consequences can be described by mathematical functions that relate storm parameters such as wave crest height or the depth of still water flooding to the percent of damage that occurs to structures. The percent damage to structure refers to the percent of the depreciated replacement costs of the structure that is damaged. Coastal storms damage structures through wave action, still water flooding, wave run-up, erosion, and wind. These hazard types are described briefly below

Waves: Most of the energy delivered to the shore by the ocean originates from the wind acting on the ocean to produce waves. Wave characteristics are determined by the wind direction, wind speed, wind duration, how far the wind blows over water, and how far the wave travels before reaching land. Wave action can cause significant damage to coastal structures. Conventional wisdom is that if breaking waves strike at or above a building's first floor elevation, that structure will be severely damaged. This is the rationale for the National Flood Insurance Program's (NFIP) characterization of a highly vulnerable zone (V-zone) for damage from wave action. The ability to prevent wave damage is considered a major benefit of Corps' shore protection measures. Although FEMA demarks the V-zone as an area subject to breaking waves at least 3 feet high, recent, FEMA-sponsored tests indicate that 1.5-foot waves can break away walls. This research suggests that the V-zone might more appropriately extended to all areas subject to 1.5-foot high breaking waves.

Stillwater flooding: Storms can cause inundation of structures with still water either through overtopping of a dunes system (coastal flooding) or through flood waters coming from the bay side of a coastal island (bay-side flooding). Coastal flooding implies still-water level flooding of structures because of overtopping of a dune system or storm surge breaking through from the coastal side and inundating beach areas. A major benefit of Corps' shore protection measures may be reduced coastal flooding damages. Bayside flooding implies still water level flooding of structures, with flooding coming from the bayside. Natural or man-made structures may have prevented flooding from storm surge on the coastal side of an island, but high seas inundated structures from the bay or backside of an island. Structures on the bayside of islands are frequently constructed with a lower level of flood protection than structures across the island on the oceanfront. For example bayside houses may be built lower to the ground whereas oceanfront houses might be raised on piles. Damage from bayside flooding is generally not reduced through shore protection measures.

Erosion: On average, the nation's shorelines are receding at an annual rate of slightly more than one foot per year, although rates vary significantly across regions and across shoreline types. In addition to long-term erosion, erosion during a storm may destroy a dune and undermine shorefront structures. The extent of damage will depend on the amount of storm-induced erosion at the structure and structural characteristics such as foundation and piling embedment. Damages from storm-induced erosion can be significant, regardless of the long-term erosion rate or whether natural processes rebuild the dune in the months following a storm. Corps shore protection measures can provide significant reduction in damages attributable to erosion. Because erosion causes beaches to narrow over time, it is a major factor to consider in conducting a life cycle analysis of project benefits and costs.

Wave Run-up: Wave run-up is the upper level reached by a wave on a beach or coastal structure, relative to still-water level (Coastal Engineering Manual, 2002). Wave run-up applies pressure on a structure in both a vertical and horizontal direction and is a function of the water depth and the square of the water velocity. Wave run-up ceases to be a damage factor when breaking waves attack a structure.

Wind Damages: High winds associated with storms can cause significant damages to structures both on the coast and much further inland. High winds and associated flying projectiles can damage doors, windows or roofs. This damage to the integrity of the structure may combine with high winds to cause severe damage or structural failure. Such breaching also allows rainwater damage to the structure. Most of the damages from Hurricanes Andrew, Iniki, and Hugo were caused by wind and wind-related rainwater as opposed to waves, flooding, wave run-up, or erosion. Because Corps' projects do not significantly affect the wind speed of storms, wind damage is not reduced through shore protection measures. Nonetheless, wind damage plays a significant role in life cycle cost analysis for Corps' storm damage reduction projects.

Requirements

The IWR project core team has the lead responsibility for achieving the project objectives, but relied on input from a larger, working group of experts to develop appropriate damage relationships. The working group represented Corps' Districts that had been active in shoreline protection projects and represented different geographic regions. In addition, it included outside experts from the Federal Emergency Management Agency, universities, and the private sector who had expertise in coastal storm damage assessment.

Participants

A list of the IWR project core team and working group for the workshop is below.

PROJECT CORE TEAM

Affiliation	Name	Role
IWR	Stuart Davis	Project Leader
IWR	Hal Cardwell	Project Leader
IWR	David Moser	IWR Program Manager
USACE-HQ	Lillian Almodovar	HQ Program Manager
BMA Engr/Un. of MD	Bilal Ayyub	Facilitator

WORKING GROUP

Affiliation	Name	Role
USACE/Wilmington	Bob Finch	In-house Technical Advisor (S.Atlantic)
USACE/Wilmington	Mike Wutkowski	In-house Technical Advisor (S.Atlantic)

USACE/Jacksonville	Dan Peck	In-house Technical Advisor (S.Atlantic)
USACE/Jacksonville	Tom Smith	In-house Technical Advisor (S.Atlantic)
USACE/SAD	Gerald Melton	In-house Technical Advisor (S.Atlantic)
USACE/New Orleans	Brian Maestri	In-house Technical Advisor (Gulf)
USACE/Los Angeles	Dan Sulzer	In-house Technical Advisor (W.Coast)
USACE/Los Angeles	Susie Ming	In-house Technical Advisor (W.Coast)
USACE-HQ	Harry Shoudy	In-house Technical Advisor
USACE-HQ	Charlie Chesnutt	In-house Technical Advisor
USACE-HQ	Jay Warren	In-house Technical Advisor
URS	Bill Coulbourne	Outside Technical Advisor (N.Atlantic)
URS	Mike Cannon	Outside Technical Advisor (N.Atlantic)
Consultant	Chris Jones	Outside Technical Advisor (S.Atlantic)
NC SeaGrant	Spencer Rogers	Outside Technical Advisor (S.Atlantic)
FEMA	Paul Tertell	Outside Technical Advisor

Workshop Results

Strawman Coastal Storm Damage Framework

The starting point for discussions of coastal storm damage processes was a "strawman framework" for structural damage estimation that was put forth by the IWR project core team. The strawman framework assumes as known, the physical parameters of the area and of the storm. These parameters include surface water elevation, ground elevation, shoreline type, wave heights, storm-induced erosion depth. Also assumed known are structural characteristics such as location, foundation type, height of lowest supporting beam of structures including their location. Long-term erosion is considered by progressively moving the shoreline landward, therefore increasing the storm-induced erosion and inundation potential from subsequent storms. Economic losses (damages) due to land lost are outside the scope. Wind damages are estimated outside of this framework; this estimate will be used to modify damage to structures from coastal flooding and erosion as appropriate. We also assume the surface water elevation accounts for bay-side flooding and dune breaches.

> *Inundation:* Damage to both contents and structures from wave run-up, breaking waves, and still water flooding is assumed to be captured through the use of FIMA[1] V-zone curves for all areas that experience breaking waves of 1.5 ft above the lowest structural horizontal member of the structure. For areas that experience less than 1.5 feet of flooding, FIMA A-zone curves will be used for structure damage.

> *Storm-induced erosion:* A curve relating damage to the depth of vertical erosion at the center of building will be developed for various foundation types. This curve will be applied for sandy beaches with small dunes (as defined by FEMA). An additional relationship for high dunes and sandy bluff shoreline types will describe storm-induced damages from near-vertical erosion scarps.

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[1] The Federal Insurance and Mitigation Administration (FIMA – formerly the Federal Insurance Administration - FIA) developed and uses depth-damage curves to estimate actuarial premiums for flood insurance. FIMA has two sets of curves, A-zone curves for riverine and coastal areas without high wave velocity, and V-zone curves for coastal areas that are expected to experience wave action. FIMA defines the V-zone as those coastal areas expected to experience a 3-foot high breaking wave.

Combined Damage vectors: The total damage to a structure will be the sum of the inundation damages and the storm-induced erosion damages, with the total not to exceed the value of the structure.

Revised Framework

Discussion at the workshop produced consensus on a revised framework for structural damage estimation. Once the damage hazards were identified, the experts focused on determining the appropriate storm variable that would relate to damage for each hazard type. For example, depth of water above the walking surface for the lowest main floor was selected as the best variable to relate to still water flooding damages. This is the X-axis in a depth (or other variable) versus damage curve. The experts then agreed on the number of relationships that would have to be developed to properly predict damages to different foundation types (e.g. slab on grade or pile) or materials (wood, concrete, masonry) were appropriate for each damage hazard. Discussion then moved to different ways to combine the damages across hazards, and how to account for regional differences in shorelines, with a focus on estimating damages to bluffs. We describe the discussions and decisions in this section. Appendix A contains results in the form of quantified relationships (curves) for storm damages.

Inundation Damage

For damages from still water inundation the workshop determined that the appropriate storm variable to use was the “Depth of water above the walking surface of the lowest main floor”. Although damages to the floors of a structure occur before the water depth reaches the walking surface, using the depth of water surface is an easier variable to use for data collection. **Structural damages that occur from inundation of the floors at slightly lower depths can be included by assigning positive values to damages when depth of water above the walking surface is negative.**

The workshop determined that damages from inundation also depend on the foundation type, on material, number of floors, and, for structures on piles, on the existence of ground-level enclosures. Separate relationship (although using the same X-axis) would need to be developed for each of the following cases:

- Wood frame with piles (with & without enclosures – small medium and full)
- Wood frame without piles
- Concrete & masonry with piles (with & without enclosure – small medium and full)
- Concrete & masonry without piles
- Number of floors (1, 1.5 and 2)

The workshop considered various existing data sources to quantify the relationships for inundation. These data sources included FIMA coastal A-zone curves, curves from New Orleans District for structures on piles and on piers, and curves issued by the Corps in 2000 based on post-flood surveys of actual damages in various parts of the United States.

Waves Damage

For damages due to breaking waves the workshop determined that the appropriate storm variable to use was the "difference between the top of wave (crest) and the bottom of the lowest horizontal member". The workshop considered using the walking floor elevation as the datum for comparison with the top of the wave height for consistency with the measure suggested for inundation. However the workshop decided that the framework would be clearer and more rigorous if it used the bottom of the lowest horizontal member as the reference point because it is at this point that waves can start to damage the structure. If practical considerations preclude measurements of the bottom of the lowest horizontal member, this value can be estimated based on the elevation of the walking surface.

The workshop determined that damages from inundation also depended on the foundation type for structures on piles and on the existence of ground-level enclosures. Separate relationships (although using the same X-axis) would need to be developed for each of the following cases:

- Structures on piles (with & without enclosures – small medium and full)

- Structures not on piles

Wave Run-up Damage

The workshop concluded that damages from wave run-up were attributable to the "Difference between the top of water and the bottom of the lowest horizontal member, and its velocity at the seaward face of the structure". The force applied by wave run-up could be described as directly dependent on the depth of the water and the square of the velocity. Forces would likely act in both a horizontal and vertical direction and be measured in lbs/linear foot. However the workshop participants did not feel that the there was enough known about the damage from wave run-up to determine an appropriate storm variable to use, and opted to delay development of a damage relationship as a long-term need.

Erosion Damage

For damages from storm-induced erosion, the workshop determined that the appropriate storm variable to use both for structures with shallow foundations and ones on piers was the "percent of footprint compromised." Shallow foundation structures were defined as structures that are on slabs or on piers. Houses on bluffs that experience erosion can be considered as structures with shallow foundations. When a shallow foundation experiences vertical erosion such that it loses support from the ground, the foundation is compromised. Six inches of vertical erosion or undermining has been conventionally considered to cause a loss of support. Whereas the workshop participants felt that this definition was relatively straightforward for shallow foundations, the selection of a variable for deep or pile-supported foundations was more contentious.

The distinction was made between a structure that was undermined by erosion and one that had its foundation "compromised". Whereas for structures on shallow foundations undermining (six vertical inches of erosion) is equivalent to compromised, pile structures can be extensively undermined with little or no damage. In these cases the entire footprint could experience vertical erosion of six inches yet no damage would occur because, although undermined, the erosion does not compromise the ability of the foundation to support the structure. Conversely, a compromised pile can be defined as one whose remaining embedment depth renders it ineffective against lateral forces such as wind and waves. Using, as the independent variable (X-axis) the "percent of footprint compromised" would allow correct categorization of damages done to a pile-support house that, because of erosion, might have its entire footprint in the surf zone (and hence undermined), but yet had minimal damage because its foundation was not compromised. The workshop noted that relating storm parameters to the percent of footprint compromised would be difficult and likely be regionally and structurally specific. Comment: This percent of footprint compromised is pretty useless to predict damage from a storm unless this can be predicted from the extent of vertical erosion at the structure. I don't think there will be any model that keeps track of all piles of a pile-founded structure. We will have to make assumptions about where piles are located and the extent of embedment.

Because the appropriate storm variable was defined so broadly, the workshop only called for two separate relationships to be developed for erosion damages: one for shallow foundation and one for deep foundations (piles). More relationships may need to be developed as definitions of "footprint compromised" are developed for specific regions and projects.

Combining Damages

Because a structure may be damaged by more than one of the four storm damage hazards identified by the workshop, a methodology must be developed for how to combine the damages. The Strawman Framework proposed a simple additive combination with a constraint that the total damages to a structure could not exceed its value. The can be expressed as %A + %B. A more commonly used rule for combining damages is to simply use the maximum percent damage from any hazard, or Max [%A, %B]. Whereas the first rule assumes that there is no common damage caused by different hazards, the latter rule assumes the other extreme - that no damage occurs that is not covered by the most damaging hazard. A third rule to consider would be the sum of the hazard percentages minus their product: %A + %B -%A%B. This framework was used in the Portland District and is akin to the probability of occurrence at least one of two independent events A and B.

The workshop concluded that the combination rule must be dependent on the types of hazard that cause damages. If both waves and inundation cause damage the workshop suggested the rule be to only use the damages caused by waves (this is consistent with FIMA's V-zone definition). If both erosion and inundation cause damage the proposed rule is to use the sum of the damages minus their product. Similarly, if both erosion and run-up cause damage the rule is to use the sum of the damages minus their product. For the case where both run-up and erosion cause damages, the workshop proposed two definitions, one for shallow foundation structures, where the rule is to use the maximum of the two damages, and one for pile foundation structures where the rule is to use the sum of the damages minus their product. We summarize these relationships below for the various cases of combination

Case 1 – Inundation + Waves	%W
Case 2 – Run-up + Waves	%W
Case 3 – Inundation + Run-up	will not occur
Case 4 – Inundation + Erosion	%I + %E - %I*%E
Case 5 – Run-up + Erosion	%R + %E - %R*%E
Case 6 – Waves + Erosion	Max %W, %E (shallow foundation)
	%W + %E - %W*%E (pile foundation)

These cases cover all likely combinations of hazards because a structure would not be subject to both moving water (run-up) at the same time as still-water inundation, and waves damages would subsume run-up as it does inundation damages. The workshop noted as a long term need, better information as to when to "switch" from the inundation damage curve to the wave damage curve. Similarly this could be one area of investigation when determining the run-up damage relationships.

Discussion at the workshop included concerns on how to calibrate damage relationships from multiple sources, and noted that the structure should permit direct data collection for the calibration

Coastlines with of Bluffs

Storm damages on coastlines with bluffs differ from those on a beach and dune coastline. Inundation is not an issue for bluffs, and neither are waves or run-up except as they promote erosion. Also, all foundations on bluffs can be treated as shallow foundations or slabs, because erosion from a bluff will undermine a deep pile foundation in the same way as a shallow foundation. Failure of a bluff can be from top to bottom, or from bottom to top.

Long-term and Short-term Needs / Next Steps

The following table summarizes the long-term and short-term needs and future steps in this area:

Priority	Long-term and Short-term Needs / Next Steps
High	Methodology (including authority) for post storm data collection to determine flood conditions during event and erosion conditions at the end of an event.
High	Define/issue guidance for "Compromised" regional Differences
High	Beach profile translation
High	Contents
High	Land Loss/estimated value
High	Post storm data – wave crest water level elevations, lower limit (elevation) of wave damage.
High	Pre-storm building inventory
High	Collection of Existing loss information (including analysis of data from Fran)
Medium	Wave damage height threshold (1.5 ft vs 3 ft) – When do we abandon the inundation curve? How far inland is wave damage an issue?
Medium	RUN-UP RELATIONSHIPS - HOW TO QUANTIFY (WEST COAST)
Medium/Low	Sedimentation damage during inundation
Medium/Low	Duration of inundation
Low	Bluff Erosion processes
Low	Curves/response of engineered buildings, and other non residential structures
Low	Salt versus fresh water inundation damage

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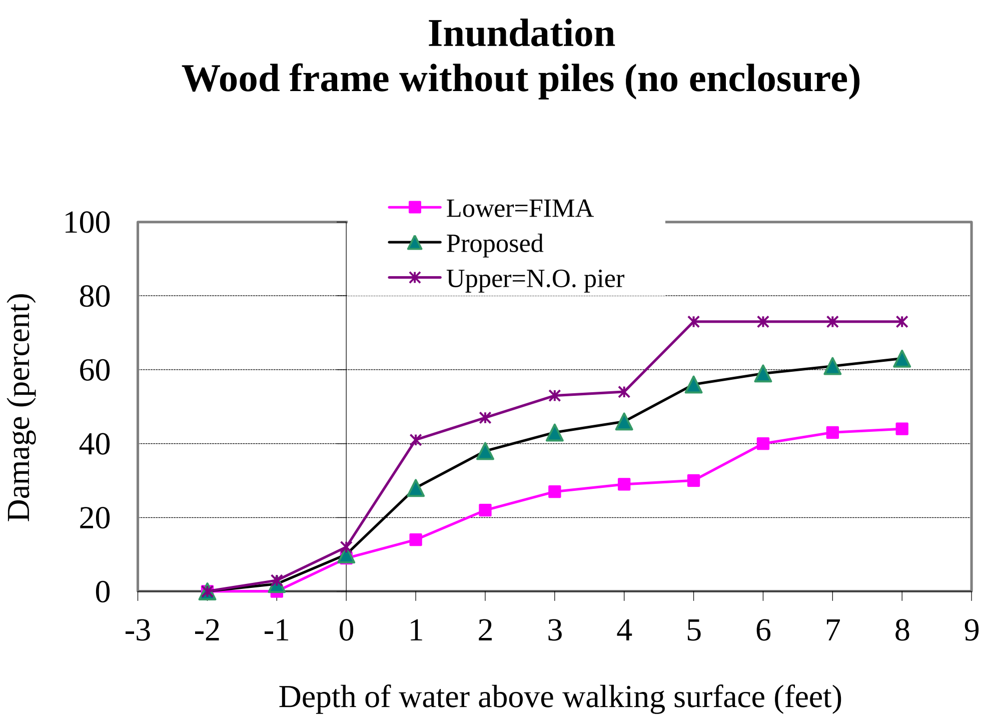
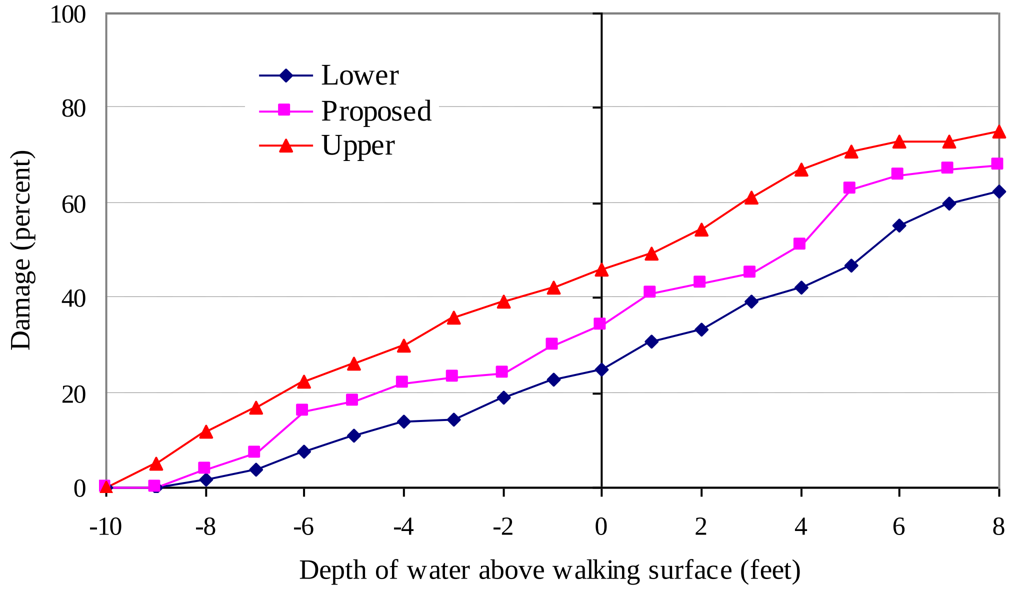
Appendix A. Damage Relationship Details

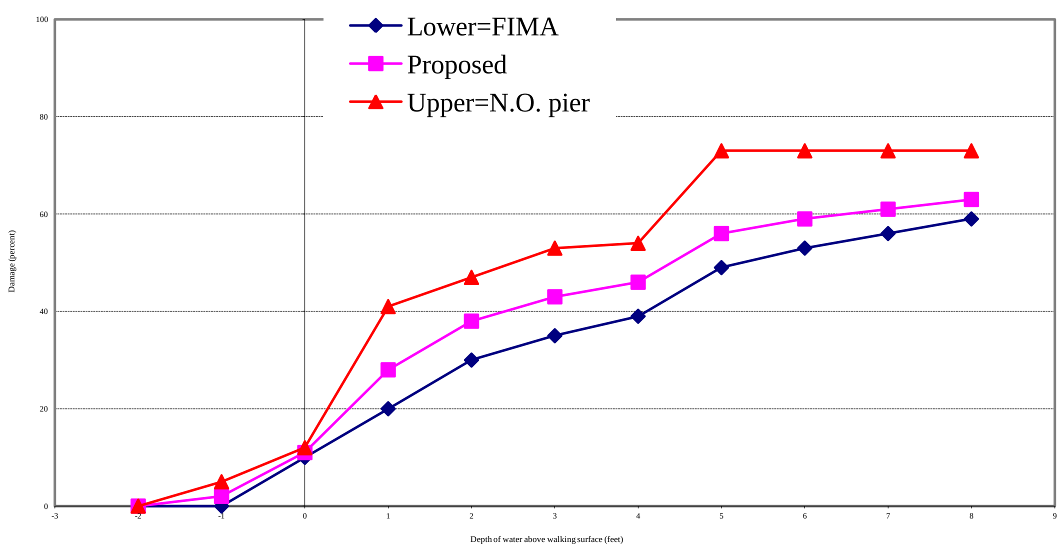
The following figures contain the details of the damage relationships developed in the workshop. The "Proposed" curve represents the experts' median estimate of damages, whereas the upper and lower represent estimates of the range of the damages. Here, 75 percent of the time damages will be less than the "Upper" curve and 25 percent of the time damages will be lower than the "Lower" curve. For the inundation curves, the upper and lower bounds were set equivalent to the estimates used by New Orleans district for structures on piers (N.O. pier), and by the FIMA coastal A-zone curves, respectively. For damages from inundation, the workshop only developed curves for the selected cases noted below. The workshop assumed that estimates for inundation damages in structures with partial enclosures would flow from the curves developed here. Likewise all curves apply for single story houses.



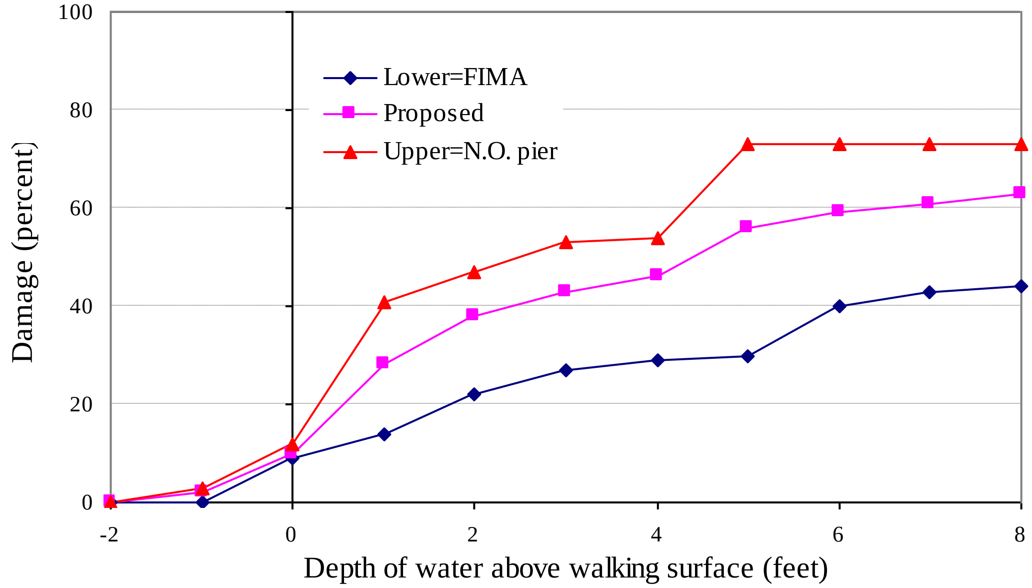
Inundation
Wood frame with piles (full enclosures)



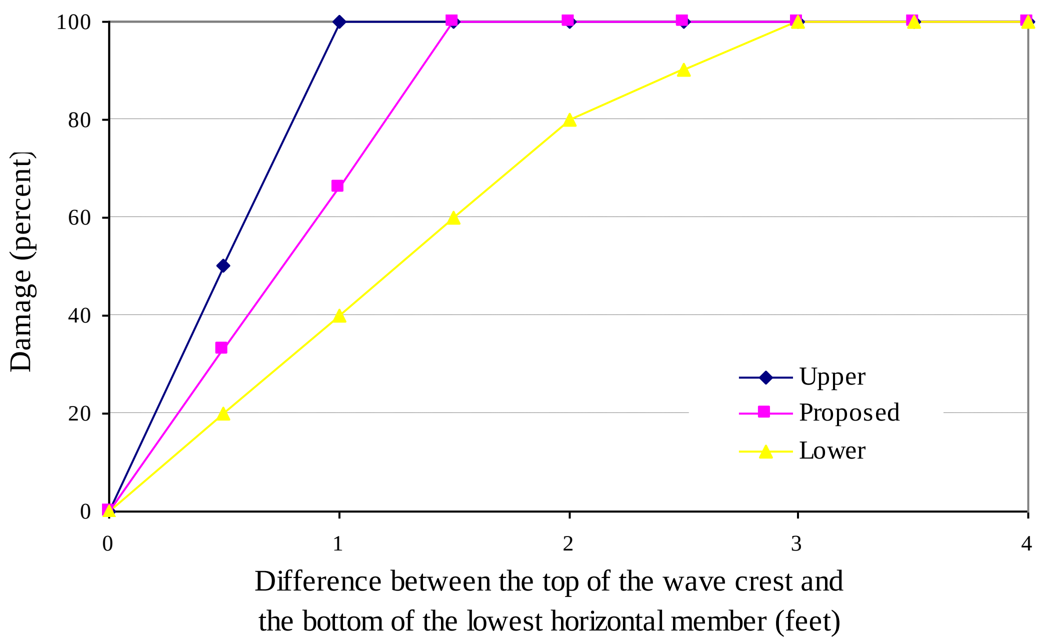
Inundation
Wood frame with piles (no enclosures)

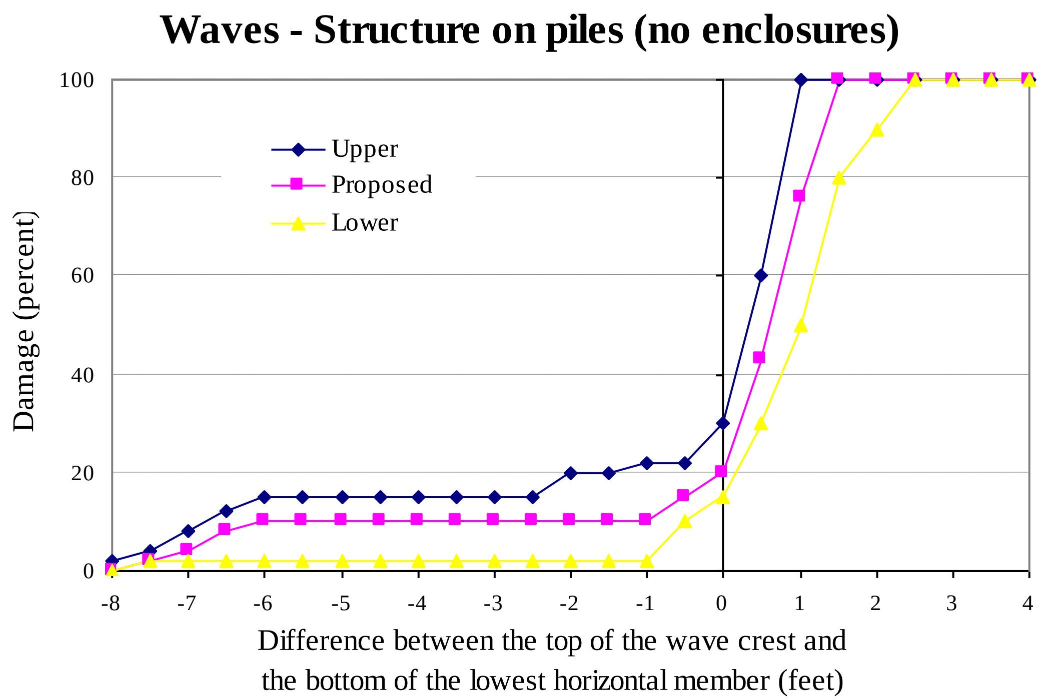


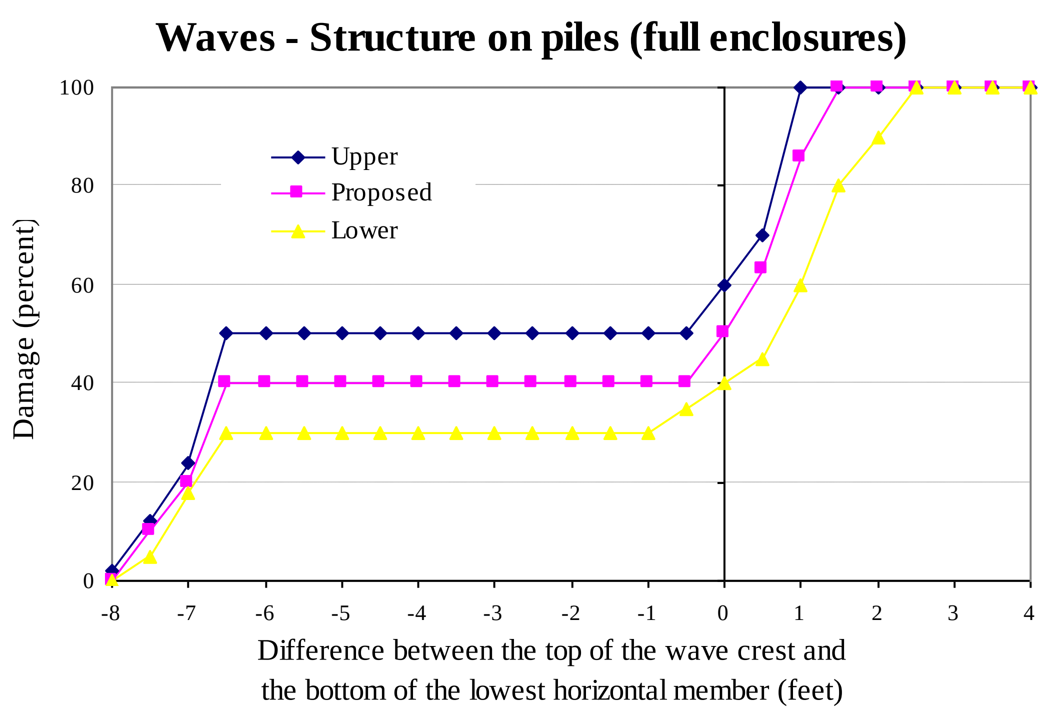
Inundation
Concrete and masonry without piles



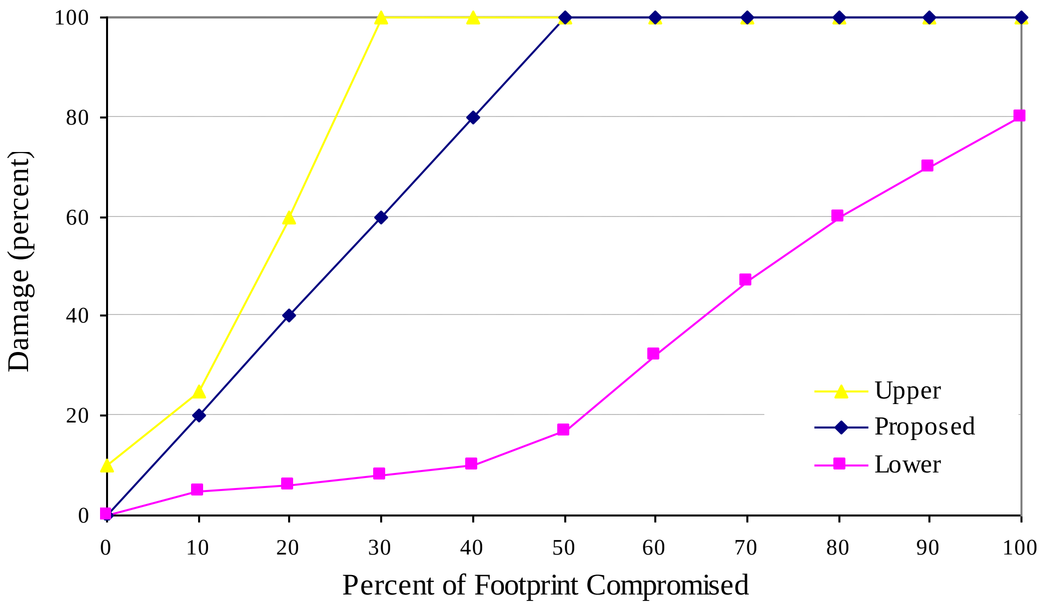
Waves - Structure not on piles



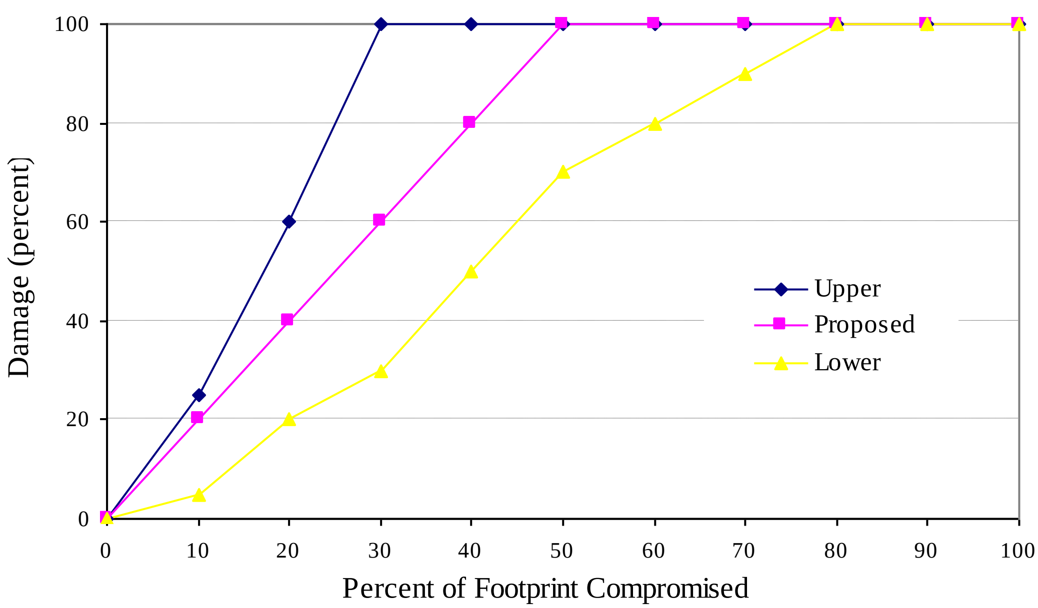

Waves - Structure on piles (no enclosures)
Damage (percent)
100
80
60
40
20
0
Upper
Proposed
Lower
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
Difference between the top of the wave crest and
the bottom of the lowest horizontal member (feet)


Waves - Structure on piles (full enclosures)
Damage (percent)
100
80
60
40
20
0
Upper
Proposed
Lower
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
Difference between the top of the wave crest and
the bottom of the lowest horizontal member (feet)

Erosion - Pile Foundation



Erosion - Shallow Foundation



Part 2:

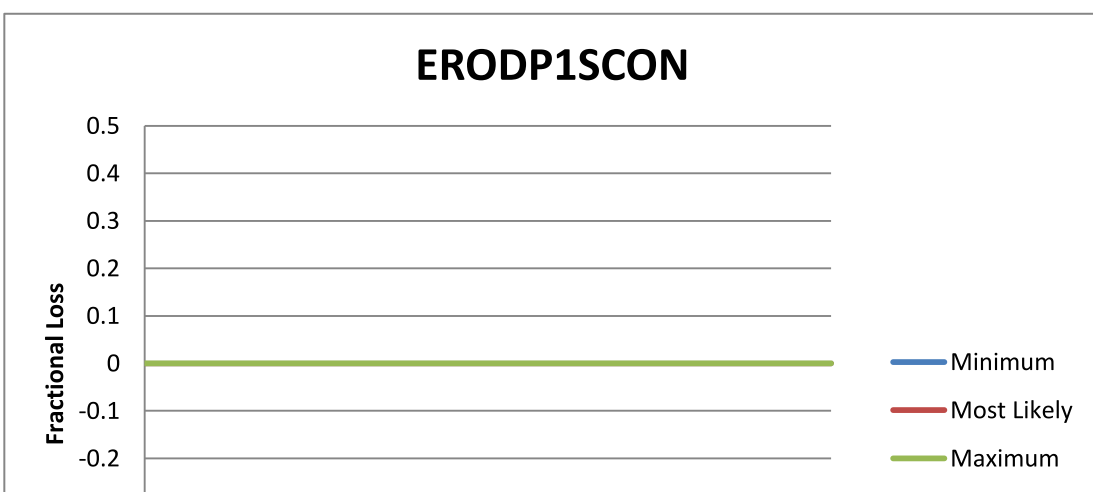
Edisto Beach Damage Functions

EDISTO BEACH DAMAGE FUNCTIONS

Erosion/Contents/Deep Piles

Multi-Family and Single Family

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
10	0	0	0
20	0	0	0
30	0	0	0
40	0	0	0
50	0	0	0
60	0	0	0
70	0	0	0
80	0	0	0
90	0	0	0
100	0	0	0

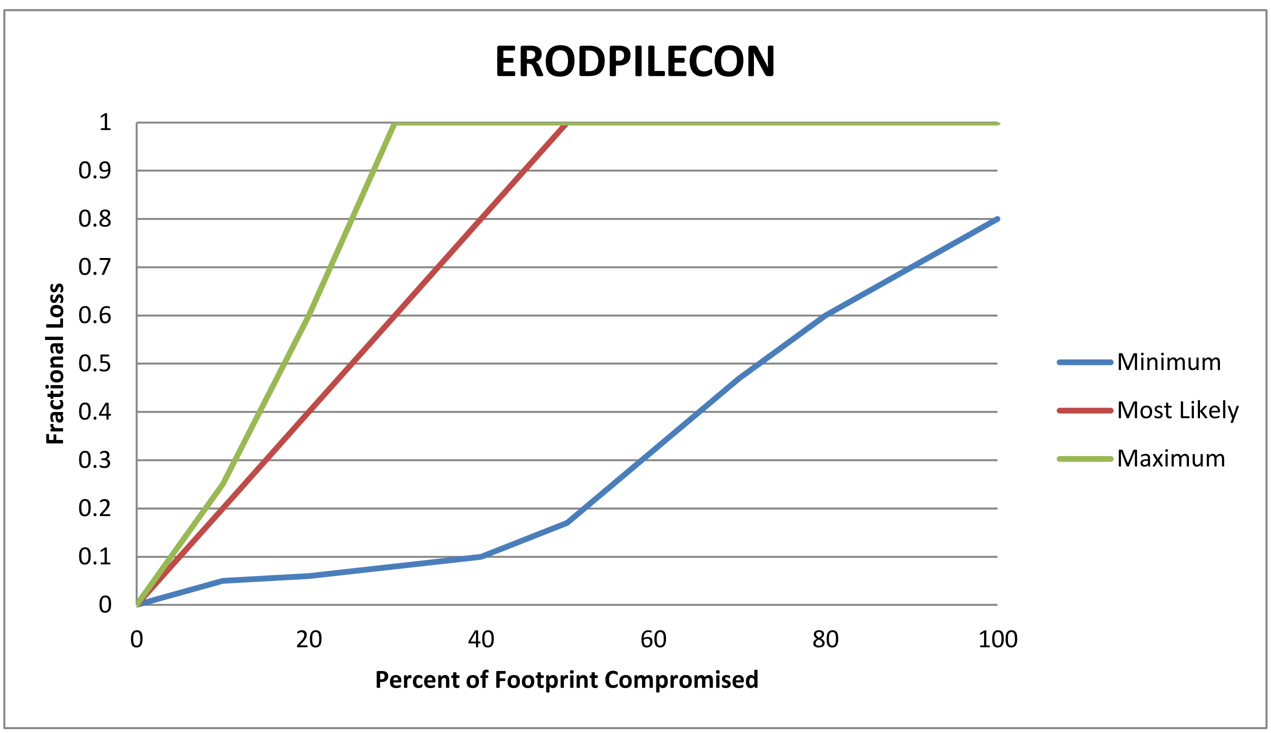


Erosion/Contents/Piles

Single Family and Walkovers

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0

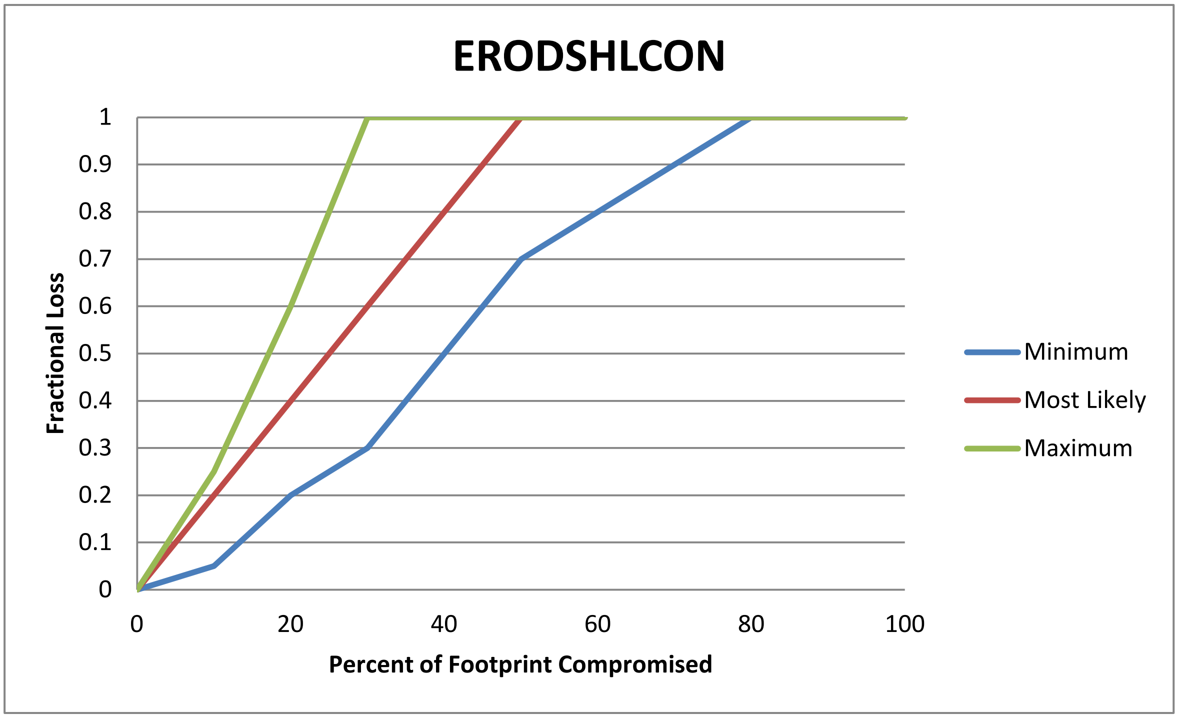
10	0.05	0.2	0.25
20	0.06	0.4	0.6
30	0.08	0.6	1
40	0.1	0.8	1
50	0.17	1	1
60	0.32	1	1
70	0.47	1	1
80	0.6	1	1
90	0.7	1	1
100	0.8	1	1



Erosion/Contents Shallow Foundation

Single Family and Walkovers

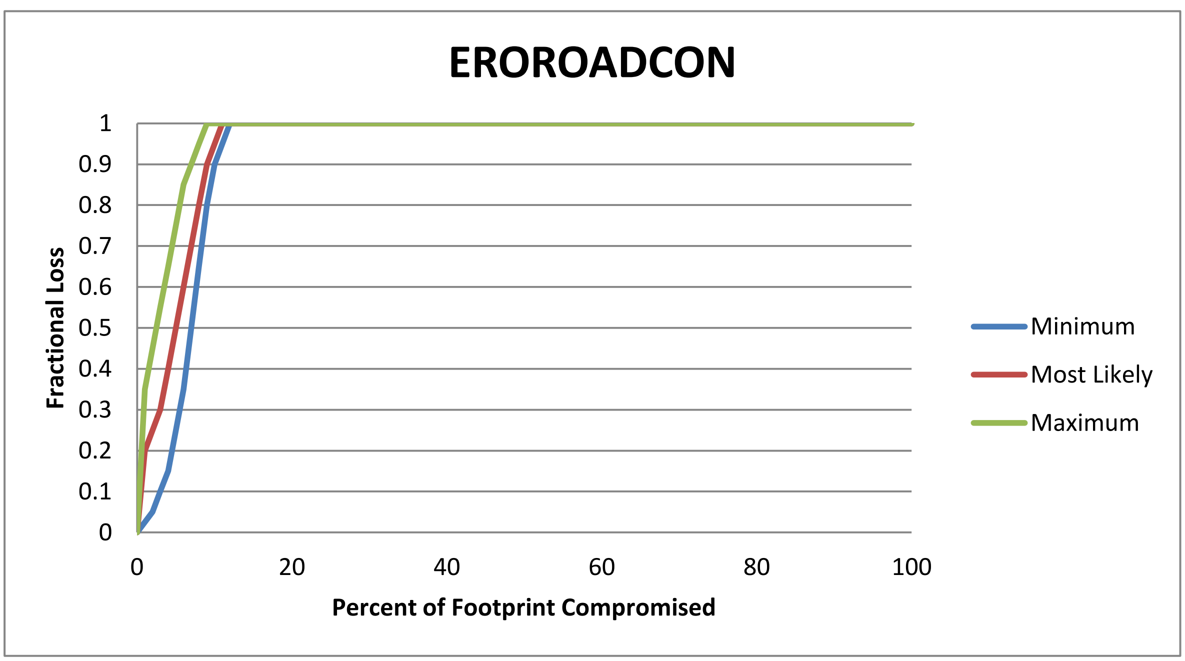
% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
10	0.05	0.2	0.25
20	0.2	0.4	0.6
30	0.3	0.6	1
40	0.5	0.8	1
50	0.7	1	1
60	0.8	1	1
70	0.9	1	1
80	1	1	1
90	1	1	1
100	1	1	1



Erosion/Contents (Water Main Adjacent to Road)

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
1	0.025	0.2	0.35
2	0.05	0.25	0.45

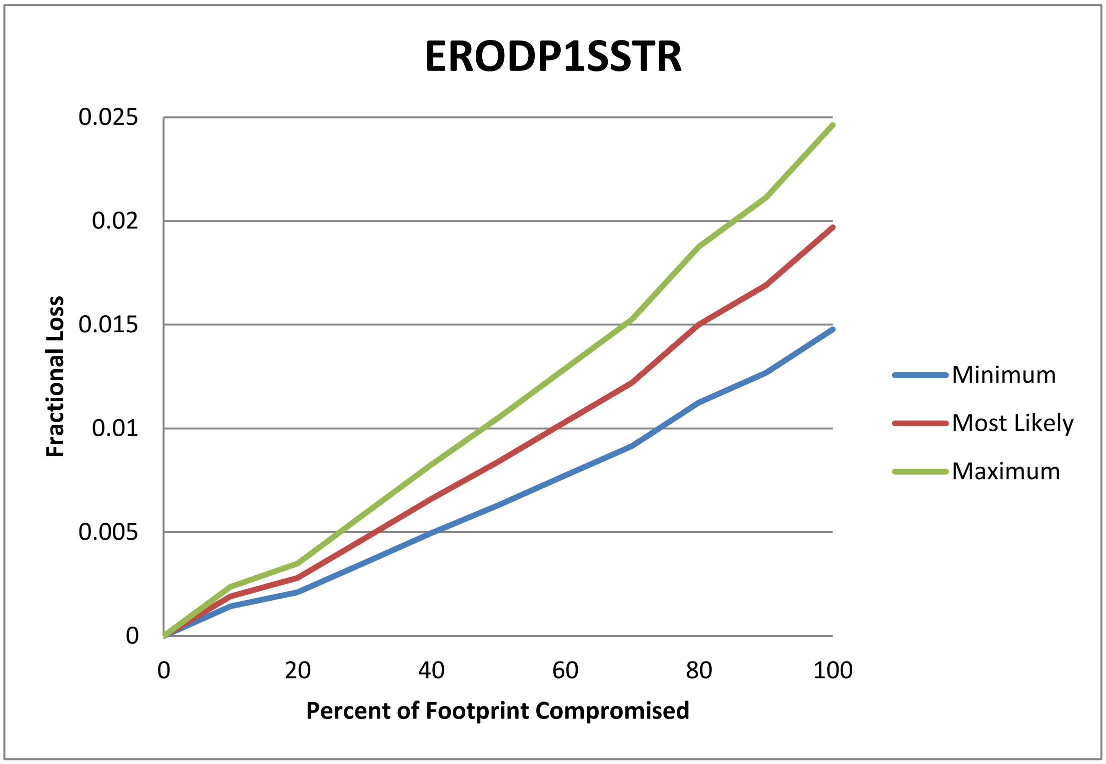
3	0.1	0.3	0.55
4	0.15	0.4	0.65
5	0.25	0.5	0.75
6	0.35	0.6	0.85
7	0.5	0.7	0.9
8	0.65	0.8	0.95
9	0.8	0.9	1
10	0.9	0.95	1
11	0.95	1	1
12	1	1	1
100	1	1	1



Erosion/ Structure Deep Piles

Multi-Family and Single Family Dwelling

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
10	0.001425	0.0019	0.002375
20	0.0021	0.0028	0.0035
30	0.003525	0.0047	0.005875
40	0.00495	0.0066	0.00825
50	0.0063	0.0084	0.0105
60	0.007725	0.0103	0.012875
70	0.00915	0.0122	0.01525
80	0.01125	0.015	0.01875
90	0.012675	0.0169	0.021125
100	0.014775	0.0197	0.024625

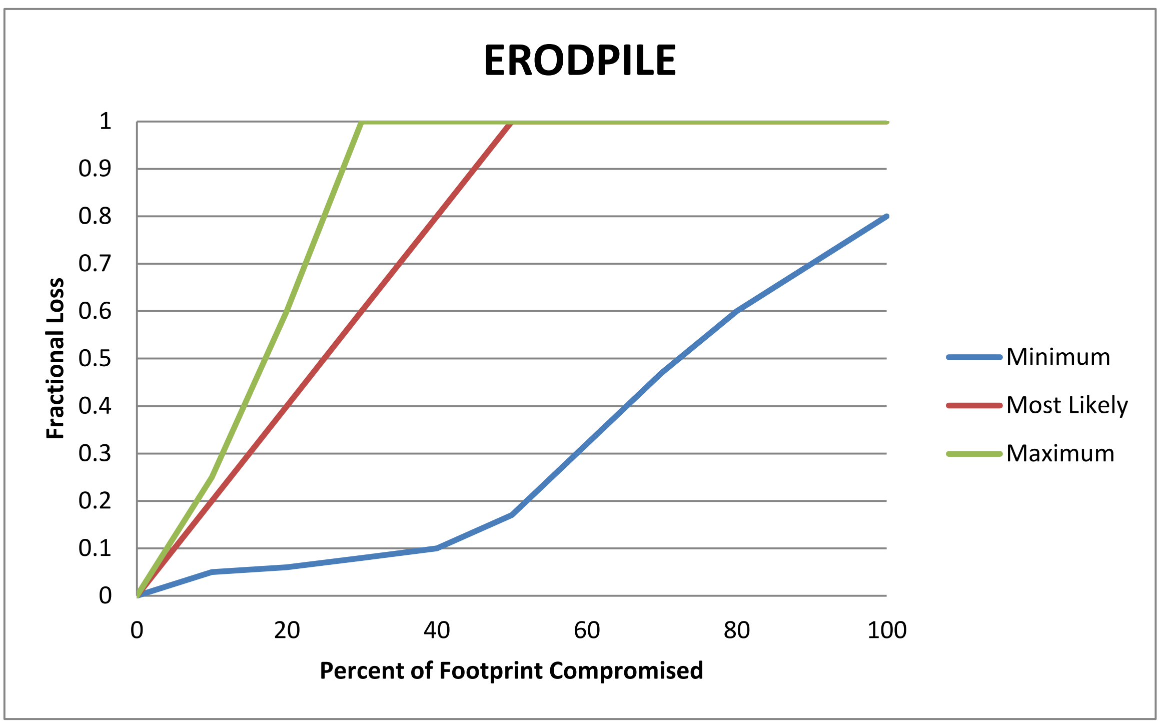


Erosion/Structure Piles

Single Family Dwelling and Walkovers

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0

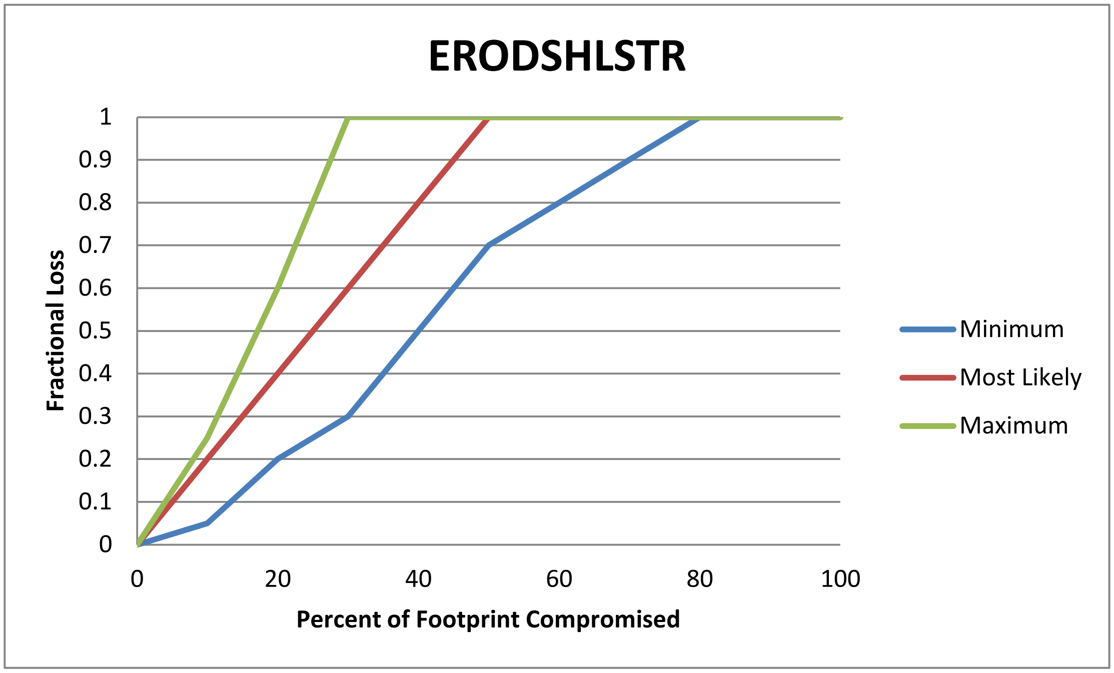
10	0.05	0.2	0.25
20	0.06	0.4	0.6
30	0.08	0.6	1
40	0.1	0.8	1
50	0.17	1	1
60	0.32	1	1
70	0.47	1	1
80	0.6	1	1
90	0.7	1	1
100	0.8	1	1



Erosion/Structure Shallow Foundation

Single Family Dwelling and Walkovers

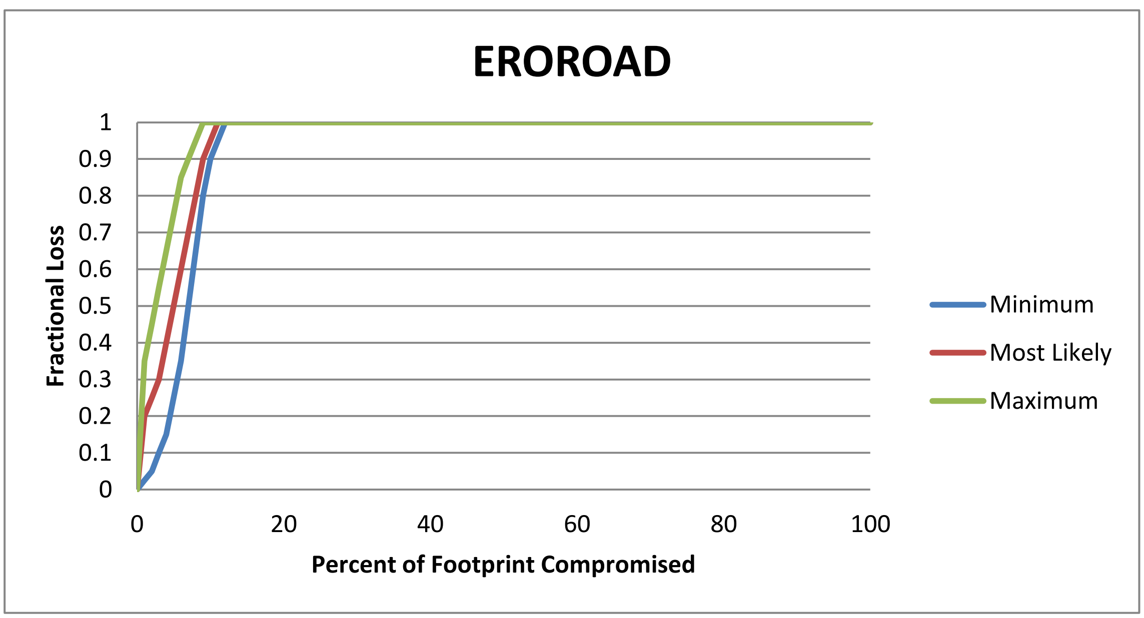
% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
10	0.05	0.2	0.25
20	0.2	0.4	0.6
30	0.3	0.6	1
40	0.5	0.8	1
50	0.7	1	1
60	0.8	1	1
70	0.9	1	1
80	1	1	1
90	1	1	1
100	1	1	1



Erosion/ Structure Road

% of Footprint Compromised	Minimum	Most Likely	Maximum
0	0	0	0
1	0.025	0.2	0.35
2	0.05	0.25	0.45

3	0.1	0.3	0.55
4	0.15	0.4	0.65
5	0.25	0.5	0.75
6	0.35	0.6	0.85
7	0.5	0.7	0.9
8	0.65	0.8	0.95
9	0.8	0.9	1
10	0.9	0.95	1
11	0.95	1	1
12	1	1	1
100	1	1	1

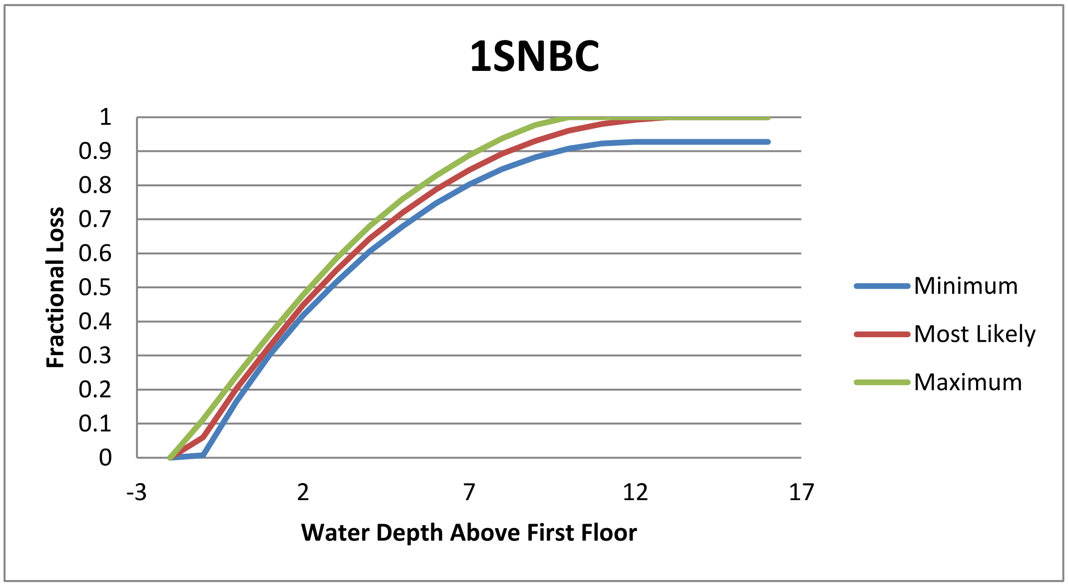


Inundation/Contents All Foundations

Multi-family and Single Family Dwellings

Water Depth Above 1st Floor	Minimum	Most Likely	Maximum
-2	0	0	0
-1	0.0075	0.06	0.1125
0	0.165	0.2025	0.24
1	0.3025	0.3275	0.3625
2	0.4175	0.4475	0.4775
3	0.515	0.55	0.585
4	0.605	0.6425	0.68
5	0.68	0.72	0.76
6	0.7475	0.7875	0.8275
7	0.8025	0.845	0.8875
8	0.8475	0.8925	0.9375
9	0.8825	0.93	0.9775
10	0.9075	0.96	1
11	0.9225	0.98	1
12	0.9275	0.9925	1
13	0.9275	1	1
14	0.9275	1	1

15	0.9275	1	1
16	0.9275	1	1

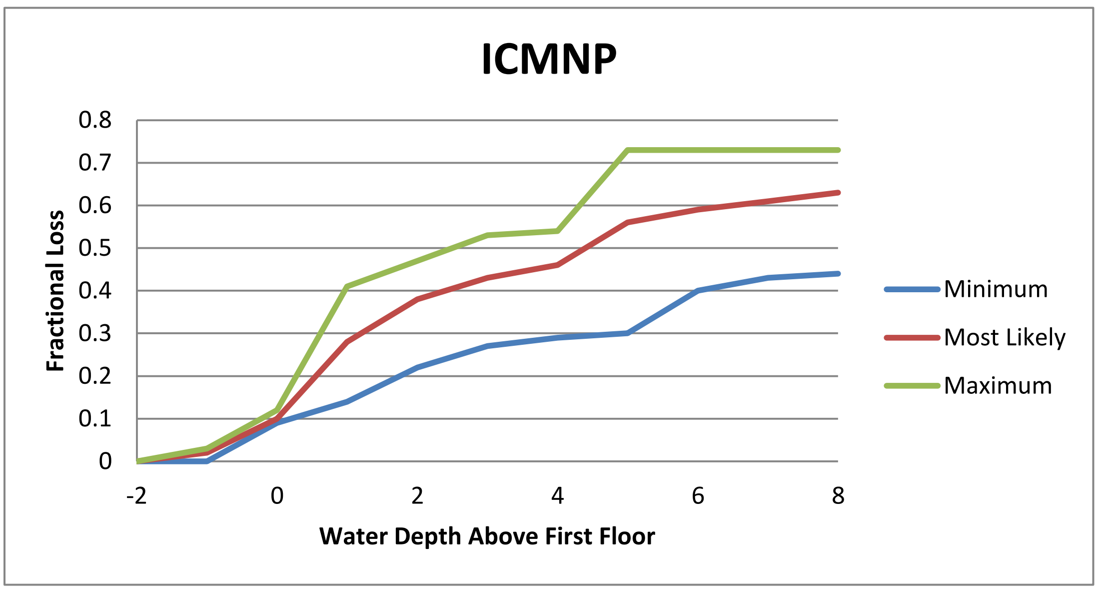


Inundations/Structure Shallow Foundation/Masonry

Single Family Dwelling

Water Depth Above 1st Floor	Minimum	Most Likely	Maximum
-2	0	0	0
-1	0	0.02	0.03
0	0.09	0.1	0.12
1	0.14	0.28	0.41
2	0.22	0.38	0.47

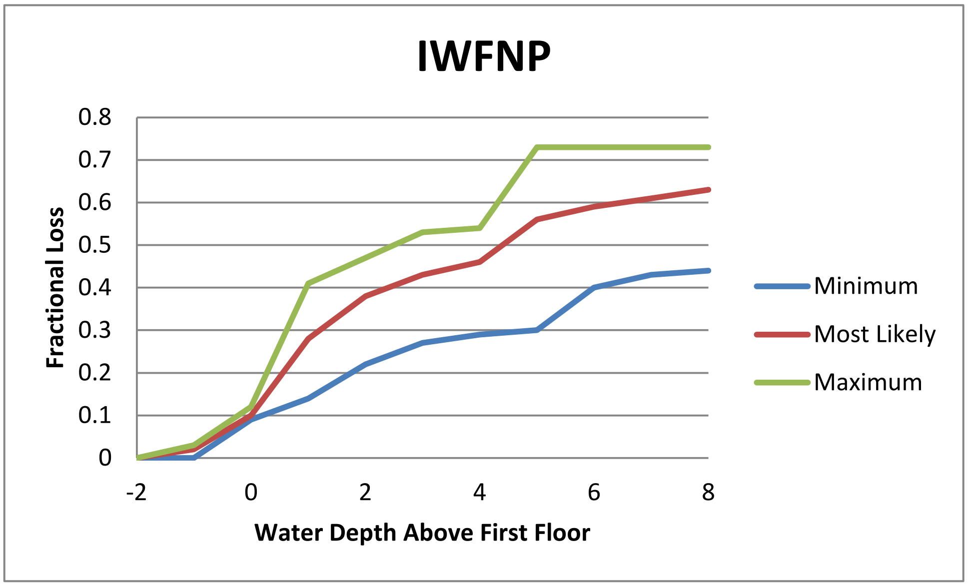
3	0.27	0.43	0.53
4	0.29	0.46	0.54
5	0.3	0.56	0.73
6	0.4	0.59	0.73
7	0.43	0.61	0.73
8	0.44	0.63	0.73



Inundation/Structure/Shallow Foundation/Wood

Single Family Dwelling

Water Depth Above 1st Floor	Minimum	Most Likely	Maximum
-2	0	0	0
-1	0	0.02	0.03
0	0.09	0.1	0.12
1	0.14	0.28	0.41
2	0.22	0.38	0.47
3	0.27	0.43	0.53
4	0.29	0.46	0.54
5	0.3	0.56	0.73
6	0.4	0.59	0.73
7	0.43	0.61	0.73
8	0.44	0.63	0.73

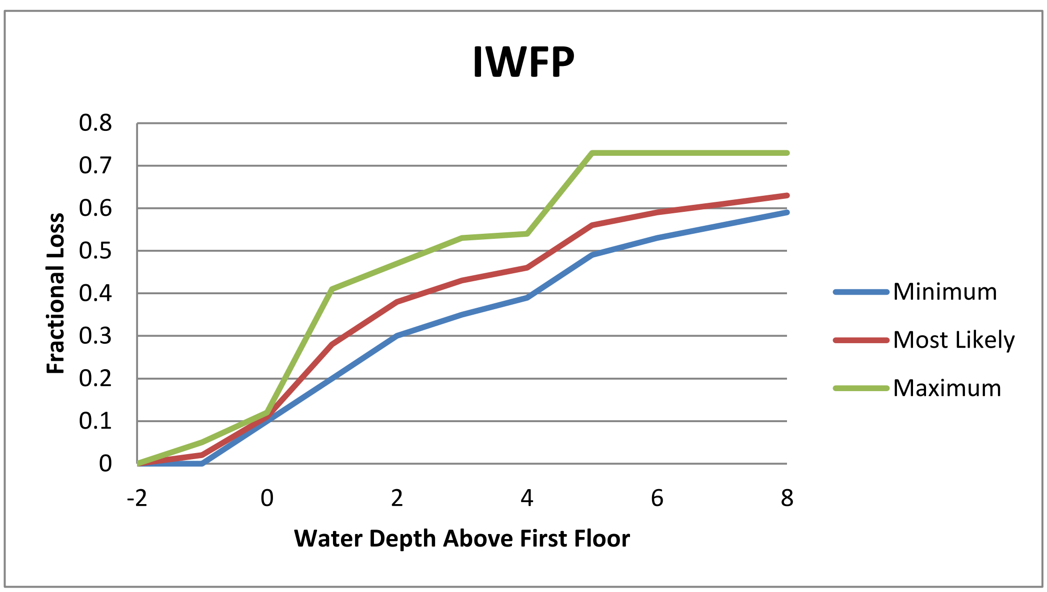


Inundation/Structure All Piles

Single Family and Multi-Family Dwelling

Water Depth Above 1st Floor	Minimum	Most Likely	Maximum
-2	0	0	0

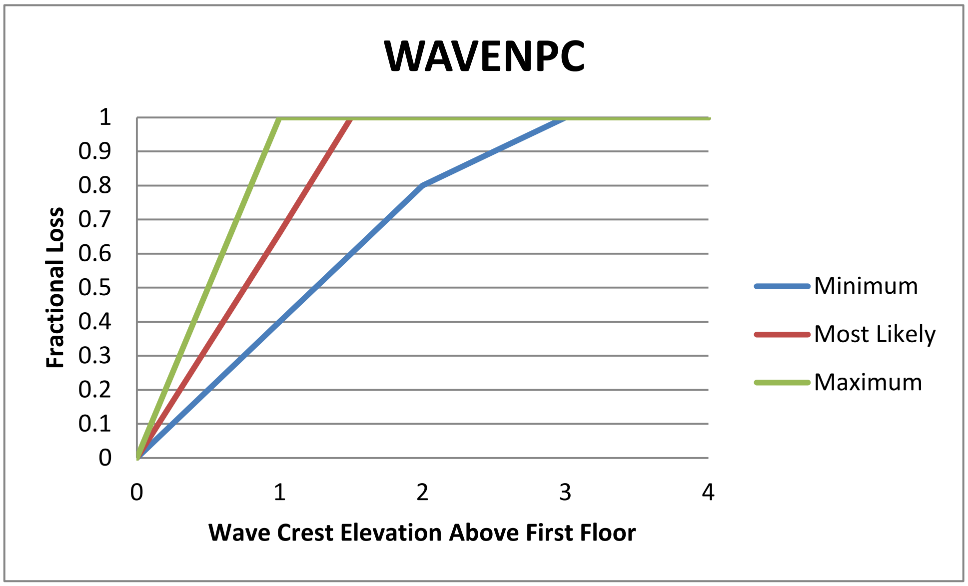
-1	0	0.02	0.05
0	0.1	0.11	0.12
1	0.2	0.28	0.41
2	0.3	0.38	0.47
3	0.35	0.43	0.53
4	0.39	0.46	0.54
5	0.49	0.56	0.73
6	0.53	0.59	0.73
7	0.56	0.61	0.73
8	0.59	0.63	0.73



Wave/Contents/Shallow Foundation

Single Family Dwelling

Wave Crest Elevation Above 1st Floor	Minimum	Most Likely	Maximum
0	0	0	0
0.5	0.2	0.33	0.5
1	0.4	0.66	1
1.5	0.6	1	1
2	0.8	1	1
2.5	0.9	1	1
3	1	1	1
3.5	1	1	1
4	1	1	1

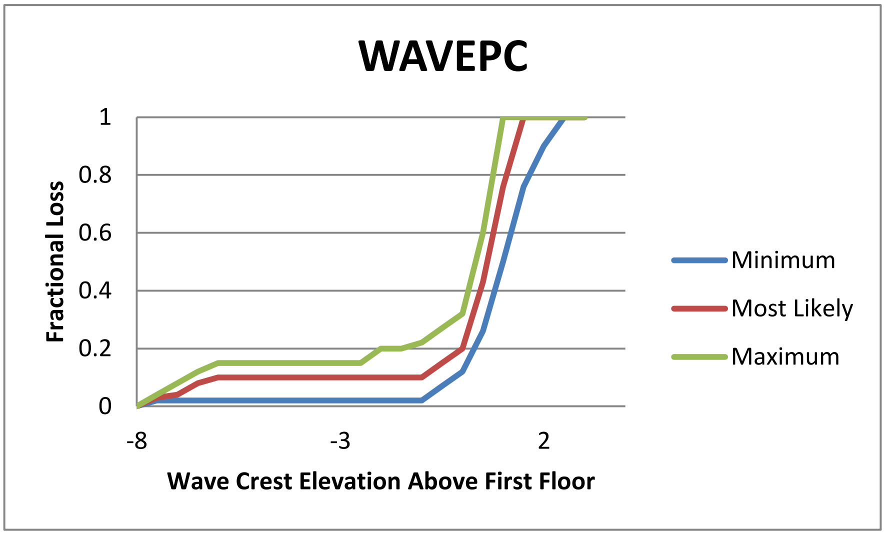


Wave/Contents Pile Foundation

Single Family Dwelling, Multi-family Dwelling and Walkovers

Wave Crest Elevation Above 1st Floor	Minimum	Most Likely	Maximum

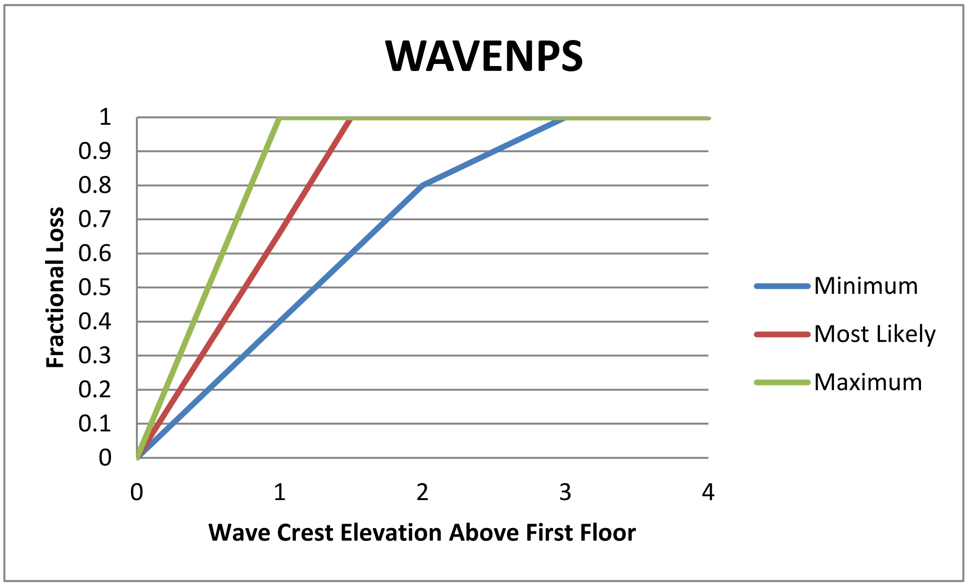
-8	0	0	0
-7.5	0.02	0.03	0.04
-7	0.02	0.04	0.08
-6.5	0.02	0.08	0.12
-6	0.02	0.1	0.15
-5.5	0.02	0.1	0.15
-5	0.02	0.1	0.15
-4.5	0.02	0.1	0.15
-4	0.02	0.1	0.15
-3.5	0.02	0.1	0.15
-3	0.02	0.1	0.15
-2.5	0.02	0.1	0.15
-2	0.02	0.1	0.2
-1.5	0.02	0.1	0.2
-1	0.02	0.1	0.22
-0.5	0.07	0.15	0.27
0	0.12	0.2	0.32
0.5	0.26	0.43	0.6
1	0.5	0.76	1
1.5	0.76	1	1
2	0.9	1	1
2.5	1	1	1
3	1	1	1



Wave/Structure/Shallow Foundation

Single Family Dwelling

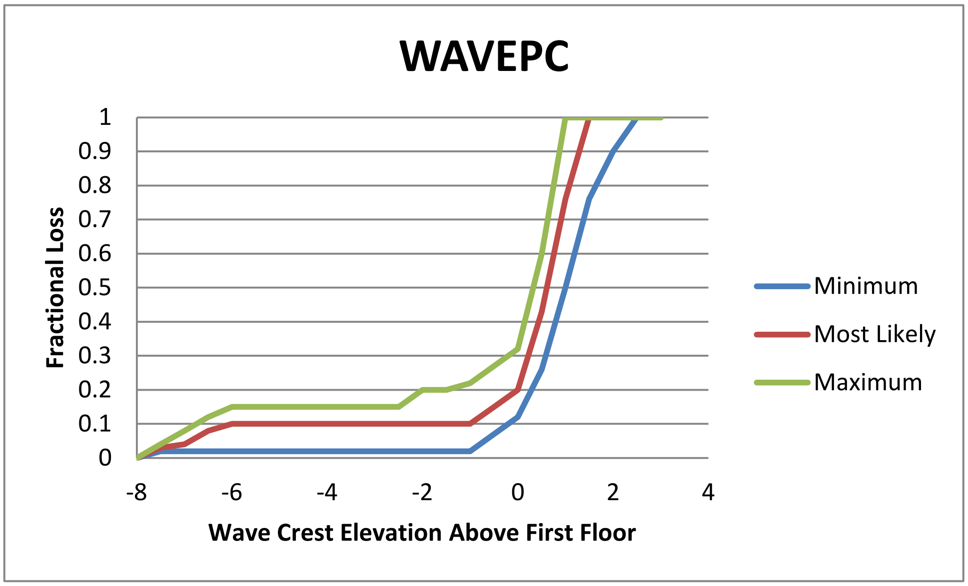
Wave Crest Elevation Above 1st Floor	Minimum	Most Likely	Maximum
0	0	0	0
0.5	0.2	0.33	0.5
1	0.4	0.66	1
1.5	0.6	1	1
2	0.8	1	1
2.5	0.9	1	1
3	1	1	1
3.5	1	1	1
4	1	1	1



Wave/Contents/Pile Foundation

Single Family Dwelling, Multi-Family Dwelling and Walkovers

Wave Crest Elevation Above 1st Floor	Minimum	Most Likely	Maximum
-8	0	0	0
-7.5	0.02	0.03	0.04
-7	0.02	0.04	0.08
-6.5	0.02	0.08	0.12
-6	0.02	0.1	0.15
-5.5	0.02	0.1	0.15
-5	0.02	0.1	0.15
-4.5	0.02	0.1	0.15
-4	0.02	0.1	0.15
-3.5	0.02	0.1	0.15
-3	0.02	0.1	0.15
-2.5	0.02	0.1	0.15
-2	0.02	0.1	0.2
-1.5	0.02	0.1	0.2
-1	0.02	0.1	0.22
-0.5	0.07	0.15	0.27
0	0.12	0.2	0.32
0.5	0.26	0.43	0.6
1	0.5	0.76	1
1.5	0.76	1	1
2	0.9	1	1
2.5	1	1	1
3	1	1	1


WAVEPC
Fractional Loss
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-8
-6
-4
-2
0
2
4
Wave Crest Elevation Above First Floor
Minimum
Most Likely
Maximum

Attachment 2

Edisto Beach

Recreation Benefits Analysis:

Table of Contents

Introduction:

The purpose of this section is to estimate National Economic Development (NED) recreation benefits that will accrue as a result of implementing the tentatively selected coastal storm damage reduction plan on Edisto Beach. It is noted that the tentatively selected plan is not formulated for recreation benefits. They are considered incidental to the primary project purpose of storm damage reduction. NED benefits are economic benefits which accrue to the nation as a whole. They should not be confused with regional economic benefits which include localized impacts that are primarily transfers from a national perspective. All benefit values are stated in constant FY13 dollars. A project life of 50 years and a federal discount rate of 3.75 percent are used in the analysis.

Currently, there are no private beaches in the project area, they are all for public use. Edisto Beach provides parking for the general public. At some access points there are parking lots that provide for up to 150 cars. The other access points have parking along the streets that are permitted by the town. The State of South Carolina recognizes that in order participate in beach nourishment projects public access is a must and therefore protects and promotes public access to the state's beaches. Parking is a reasonable walking distance to the beach.

Evaluation Procedure:

The evaluation procedure used for this report is the Unit Day Value method (UDV). This method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. Unit Day Value (UDV) method was selected as the evaluation procedure because there are no specialized recreational activities for the area and the annual visits expected do not exceed 750,000.

Location:

The Town of Edisto Beach (the Town) and Edisto Beach State Park are part of Edisto Island located in South Carolina. The Town of Edisto Beach occupies the central and southern portions of the island and is generally separated from Edisto Beach State Park by State Highway 174. Its beachfront extends approximately 4.5 miles between Highway 174 and the South Edisto River/St. Helena Sound. The town has been developed as a permanent and seasonal residential area with limited commercial development. Edisto Beach State Park occupies approximately 1,255 acres of the island and is structured around a dense live oak and maritime forest. It offers ocean and marsh side camping sites, as well as cabins, picnic areas, and nature and hiking trails.

The park had approximately 312,640 recorded visitors in 2012. Its beachfront extends approximately 1.5 miles between Jeremy Inlet and Highway 174.

Competing Resources:

Edisto Beach provides a variety of recreational activities including sunbathing, swimming, beachcombing, walking/jogging, cycling, fishing, surfing, sand sculpting, beach games and has become increasingly popular for weddings, parties and receptions. The Town has 4.67 miles of bike/walking trails integrated throughout the town that provide recreational activities for the public. Competing resources are other beaches such as Isle of Palms, Hilton Head, Sullivan Beach, Kiawah Island and Folly Beach. However, Edisto Beach is one of the few remaining un-commercialized, family-oriented beaches on the coast of South Carolina.

Benefit Evaluation:

In order to determine the recreation benefits of the tentatively selected plan an economic value must be placed on the recreation experience at the Edisto Beaches. By applying a unit day value to estimated use, an approximation is obtained that will be used to estimate project recreation benefits. For this analysis, general unit day values (UDV) are used to determine the economic value of recreation at Edisto Beach. UDV are administratively determined values which represent the NED recreation values for typical types of recreation. Guidance for their use is provided by Engineering Regulation 1105-2-100.

Current Visitation:

In 2012, the Town of Edisto Beach area had approximately 371,000 beach visitors. Traffic counts combined with estimated rentals determine expected visitors per year. This estimate is based on data provided by the Town of Edisto Beach. Visitation is generally constrained by availability of beach area only during peak days and is not limited at other times of the year. The peak recreation season is Memorial Day through Labor Day. Recreational visitation reaches a peak four times a year. These times are Spring Break, Memorial Day, Independence Day and Labor Day. Table 1 shows annual visitation from 2009 to 2012.

Table 25: Edisto Beach Annual Visitation

Year	Visitation
2009	245,000
2010	297,500
2011	350,000
2012	371,000

Parking and Access:

Public parking along the right of way in the Town of Edisto's streets is permitted by the Town. There are 113 on street parking spaces. There are 24 public access points that provide an additional 214 parking spaces. There are two private parking areas that provide additional parking; Pavilion Pier and the facility at the Wyndham Resort. The State Park also provides some parking for those visitors who park at the State Park and recreate on the Edisto Beaches outside of the park limits due capacity constraints at the park. Edisto Beach has 206 off-street parking spaces with an additional 113 on street parking spaces, these totals 319 designated parking spaces. Some of the remaining beach capacity could be used by the public dropping visitors off without parking, and residence and vacationers of Edisto Beach.

There are a total of 38 public access points, excluding the State Park, in Edisto Beach that lie along Palmetto Boulevard, Point Street and Yacht Club Road. Each access is marked with a highly reflective blue sign and numbered 1 thought 38 for notification of where the accesses are located. The average width of each access is 50 feet with an average distance between each access point of 400ft. Maintenance is performed on an annual basis at each access point by volunteer groups and town personnel. There is a private access area that serves Wyndham Resorts, but the right of way leading to the facility is owned by the Town. This facility is accessible to the public and contains a drop off area for a tram shuttle, concessions, showers, restrooms, handicap access, among other amenities.

According to ER1105-2-100, reasonable access is access approximately every one-half mile or less. Each access point is identified with "Beach Access" signs. The 38 access points are exclusive of the State Park. Provisions of reasonable public access rights of ways are present in

Edisto Beach. The following table shows the beach access location and facilities at each location.

Table 26: Edisto Beach Parking and Access

	PARKING & ACCESS								
Location	Feet Between Access Points	Sign Number	Pedestrian Only	Boardwalk	Walkover	Off-Street Parking	On-Street Parking	Handicapped Access	Signage
Coral St	842	1					x		x
Fenwick St	807	1a	x				x		x
Mary St	829	2	x				x		x
Whaley St	791	3	x				x		x
Matilda St	797	4	x				x		x
Cupid St	787	5	x				x		x
Atlantic St	802	6	x				x		x
Portia St	797	7	x				x		x
Dawhoo St	300	8				6	x		x
Cheehaw St	288	9				11	x		x
Osceola St	290	10				8	x		x
Byrd St	300	11	x				x		x
Nancy St	302	12				5	x		x
Thistle St	317	13				11	x	x	x
Chancellor St	300	14	x				x		x
Dorothy St	300	15	x				x		x
Marianne St	284	16				10	x	x	x
Lybrand St	300	17		x	x	10	x	x	x
Catherine St	300	18	x	x			x		x
Mitchell St	303	19			x	15	x	x	x
Baynard St	300	20	x		x	2	x	x	x
Edings St	300	21		x	x	7	x	x	x
Jenkins St	300	22				4	x	x	x
Seabrook St	300	23				10	x	x	x
Murray St	300	24				10	x	x	x
Holmes St	308	25				10	x	x	x
Loring St	300	26				10	x	x	x
Laroche St	300	27				10	x	x	x
Neptune St	907	28	x				x	x	x
Billow St	300	29	x	x			x		x

	PARKING & ACCESS								
Location	Feet Between Access Points	Sign Number	Pedestrian Only	Boardwalk	Walkover	Off-Street Parking	On-Street Parking	Handicapped Access	Signage
White Cap St	350	30				9	x	x	x
Edisto St.	387	31				6	x	x	x
Mikell St.	599	32		x		2	x	x	x
Townsend St.	1249	33	x				x		x
Louise St.	600	34	x	x			x		x
Ebb Tide St.	1425	35		x	x	4	x	x	x
Yacht Club Rd.	865	36	x	x			x		x
Yacht Club Rd.		37		x		2	x		x

Beach Area and Capacity:

Beach area acts as a constraint on the number of visitors that will visit the Edisto Beaches during peak days. To measure the beach capacity of the existing condition, the existing condition beach profile was used to calculate the total area that can be used for recreation. The total length of the project in which beach visitors can recreation on the existing berm is 27,128 feet. The length is then multiplied by the berm width of the given reach to determine the total area of that reach. The total area of all reaches in which recreation occurs for the Without project condition is 944,965 square ft. It is assumed that each visitor will require 100 square feet of beach each day. In the Without project condition, Edisto Beach parking areas are capable of supporting 9,450 users per day. In the With Project condition, the total beach area is 956,371and the beach is capable of supporting 9,565 visitors per day. Assuming an average of 4 persons per automobile and a turnover rate of 1.5 cars per parking space per day because some visitors spend only part of the day at the beach, the 319 parking spaces will support visitation of about 1,914. Besides the parking spaces and spill over from the State Park, Edisto Beach has the potential to receive many more visitors. The entire Town of Edisto has the capability of walking to the beach. The structures are located such that the distance for a walk to the beach on the island is a half mile or less. There are about 2,400 residences in walking distance to the beach.

Without and With Project Values:

The UDV are determined using a point system that takes into account the following factors: recreation experience, availability of opportunity, carrying capacity, accessibility, and environmental (esthetics) quality. A good deal of judgment is required in the assessment of point values. A group of five planning professionals and experts of the study area made independent judgments of the UDV values which were averaged. The differences in the values were applied to the estimated visitation. The difference in the Without and With project values of recreation determine the NED recreation benefits. The source of the value of recreation is obtained from the Economic Guidance Memorandum, 13-03, Unit Day Values for Recreation for Fiscal Year 2013.

Point System:

Recreation Experience. Under the Without project condition, Edisto beaches have several general recreation activities including swimming, boating, picnicking, crabbing, shrimping, kayaking and sunbathing, providing a recreation experience equivalent to 16 points out of 30. In the With project condition, it is assumed the beach area will provide for a better recreation experience due to the beach area being increased and the project being maintained to a certain template and received a rating of 28.

Availability of Opportunity. Availability of opportunity is considered high because there are not similar beaches within 30 minutes to one hour driving time. Edisto Beach is rare because it remains one of the few family-oriented, gently developed beaches in South Carolina. Because there are not a large number of competing recreation opportunities, this category was 16 points out of 18 in the Without project condition and 18 points in the With project condition.

Carrying Capacity. The carrying capacity of the facilities is considered adequate to conduct recreation during peak demand days, although facilities can certainly be strained at those times. The carrying capacity is the same in the Without and With project condition and a rating of 13 out of 14 was given to both conditions.

Accessibility. The project is considered very accessible, with high quality roads to the site and 38 access points within the site. This equates to 13 points out of a total of 18 both for the With and Without project conditions since the conditions will not change.

Environment. A rating of 4 out of a total of 20 points was awarded because the current aesthetic value is of average quality. Under the With project condition, it was felt that the additional beach width would result in an increase in esthetic value during peak days. It is expected the aesthetic quality of the beach will be enhanced as a result of the project and will not degrade over time due to erosion as would occur in some areas in the Without project condition and a With project condition value of 15 is applied.

The UDV point totals convert to a recreation value of $9.02 in the Without project condition and the $10.57 in the With project condition per Economics Guidance Memorandum, 13-03, Unit Day Values for Recreation, Fiscal Year 2013. The difference in the Without and With project conditions general recreation values is $1.55. The dollar values for UDV scores of 62 and 85 were obtained by interpolating between 60 and 70 in the Without project condition and 80 and 90 in the With project condition. Table 3 shows the UDV for Edisto Beach.

Table 27: UDV for Edisto Beach

Criteria	W/O Project Points	W/ Project Points
Recreation Experience	16	28
Availability of Opportunity	16	18
Carrying Capacity	13	13
Accessibility	13	13
Environment (Esthetics)	4	15
Total Points	62	85
General Recreation Value	$9.02	$10.57

Because Edisto Beach is already a public beach, there will be no new visitation based on the beach becoming accessible to the general public due to a Federal project. It is assumed that the 2012 visitation is indicative of future visitation given that the Edisto Island beach front is almost fully developed and generally there is no more room for parking areas. However, it is recognized that visitation could be much higher than reported due to the homes and vacation rentals being in walking distance from the beach and spill over from the State Park. Applying the unit day values of $9.02 in the Without project condition of 62 total points and $10.57 for the With project condition of 85 points results in annual recreation benefits of approximately $573,200. Table 4 shows the benefit to cost ratio analysis with recreation benefits.

Table 28: Summary of Benefits and Cost

Average Annual CSDR Benefits	$ 2,482,600
Average Annual Recreation Benefits	$ 573,200
Total Average Annual Benefits	$ 3,055,800
Total Average Annual Cost	$ 1,804,900
Benefit-to-Cost Ratio	1.7
Net Benefits	$ 1,250,860

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX C

STRUCTURE INVENTORY ANALYSIS

<u>EDISTO BEACH STRUCTURE INVENTORY ANALYSIS</u>

<u>Colleton County, SC</u>

For

Charleston District

Prepared By:

Andrew Capwell

Staff Appraiser

Real Estate Appraisal Branch

For

U.S. Army Corps of Engineers

Savannah District

100 West Oglethorpe Avenue

Savannah, Ga. 31401

INTRODUCTION

On August 13, 2010 a Structure Inventory Analysis was requested to be conducted by the Mobile and Charleston Districts for Edisto Beach, South Carolina. Edisto Beach last tax assessment was January 01, 2005. The analysis will be based on Current Recorded Sales compared to 2005 Tax Assessed Values for beachfront homes, near shore homes, interior homes, vacant beach front land, vacant near shore land and vacant interior land.

LOCATION

The Town of Edisto Beach is in southeastern South Carolina, approximately 45 minutes southwest of the City of Charleston. Bounded by Charleston County to the North, Saint Helena Sound to the southwest, and the Atlantic Ocean to the east, Edisto Beach is the barrier island part of Edisto Island which is located in Colleton County.

According to the Edisto Beach Management Plan conducted by the Planning Services Group, Inc., Edisto Beach's beachfront is 4.0 miles (6.4 km) long, and a maximum width, including both high ground and marsh, of 1.5 miles (2.4 km). There are 920 acres of high land and 464 acres of salt marsh. The island is roughly 2.16 square miles, and elevations on the island range from sea level to 20 feet above sea level (9.1 m).

NEIGHBORHOOD CHARACTERISTICS

Edisto Beach is primarily residential in the form of single and multi-family dwelling units. There is one gated community which was built as a planned unit development. Commercial development is limited and includes a grocery store, restaurants, service station and tourist related retail.

SCOPE OF WORK

The U.S. Army Corps of Engineers will use the current sales within the study area, apply cost approach information using the *Marshall & Swift Residential Cost Handbook* to the current sales and compare them to the 2005 Tax Assessors values to determine a Factor to bring the tax values up to the current sales prices. Information concerning the study area will be gathered from the Colleton County Tax Assessors Office, The Town of Edisto Beach and the Multi-Listing Service. To determine the age and physical characteristics of homes in the study area the Multi-Listing Service and Property Tax Records were used. There were no physical inspections conducted on the individual properties. Only a drive-by inspection of the area was performed.

TERMS

Ratio: The ratio as used in this report refers to the current sales price divided by the 2005 total tax appraised value. The quotient represents the percentage the sales price is from each tax appraised value.

Factor: The Factor is that percentage which is applied to the current taxed appraised value that when multiplied is equal to the sales price. In this report, a single factor will be applied to a section of properties to achieve an overall *Ratio* near the target.

Cost Approach: A set of procedures through which a value indication is derived for real property improvements by estimating the current cost to construct a replacement for the existing structures, and then deducting physical depreciation from the replacement cost; and adding the estimated land value.

Replacement Cost: The estimated cost to construct, at current prices as of the effective appraisal date, a building with utility equivalent to the building being appraised, using modern materials and current standards, design, and layout.

ASSUMPTIONS AND LIMITING CONDITIONS

This report was prepared for the internal use of my employer, the U.S. Army Corps of Engineers. This report is only an effort to statistically update current Edisto Beach, South Carolina structural values and is not considered an appraisal or appraisal report. Therefore, the provisions of USPAP are not applicable in this situation.

DETERMINATION OF THE "RATIO" AND "FACTOR" FOR THE STRUCTURE VALUES

To determine a *Factor* to bring the tax values up to the current sales prices the Multi-Listing Service and the County Tax Assessors Records were used. The County Tax Records have not been re-assessed since January 01, 2005. The number of current sales included: 44 single family residential, 5 condominiums and 16 vacant land sales making a total of 65 current sales. The sales dates included the past prior 12 months to present.

Sales Price/County Tax Appraised Value = Ratio. The quotient (or Factor) represents the percentage the sales price is from the Tax appraised value.

After calculating the Ratio of the 65 current sales the **Factor = 1.27**

IMPROVED SALES

PIN	Imp Type	SaleDT	Sale Price	County Tax Value	Ratio	Location
356-15-00-105	SFR	2010	385000	464200	0.83	Access
354-08-00-464	SFR	2010	215000	250500	0.86	Golf
357-05-00-204	SFR	2010	290000	329400	0.88	Access
356-15-00-149	SFR	2010	590000	612000	0.96	Access
354-08-00-417	SFR	2010	235000	240500	0.98	Golf
357-09-00-099	SFR	2009	250000	240800	1.04	Access
354-08-00-415	SFR	2009	255000	240500	1.06	Golf
354-12-00-252	SFR	2010	415000	384400	1.08	Access
357-03-00-041	SFR	2009	540000	495900	1.09	Ocean
357-09-00-127	SFR	2009	280000	255700	1.10	Access
354-12-00-201	SFR	2009	399000	360800	1.11	Golf
357-03-00-055	SFR	2010	610000	545400	1.12	Ocean
357-03-00-063	SFR	2009	496000	442400	1.12	Ocean
357-06-00-051	SFR	2010	303000	270000	1.12	Access
354-03-00-088	CN	2010	232900	205500	1.13	Ocean
354-03-00-120	CN	2009	229000	200500	1.14	Ocean
354-03-00-091	CN	2010	195000	170500	1.14	Ocean
357-05-00-031	SFR	2009	305000	263300	1.16	Access
357-05-00-074	SFR	2010	400000	344100	1.16	Access
354-12-00-261	SFR	2009	465000	398400	1.17	Access
357-09-00-120	SFR	2009	290000	247900	1.17	Access
356-15-00-157	SFR	2010	505000	429100	1.18	Access
357-03-00-104	SFR	2009	570000	484000	1.18	Access
357-03-00-021	SFR	2009	530000	444600	1.19	Access
356-15-00-070	SFR	2010	335000	279300	1.20	Access
357-06-00-095	SFR	2009	365000	302700	1.21	Access
356-15-00-099	SFR	2009	625000	516900	1.21	Ocean
354-12-00-020	SFR	2010	275000	224700	1.22	Access
356-15-00-074	SFR	2009	380000	305800	1.24	Access
357-06-00-130	SFR	2009	350000	281600	1.24	Access
357-09-00-060	SFR	2010	530000	425000	1.25	Access
357-05-00-176	SFR	2009	349000	279800	1.25	Golf
354-16-00-056	SFR	2009	469900	376700	1.25	Access
357-03-00-034	SFR	2009	500000	400000	1.25	Ocean
357-06-00-055	SFR	2009	294000	233500	1.26	Access
354-08-00-114	SFR	2010	220000	170500	1.29	Interior
354-08-00-057	CN	2010	130000	100500	1.29	Golf
354-12-00-017	SFR	2010	855000	649000	1.32	Access
354-08-00-431	SFR	2010	325000	245500	1.32	Interior
357-09-00-137	SFR	2010	415000	311300	1.33	Access
357-02-00-196	SFR	2009	509000	373500	1.36	Access
354-08-00-110	SFR	2009	267500	195500	1.37	Golf
354-08-00-184	CN	2010	144500	105500	1.37	Golf
354-12-00-292	SFR	2010	412000	295800	1.39	Golf
357-09-00-046	SFR	2010	1035000	731300	1.42	Ocean
354-12-00-237	SFR	2010	245000	170500	1.44	Golf
354-08-00-012	SFR	2009	277000	138500	2.00	Golf
357-05-00-084	SFR	2010	835000	320000	2.61	Access
354-12-00-095	SFR	2010	595000	190000	3.13	Access
Average					**1.27**	
Median					**1.20**	

VACANT LAND SALES

PIN	Imp Type	SaleDT	Sale Price	County Tax Value	Ratio	Location
357-05-00-037	Land	2010	150000	225000	0.67	Marsh
357-06-00-029	Land	2010	425000	557800	0.76	Ocean
354-12-00-185	Land	2010	200000	190000	1.05	Access
357-02-00-010	Land	2009	330000	300000	1.10	Creek
354-08-00-520	Land	2010	139000	125000	1.11	Golf
354-12-00-043	Land	2010	274000	245000	1.12	Access
354-12-00-316	Land	2009	118500	100000	1.19	Interior
354-03-00-165	Land	2010	89900	75500	1.19	Boat Slip
354-03-00-0188	Land	2009	85000	70500	1.21	Boat Slip
354-12-00-185	Land	2010	250000	190000	1.32	Interior
357-01-00-012	Land	2009	300000	225000	1.33	Access
357-05-00-250	Land	2010	200000	150000	1.33	Interior
354-08-00-405	Land	2010	240000	150000	1.60	Golf
354-03-00-207	Land	2010	113750	70500	1.61	Boat Slip
357-01-00-024	Land	2010	345000	210700	1.64	Creek
354-04-00-016	Land	2010	325000	175000	1.86	Creek
Average					**1.26**	
Median					**1.20**	

<u>DETERMINATION OF THE STRUCTURE VALUES USING THE COST APPROACH</u>

The data used in this analysis is the Taxed Appraised Values provided from the Colleton County Tax Office. In interviews with the staff, the methodology used to determine the appraised improvements values is the cost approach.

NOTE: The county records have not been updated since January 01, 2005.

To confirm the tax assessor's values to present values using the cost approach, I took a sample of 10 properties and manually calculated their replacement cost new, then added the 2005 tax land value, multiplying the land value by the Factor of 1.27. The result is the cost approach using the replacement cost new less physical depreciation. The source of information used to calculate the cost approach was the *Marshall & Swift* valuation service. This is a common cost services used by many real estate valuation professionals and is widely recognized as an authoritative cost source. The physical depreciation estimate for each sample property was derived from using the effective age from the physical depreciation table in Marshall & Swift.

The following are 10 different structures observed within the boundaries and how the structure values were determined.

COAST APPROACH

Property Address:	538 Oristo Ridge Road				
Quality	Avg				
Year Built	1998				
Typ Life Expectancy	60				
Effective Age	5				
		$ Rate	Size SF	RCN	
Base Rate		$119.59	2216	$265,011	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$24.20	400	$9,680	
Deck/Porch		$23.30	331	$7,712	
Other:				$15,000	
Lump Sum Items:				$5,125	
RCN				$302,529	
Location Factor				0.87	
Total RCN All Items				$263,200	
		% Depr.			
Less Physical Depreciation		4%		-$10,528	
RCN - Depr				$252,672	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$257,672	
Add Land Value				$171,450	
IND. Value by Cost Approach				$429,122	
Sales Price		2010		$412,000	
Sales Price / Cost Approach				0.96	
Sales Price / Factored Tax Value				1.10	
	295800				
	1.27				
	375666				
Factored Tax Value / Cost Approach				0.88	
	295800				
	1.27				
	375666				

COST APPROACH

Property Address:	1216 Nancy Street				
Quality	Avg				
Year Built	1974				
Typ Life Expectancy	60				
Effective Age	20				
		$ Rate	Size SF	RCN	
Base Rate		$122.00	1319	$160,918	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$16.15	1684	$27,197	
Deck/Porch		$23.30	556	$12,955	
Other:				$15,000	
Lump Sum Items:				$5,125	
RCN				$221,194	
Location Factor				0.87	
Total RCN All Items				$192,439	
		% Depr.			
Less Physical Depreciation		18%		-$34,639	
RCN - Depr				$157,800	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$162,800	
Add Land Value				$234,950	
Ind. Value by Cost Approach				$397,750	
Sales Price	2009			$350,000	
Sales Price / Cost Approach				0.88	
Sales Price / Factored Tax Value				0.98	
	281600				
	1.27				
	357632				
Factored Tax Value / Cost Approach				0.90	
	281600				
	1.27				
	357632				

COST APPROACH

Property Address:	2202 Myrtle Street				
Quality	Avg				
Year Built	1991				
Typ Life Expectancy	60				
Effective Age	10				
		$ Rate	Size SF	RCN	
Base Rate		$122.99	1386	$170,464	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
Garage/Carport		$16.15	1650	$26,648	
Deck/Porch		$23.30	432	$10,066	
Other:				$15,000	
Lump Sum Items:				$5,125	
RCN				$227,302	
Location Factor				0.87	
Total RCN All Items				$197,753	
		% Depr.			
Less Physical Depreciation		8%		-$15,820	
RCN - Depr				$181,933	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$186,933	
Add Land Value				$241,300	
Ind. Value by Cost Approach				$428,233	
Sales Price	2010			$415,000	
Sales Price / Cost Approach				0.97	
Sales Price / Factored Tax Value				1.05	
	311300				
	1.27				
	395351				
Factored Tax Value / Cost Approach				0.92	
	311300				
	1.27				
	395351				

COST APPROACH

Property Address:	2303 Murray Street				
Quality	Avg				
Year Built	1955				
Typ Life Expectancy	60				
Effective Age	30				
		$ Rate	Size SF	RCN	
Base Rate		$121.09	1140	$138,043	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport				$0	
Deck/Porch		$23.30	336	$7,829	
Other:				$9,375	
Lump Sum Items:				$5,125	
RCN				$160,371	
Location Factor				0.87	
Total RCN All Items				$139,523	
		% Depr.			
Less Physical Depreciation		31%		-$43,252	
RCN - Depr				$96,271	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$101,271	
Add Land Value				$190,500	
Ind. Value by Cost Approach				$291,771	
Sales Price	2010			$275,000	
Sales Price / Cost Approach				0.94	
Sales Price / Factored Tax Value				0.96	
	224700				
	1.27				
	285369				
Factored Tax Value / Cost Approach				0.98	
	224700				
	1.27				
	285369				

COST APPROACH

Property Address:	419 Palmetto Blvd				
Quality	Avg				
Year Built	1960				
Typ Life Expectancy	60				
Effective Age	30				
		$ Rate	Size SF	RCN	
Base Rate		$112.92	1401	$158,201	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport				$0	
Deck/Porch		$23.30	348	$8,108	
Other:				$9,375	
Lump Sum Items:				$5,125	
RCN				$180,809	
Location Factor				0.87	
Total RCN All Items				$157,304	
		% Depr.			
Less Physical Depreciation		31%		-$48,764	
RCN - Depr				$108,540	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$113,540	
Add Land Value				$431,800	
Ind. Value by Cost Approach				$545,340	
Sales Price	2009			$530,000	
Sales Price / Cost Approach				0.97	
Sales Price / Factored Tax Value				0.94	
	444600				
	1.27				
	564642				
Factored Tax Value / Cost Approach				1.04	
	444600				
	1.27				
	564642				

COST APPROACH

Property Address:	202 Jungle Road				
Quality	Avg				
Year Built	1986				
Typ Life Expectancy	60				
Effective Age	15				
		$ Rate	Size SF	RCN	
Base Rate		$110.27	1564	$172,462	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$16.15	400	$6,460	
Deck/Porch		$23.30	271	$6,314	
Other:				$9,375	
Lump Sum Items:				$5,125	
RCN				$199,737	
Location Factor				0.87	
Total RCN All Items				$173,771	
		% Depr.			
Less Physical Depreciation		12%		-$20,852	
RCN - Depr				$152,918	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$157,918	
Add Land Value				$209,500	
Ind. Value by Cost Approach				$367,418	
Sales Price	2009			$380,000	
Sales Price / Cost Approach				1.03	
Sales Price / Factored Tax Value				0.98	
	305800				
	1.27				
	388366				
Factored Tax Value / Cost Approach				1.06	
	305800				
	1.27				
	388366				

COST APPROACH

Property Address:	52 Windsor Court				
Quality	Avg				
Year Built	1986				
Typ Life Expectancy	60				
Effective Age	15				
		$ Rate	Size SF	RCN	
Base Rate		$131.50	1499	$197,119	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$13.25	816	$10,812	
Deck/Porch		$23.30	451	$10,508	
Other:				$9,375	
Lump Sum Items:				$5,125	
RCN				$232,939	
Location Factor				0.87	
Total RCN All Items				$202,657	
		% Depr.			
Less Physical Depreciation		12%		-$24,319	
RCN - Depr				$178,338	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$183,338	
Add Land Value				$165,100	
Ind. Value by Cost Approach				$348,438	
Sales Price	2009			$349,000	
Sales Price / Cost Approach				1.00	
Sales Price / Factored Tax Value				0.98	
	279800				
	1.27				
	355346				
Factored Tax Value / Cost Approach				1.02	
	279800				
	1.27				
	355346				

COST APPROACH

Property Address:	210 Jungle Road				
Quality	Avg				
Year Built	1983				
Typ Life Expectancy	60				
Effective Age	15				
		$ Rate	Size SF	RCN	
Base Rate		$117.84	1363	$160,616	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$16.15	400	$6,460	
Deck/Porch		$23.30	200	$4,660	
Other:				$9,375	
Lump Sum Items:				$5,125	
RCN				$186,236	
Location Factor				0.87	
Total RCN All Items				$162,025	
		% Depr.			
Less Physical Depreciation		12%		-$19,443	
RCN - Depr				$142,582	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$147,582	
Add Land Value				$203,200	
Ind. Value by Cost Approach				$350,782	
Sales Price	2009			$335,000	
Sales Price / Cost Approach				0.96	
Sales Price / Factored Tax Value				0.94	
	279300				
	1.27				
	354711				
Factored Tax Value / Cost Approach				1.01	
	279300				
	1.27				
	354711				

COST APPROACH

Property Address:	815 Cheehaw Street				
Quality	Avg				
Year Built	1970				
Typ Life Expectancy	60				
Effective Age	30				
		$ Rate	Size SF	RCN	
Base Rate		$126.31	892	$112,669	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport				$0	
Deck/Porch		$23.30	152	$3,542	
Other:				$18,750	
Lump Sum Items:				$5,125	
RCN				$140,085	
Location Factor				0.87	
Total RCN All Items				$121,874	
		% Depr.			
Less Physical Depreciation		31%		-$37,781	
RCN - Depr				$84,093	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$89,093	
Add Land Value				$228,600	
Ind. Value by Cost Approach				$317,693	
Sales Price	2009			$294,000	
Sales Price / Cost Approach				0.93	
Sales Price / Factored Tax Value				0.99	
	233500				
	1.27				
	296545				
Factored Tax Value / Cost Approach				0.93	
	233500				
	1.27				
	296545				

COST APPROACH

Property Address:	810 Dawhoo Street				
Quality	Avg				
Year Built	1977				
Typ Life Expectancy	60				
Effective Age	30				
		$ Rate	Size SF	RCN	
Base Rate		$117.84	1447	$170,514	
Adjustments:					
Floor				$0	
Roof				$0	
Seismic				$0	
				$0	
				$0	
Garage/Carport		$16.15	400	$6,460	
Deck/Porch		$23.30	200	$4,660	
Other:				$18,750	
Lump Sum Items:				$5,125	
RCN				$205,509	
Location Factor				0.87	
Total RCN All Items				$178,793	
		% Depr.			
Less Physical Depreciation		31%		-$55,426	
RCN - Depr				$123,367	
Add AS IS Value of Site Imps.				$5,000	
Total Depr Imp Value				$128,367	
Add Land Value				$254,400	
Ind. Value by Cost Approach				$382,767	
Sales Price	2009			$303,000	
Sales Price / Cost Approach				0.79	
Sales Price / Factored Tax Value				0.88	
	270000				
	1.27				
	342900				
Factored Tax Value / Cost Approach				0.90	
	270000				
	1.27				
	342900				

SUMMARY OF REPLACEMENT COST NEW LESS PHYSICAL DEPRECIATION

PIN#	Address	Sales $ / Cost Approach	Sales $ / Factored Tax Value	Factored Tax Value / Cost Approach
352-12-00-292	538 Oristo Ridge Rd	0.96	1.10	0.88
357-06-00-130	1216 Nancy Street	0.88	0.98	0.90
357-09-00-137	2202 Myrtle Street	0.97	1.05	0.92
354-12-00-020	2303 Murray Street	0.94	0.96	0.98
357-03-00-021	419 Palmetto Blvd	0.97	0.94	1.04
356-15-00-074	202 Jungle Road	1.03	0.98	1.06
357-05-00-176	52 Windsor Court	1.00	0.98	1.02
356-15-00-070	210 Jungle Road	0.96	0.94	1.01
357-06-00-055	815 Cheehaw Street	0.93	0.99	0.93
357-06-00-051	810 Dawhoo Street	0.79	0.88	0.90
Average		0.94	0.98	0.96
Median		0.96	0.98	0.96

CONCLUSION: AVERAGE AND MEDIAN

"Sales Price / Cost Approach" = Sales price is under the cost approach (<1.00) which means the cost approach is too high, possibly due to the land value estimates.

"Sales Price / Factored Tax Value" = Sales price is under the factored tax value (<1.00) which means the 1.27 factor might be too high.

"Factored Tax Value / Cost Approach" = 1.27 factored tax value is slightly less than the calculated cost approach (<1.00) which implies the cost approach might be too high, possibly due to the land value estimates.

Overall, the different ratio comparisons are close enough to 1.00 for the purpose of this analysis. Some ratios show the land value (factored) may be too high. Others show the Marshall and Swift cost approach may be too high. Most weight is placed on the original improved and vacant land sales ratio on pages 5 and 6 which support the original 1.27 average factor.

Attached is a spreadsheet showing all tax appraised values for each PIN and property record card from the pdf file that was supplied by SAM and SAC on the list of 530 tax parcels given in the various reaches. There are a number of PINs with no improvement values on the property record card, there the "RCN less Phys Depr Tax Assessor" column will be blank.

DETERMINATION OF THE Near Shore Land Values

To compare the tax assessor's values to present values, I took a sample of 12 recent land sales and manually calculated their cost per square foot. The source used was from the Multi-Listing Services. The following are 12 different land sales within the boundaries and how the price per square foot was determined.

FORMULA: Sales Price / Lot Size = Price Per Square Foot

Using the recent vacant land sales calculations the average price per square foot is **$19.76.**

Using the recent vacant land sales calculations the median price per square foot is **$16.78.**

LAND: PRICE PER SQUARE FOOT

PIN#	Address	Sales $	Lot Size	$ Per Sq Ft
354-12-00-316	B3 King Cotton Rd	118,500	11,326	$10.46
	B5 Oristo Ridge Rd	115,000	10,890	$10.56
357-05-00-250	74 Rice Lane	200,000	18,292	$10.93
357-05-00-037	1405 Jungle Rd	150,000	10,890	$13.77
357-02-00-010	505 Jungle Shores	330,000	21,780	$15.15
354-08-00-520	2 Club Cottage Rd	139,000	9,148	$15.19
354-12-00-185	3107 Myrtle Street	200,000	10,890	$18.37
354-08-00-405	7 Heron Cove	240,000	10,890	$22.04
354-12-00-185	3107 Myrtle Street	250,000	11,326	$22.07
354-12-00-043	2404 Murray Street	274,000	10,890	$25.16
357-01-00-012	3901 Lybrand Street	300,000	9,148	$32.79
357-06-00-029	710 Palmetto Blvd	425,000	10,454	$40.65
Average				$19.76
Median				$16.78

PUBLIC BEACH ACCESS BOARDWALKS

The source used to determine the number and locations of the Beach Access Boardwalks was the Town of Edisto Beach Local Comprehensive Beach Management Plan. There are a total of 9 boardwalks. I physically inspected the boardwalks. The dimensions of the boardwalks are generally 6’ X 40’ making them a total of 240 square feet. The following table the 9 boardwalk locations.

BOARDWALK LOCATIONS AND DIMENSIONS

Location	Dimensions	Total Square Feet
Lybrand Street	6' X 40'	240.00
Catherine Street	6' X 40'	240.00
Edings Street	6' X 40'	240.00
Billow Street	6' X 40'	240.00
Mikell Street	6' X 40'	240.00
Louise Street	6' X 40'	240.00
Ebb Tide Street	6' X 40'	240.00
Yacht Club Road	6' X 40'	240.00
Yacht Club Road	6' X 40'	240.00

CONCLUSION

In conclusion, to update the current tax values, the quotient (or Factor) for the percentage the tax value is from the current sale price was determined, the structure values using the cost approach were determined, compared the tax assessor's values to present values, and determined the number, dimensions and locations of the beach access boardwalks.

After analyzing extensive sales data, county data, assessor's interviews, and applying the Marshall & Swift Cost Handbook, it is the appraiser's opinion the Edisto Beach Structure Inventory Analysis is as follows:

The county appraised tax values require a factor of **1.27** to equate to the current sales data, which reflects the current RCN less depreciation plus land value.

The recent vacant land sales calculations the **average** price per square foot is **$19.76.**

The recent vacant land sales calculations the **median** price per square foot is **$16.78.**

The Structured Inventory Analysis attached shows a factored RCN less physical depreciation improvement total = **$101,836,982**

Andrew W. Capwell

Andrew Capwell Date: 9/2/2010

U.S. Army Corps of Engineers

Savannah District

Staff Appraiser

Michael V. Lawless

Michael V. Lawless Date 9/2/10

U.S. Army Corps of Engineers

Savannah District

Chief Appraiser

Typically beach front scene

Typical beach front houses

Typical walkovers -

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX D
GEOTECHNICAL ENGINEERING

Appendix D: Geotechnical Analyses

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1.0 INTRODUCTION

In order to provide a suitable amount of beach quality sand for the Edisto Beach Shore Protection Project, a Geotechnical analysis of potential borrow sources was performed. It is believed that between 10 million cubic yards and 20 million cubic yards of beach quality sand is required to me the 50 year needs of this project.

A contract was executed with HDR Engineering, Inc of the Carolinas (HDR) to perform the geotechnical investigations and analyses. Coastal Science & Engineering (CSE) was hired by HDR due to the extensive knowledge of the area and previous investigations performed in the Edisto Beach area. The work was to be done in 3 phases.

Phase 1 work included:

• Delineation of a sand search area based on previous experience with nourishment projects at Edisto Beach (CSE 2003, 2006).

• Collection of 38 initial borings on a coarse grid, with four additional boring sites visited and characterized. Core recovery was attempted but not successful at the four sites.

• Logging and sampling of all cores using standard methodology.

• A low-resolution bathymetric survey of the sand search area.

• Collection of native beach samples for native sediment quality analysis.

Phase 1 work was focused on locating and delineating offshore area(s) that may provide at least 20 million cubic yards of beach-quality sediment meeting or exceeding federal criteria for sediment compatibility. Phase 2 used results from Phase 1 to achieve higher resolution data and to refine the potential borrow area(s). Out of 40 boring locations occupied and attempted, an additional 39 borings were obtained in Phase 2. The results from Phase 1 and Phase 2, including:

• Location of the sand search area and the 77 borings obtained in both phases.

• Sediment descriptions for all cores collected.

• Grain-size distributions and statistical parameters for sediment samples using graphical and moment measures.

• Core photos and logs recorded by an SC-registered professional geologist.

• Bathymetric cross-sections showing the location and depth of recovery of cores along the transect.

• Isopach maps of mean grain size, mud content, and shell content.

• High-resolution bathymetric model of sand search area based on a detailed bathymetric survey with 200-foot (ft) line spacing.

• Native beach sediment descriptions and statistics.

• Overfill factors (RA) for sediment-compatibility analyses using two native beach sediment-size distributions (scenarios).

• Isopach maps of sediment recovery depth and sediment compatibility estimates using the overfill factor (RA).

• Alternate borrow area delineations and estimated volumes available for various sediment-compatibility scenarios.

Phase 3 was performed to better delineate the bathometry of the ocean bottom in the vicinity of Edisto Beach and to locate potential sources of beach quality sand and to determine future boring locations if additional beach quality sand is necessary. Phase 3 work included:

• Perform a bathymetric survey from roughly the North Edisto River and Seabrook Island in the north to the South Fork Edisto River and Pine Island in the south. This area measures approximately 52.5 square miles in size.

• Designate proposed locations of additional borings in the offshore area when may yield additional sources of beach quality sand that will be drilled in the future if additional volume is necessary.

2.0 GEOLOGIC SETTING

The Edisto Beach borrow survey area is located offshore the modern South Edisto River, South Carolina; one of several tide dominated drainage channels and passages between barrier islands in the center of a large, curved, embayment called the Georgia Bight that stretches from Myrtle Beach, South Carolina in the north to St. Marys River, Florida in the south. To the west, along the coast, are a series of drumstick barrier islands, and their marsh land lagoons that first formed about 40,000 years ago with higher sea levels and then again over the last 6,000years with Holocene sea level rise and continental shelf transgression (Booth et al. 1999). The survey area is 1.2 to 2.7 statute miles (1.9 to 4.3 kilometers) offshore in 3 to 15 feet of water (1to 3 meters), on the “inner” shelf. To the east and extending offshore, a large expanse of continental shelf gradually slopes to the shelf break located 75 statute miles (120 kilometers) offshore, where coastlines were at full glacial times.

The Georgia Bight is referred to as a “passive” continental margin meaning that it is not tectonic or isostatically influenced, although evidence for isostasy farther from the ice margins than expected seems to be gaining consensus—even as far south as the Project Area in South Carolina(Baldwin et al. 2006; Colquhoun et al 1995;6). The

Georgia Bight is the result of "paleooceanographic processes" (Garrison et al. 2012:109) which is to say regression and transgressionover several cycles of glaciation and deglaciation; exposing, then flooding, and creatingpatterned paleolandscape settings formed from reworking and development of marine derivedand terrestrially derived sediments. These glacial-interglacial "couplets"—11 over the past 2.8 million years—are caused by Earth orbit parameters (Emiliani et al. 1975), but it is only the last,"Flandrian," latest Pleistocene-early Holocene melting of huge expanses of glaciers andconcomitant transgression of the continental shelves by rising sea levels that is of concern forthis Project Area. This is because the earliest vestiges of human occupation of the region,outlined below, are constrained to these times. Basically, glacial melting started globally about17,000 calibrated years before present (calYBP), slowed substantially by 6,000 calYBP, and has fluctuated in relatively minor ways (geologically) since. Sea levels for this project are discussed in more detail below. The continental shelf of the Georgia Bight is covered with a significant amount of transgressive lag deposits in the form of a marine sediment bed drape. Ravinement (erosion) is dominant during transgression, meaning that terrestrial deposits are truncated and redeposited into marine dominated sediments with sea level rise.

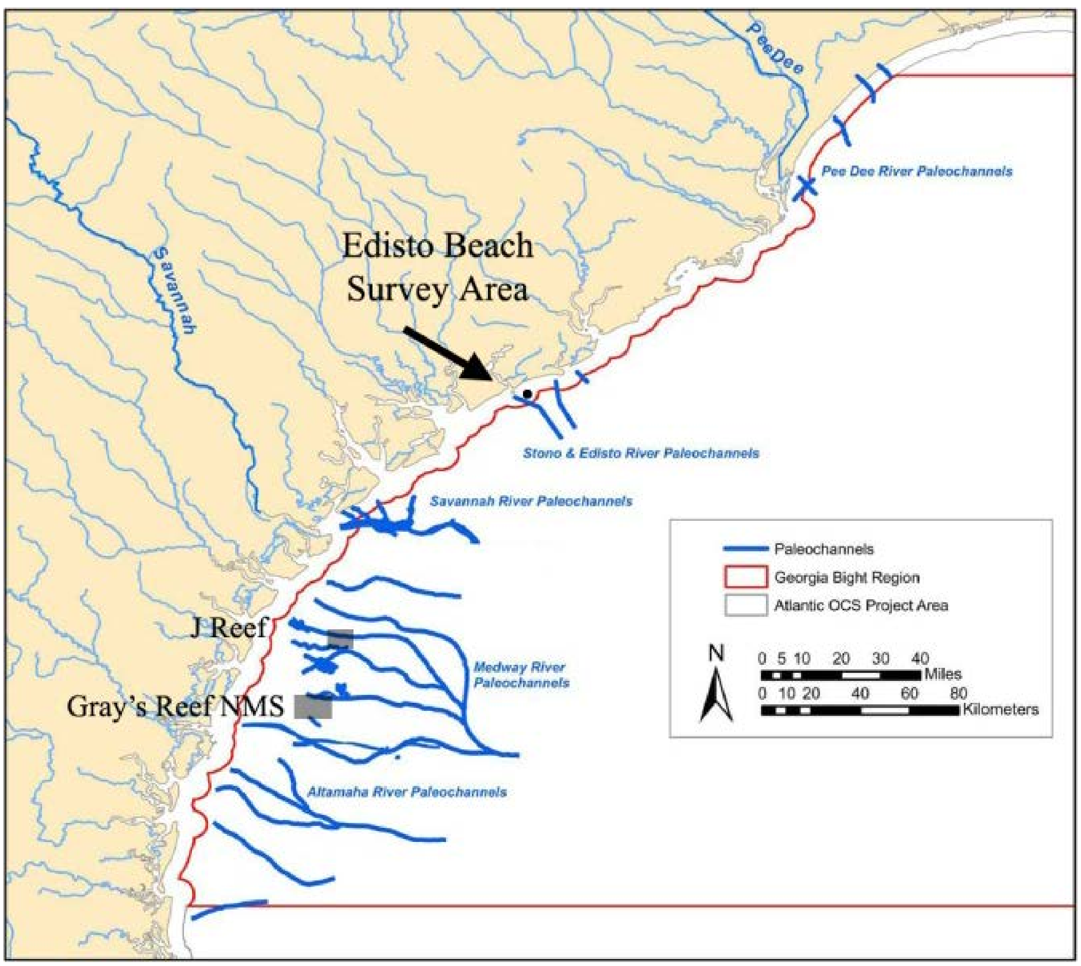


Figure D.1. A portion of the Georgia Bight's known Paleochannels, J Reef and Gray's Reef and the location of the Edisto Beach survey area.

Much of the Georgia Bight is covered with a 1- to 2-meter (thin) veneer of sandy sediments (Harris et al. 2005; Garrison et al. 2012). These are the "… eroded relicts of earlier subaerial coastal landforms characterized by dunes, wetlands, coastal rivers and forest much like today" (Garrison et al. 2012:109). These sediments have been reworked within the sand and shell marine dominated sediments that form the "palimpsest sand sheet" that blankets the continental shelf. This sand sheet is also reworked and moved by bottom currents generated by storms, tides, and wind depending.

These large areas of sand offshore are interspersed with rocky outcrops of "harbottom" (Garrison et al. 2012:111) that are Miocene- and Pliocene-aged limestones scattered as erosional remnants, ledges, and "ramps." Some of these features indicate weathering in subaerial (exposed) conditions, including evidence for stream erosion and karst formation (Garrison et al. 2012:111). Notches in the Pliocene-aged Raysor Formation at the 20-meter isobath, indicate a still stand, but its age of formation is unknown. These limestone outcrops are the main geomorphic features that occur in the Georgia Bight, some having live bottoms like Gray's Reef and J Reef shown in Figure D.1, indicating sustained exposure of the outcrop.

Other geomorphic features more relevant to the Edisto Beach study area include Pleistocene - and Holocene-aged shoal complexes made up of silt to gravel-sized sediments of terrigenous origin, abundant shell, and areas of dispersed peat (Sexton et al. 1992). The seaward relief of these features can be steep, with the near-coastal portions less of a slope. The shoal complex seaward of the Santee/PeeDee Delta is the largest—a deltaic deposit with shore parallel scarps that are evidence of pause or still stand during Holocene sea level rise. The islands are supposed to be migrating along with sea level rise, but abandoned examples could be expected given the magnitude and rapidity of some sea level rise estimates.

Sources of terrigenous sediments are the rivers draining the coastal plain, including reworking from previous high stand materials as parent materials for subaerial pedogenesis and landforms, with reworking again with Holocene transgression. Sediment packages build up in the lagoon on the lee side of the islands, and if those were preserved offshore, they could be expected to retain stratigraphic integrity and be at or near locations of human activities and refuse.

Drowned coastal stream and river paleochannels occur, but most are truncated and buried under the sand sheet drape such that they are not usually apparent on the surface in the bathymetry. Therefore, they cannot be adequately remotely sensed with bathymetric or sidescan sonar devices; rather, they need be remotely sensed with seismic subbottom profiler devices (Baldwin et al. 2006). Studies by Garrison et al. (2008) and others (Baldwin et al. 2006; Harris et al. 2005) confirm that these paleochannels are buried, albeit shallowly, under the reworked marine sediment drape cover (Garrison et al. 2012). Baldwin et al. (2006) used a dense pattern of subbottom profiler lines over great space to reconstruct and offer ages for the paleochannels offshore South Carolina.

Figure D.1 above shows the Garrison et al. (2012) compilation of Geographic Information System (GIS) data for the Paleo-Altamaha, Paleo-Savannah, and Paleo-Meway rivers offshore Georgia, and the Stono-Edisto and Pee Dee paleochannels offshore South Carolina. Several generations of the ancestral Pee Dee River system have been mapped beneath and along the coast and inner continental shelf revealing a complex pattern of paleochannels of different ages (Baldwin et al. 2006). Figure D.1 also shows the location of the Edisto Beach study area. The Investigative Findings chapter of this document reports another channel segment vestige or segment.

During sea level low stands, drainage valleys are shallowly incised into the continental shelf andbackfilled with various sediment types, depending on local conditions and sea level rise and fall rates. Paleovalleys have backfilled during cyclic changes in sea level with sediment types ranging from estuarine muds to clean shelly sands (Harris et al. 2005 in Garrison et al. 2012:116). Quaternary paleochannels tend to be filled with muds, sandy muds, and muddy sands; whereas, tidally scoured paleochannels general contain clean shelly sands (Harris et al. 2005:511). Prior to 7,000 years ago, the islands would have been part of the mainland, hill-like ridges with valleys in between with tributary gullies cutting into the hills. The marshes surrounding the Project Area would have been drier swales. In a similar way, Garrison and Tribble (1981) model the paleolandscape of the marshland during the late Pliestocene-Early Holocene as grassland and savannas with non-tidal perched streams and possible spring connections. If these spring locations could be identified, there may be archaeological remains around them.

The age of a peat bed marking coastal marsh at Cracker Tom Marsh on St. Catherine's Island, Georgia was around 6,800 calYBP (Booth and Rich 1999; Rich and Booth 2011:134). But in the coastal plain s of the Project Area, archaeological sites are lacking in the middle Holocene (and earlier) age frame (Turck et al. 2011). Sites earlier than calYBP are either missing or possibly lovated in buried stratigraphic units buried by later Holocene transgression and sedimentary processes, or in the areas offshore that have been submerged. An exposed paleolandscape setting 28 feet below the river water level found in a St Augustine River study area confirms the potentials of this kind of buried archaeology. The radioactive age of an inplace stump there was 8,100 calYBP (7300 +/- 40 YBP ; Beta 36234: James, et al. 2012).

The earliest Holocene salt marsh in this newly submerged area, recently discovered at a location along the wouthwestern edge of St. Catherine's Island, has been radiocarbon dated to 4,060 plus or minus 50 YBP shell, United States Geological Survey (USGS) #WW1262. This provides the best available indication of when the island became isolated from the mainland (Booth et al. 1999:84) and probably the age at which the Edisto Beach study area was completely submerged.

The configuration of the survey area appears to be a paleobarrier feature transgressed by late Holocene sea level rise. Paleochannel margins, of late Pleistocene early

Holocene age, are prime locations for submerged pre-Contact archaeological sites and barrier-marsh coastal systems are likely draws to humans for a variety of resources.

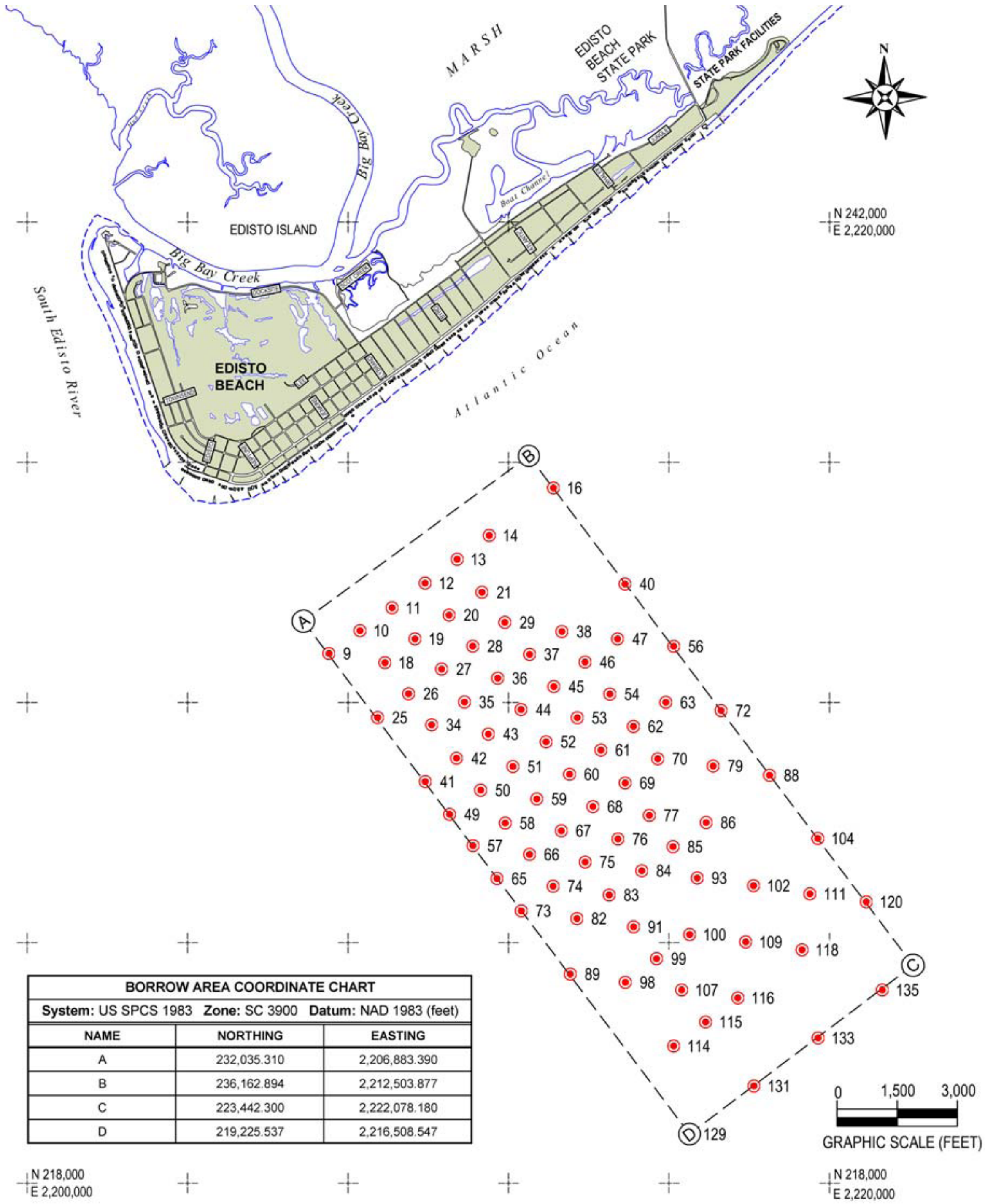
3.0 FIELD LABORATORY METHODS

CSE delineated an initial sampling grid on roughly 2,000-ft spacing based on previous sand search experience at Edisto Beach (CSE 1990, 1992; CSE-Baird 1996; CSE 2003, 2004, 2006). The sand search area targeted the seaward shoal of South Edisto River Inlet at the southern end of Edisto Beach. The shoal is part of the ebb-tidal delta of St Helena Sound and is known to contain mixed sand and shell sediments that are similar to the native beach (CSE 2006). The search area encompassed an area 7,000 ft by 16,000 ft (~4 square miles) paralleling the north side of the main channel of South Edisto River Inlet. Figure D.2 shows the location of the search area relative to Edisto Beach.

Phase 1 core locations were selected generally following a 2,000-ft grid within the search area. To maximize the number of cores containing beach-quality sediments, minor modifications to the grid were made when areas with incompatible sediments were found.

CSE occupied 42 boring locations within the search area during the Phase 1 scope of work. Four of these sites contained very coarse, shell lag deposits and coring was not possible with the equipment used. Grab samples were obtained from two of these sites for reference.

Phase 2 aimed to confirm potential beach quality sand in the vicinity of the shoal and to define boundaries between acceptable and unacceptable material. Combined with Phase 1, Phase 2 generally produced a 1,000-ft grid of borings covering the majority of the shoal adjacent to the South Edisto River Inlet. CSE occupied 40 locations in Phase 2, obtaining 39 borings and 1 grab sample (Fig D.2).



BORROW AREA COORDINATE CHART		
System: US SPCS 1983	**Zone:** SC 3900	**Datum:** NAD 1983 (feet)
NAME	**NORTHING**	**EASTING**
A	232,035.310	2,206,883.390
B	236,162.894	2,212,503.877
C	223,442.300	2,222,078.180
D	219,225.537	2,216,508.547

Figure D.2. Sand search grid over the shoals of South Edisto River Inlet beginning ~4,000 ft offshore of the south tip of Edisto Beach.

4.0 FIELD DATA AQUISITION

CSE used a custom designed coring system operated by personnel from the 22-ft research vessel R/V *Irie* during Phase 1 and from CSE's new shallow-draft research vessel R/V *Congaree River* for Phase 2 (Fig 3). This proprietary system (developed by CSE) uses a hydraulic pump, manifold, and three-inch aluminum core barrels to obtain relatively undisturbed cores up to 12-ft long in water depths from ~10 ft to 60 ft. Depending on the particular requirements of the project, the CSE coring system can be combined with a conventional vibracore device to aid in the collection of cores. CSE navigated to the coordinates of each preselected core site, anchored, and then lowered coring equipment over the side. Navigation and soundings were via Furuno Model 1850DF. Water depth, time, and personnel were recorded in a field notebook. Final elevations (top of core) were based on modeled bathymetry using data from a May 2008, high-resolution bathymetric survey (36 lines 15,000 ft long at 200-ft spacing for a total of ~102 miles of track lines, Fig 4). The Phase 1 low-resolution bathymetry involved a limited number of vessel track lines that ran the sample grid (1,000-ft spacing). Both bathymetric surveys were conducted using a Trimble R8 GNSS RTK-GPS combined with an ODOM HydroTrac™ precision echo-sounder mounted on the research vessel. Survey lines overlapped core locations; therefore, “modeled” elevations from the survey closely match true elevations

Upon completion of coring, the coring device was removed from the barrel, and the core barrel was cut 1 ft above the substrate. Cores were capped at the top, removed from the sea floor, then capped or sealed at the bottom before being hauled on board. Core recovery length was measured and recorded on board after removing the top cap and inserting a measuring rod to the top surface of the sediment. The topmost section of the core barrel was recut slightly above the top layer of sediment, then sealed for transport to the lab. Cores were stored in an upright position or inclined upward for transit. Sediment samples were collected in December 2007 along the native beach at 1,000-ft intervals from Big Bay Creek to Edingsville Beach. At each location, four samples were taken along the width of beach profile (transect) covering the toe of the dune, berm, beach face, and low-tide terrace (low-tide swash zone). Samples were recovered from the top ~20 centimeters (cm) of sand and analyzed for grain-size distributions and shell content. Mud content was considered insignificant (trace) and was not analyzed for the beach samples. Samples for transects 32-34 were located on Edingsville Beach.

5.0 LOGGING AND SAMPLE TESTING

At CSE’s lab, each core was split, logged, and sampled by a registered professional geologist and technical staff. For this project, one half of each core was preserved intact, sealed in clear plastic sleeves, and stored at CSE for eventual transfer to the US Army Corps of Engineers. The other half of each core was further divided into samples representing the typical lithology for the section and used for detailed sediment testing. Typically, two or three samples were taken from each core. CSE’s procedure was to take the entire section for analysis, mixing each unit well, then extract about 100-500 grams for analysis. Where significant fines were visible, one fraction of raw sample was reserved for determination of silt/clay percentage. Similarly, a fraction was reserved for determination of percent shell material (calcium carbonate percentage). The principal fraction was used for dry sieving. Standard laboratory procedures were followed, including:

• Drying unwashed samples.

• Weighing to 0.01 grams.

• Disaggregating clays and wet-sieving one fraction for the percent mud determination using a 230 sieve [0.0625-millimeter (mm) mesh].

• Redrying and reweighing one wet-sieved (saved) fraction (one ~20-gram fraction reserved for percent shell analysis).

• Dry sieving at 0.25 phi (φ) intervals (sand size range).

• Dry sieving at 0.5 φ to 1.0 φ intervals between -4.0 φ and -1.0 φ for selected samples having a significant coarse fraction (granule to medium pebble size range).

• Weighing each saved fraction on the sieves.

• Recording weights and analyzing grain-size distributions by standard method of moments and graphic techniques using custom software.

Sediment statistics were obtained through graphical and moment measures. Folk (1974) gives graphical measures of mean, standard deviation, skewness, and kurtosis, which use cumulative percentage values (the grain size at which a given percentage of the total sample is coarser) to calculate grain-size statistics.

Table D.1. Folk graphical method taken from Blott and Pye (2001)

Mean	Standard deviation	Skewness	Kurtosis
$M_Z = \frac{\phi_{16} + \phi_{50} + \phi_{84}}{3}$	$\sigma_I = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6 \cdot 6}$	$Sk_I = \frac{\phi_{16} + \phi_{84} - 2\phi_{50}}{2(\phi_{84} - \phi_{16})} + \frac{\phi_5 + \phi_{95} - 2\phi_{50}}{2(\phi_{95} - \phi_5)}$	$K_G = \frac{\phi_{95} - \phi_5}{2 \cdot 44(\phi_{75} - \phi_{25})}$

Sorting (σ_1)		Skewness (Sk_1)		Kurtosis (K_G)	
Very well sorted	<0·35	Very fine skewed	$^+0 \cdot 3$ to $^+1 \cdot 0$	Very platykurtic	<0·67
Well sorted	0·35–0·50	Fine skewed	$^+0 \cdot 1$ to $^+0 \cdot 3$	Platykurtic	0·67–0·90
Moderately well sorted	0·50–0·70	Symmetrical	$^+0 \cdot 1$ to $^-0 \cdot 1$	Mesokurtic	0·90–1·11
Moderately sorted	0·70–1·00	Coarse skewed	$^-0 \cdot 1$ to $^-0 \cdot 3$	Leptokurtic	1·11–1·50
Poorly sorted	1·00–2·00	Very coarse skewed	$^-0 \cdot 3$ to $^-1 \cdot 0$	Very leptokurtic	1·50–3·00
Very poorly sorted	2·00–4·00			Extremely leptokurtic	>3·00
Extremely poorly sorted	>4·00				

The graphical method provides an easy calculation of parameters; however, it is not as representative as the method of moments. The moment method is a mathematical measure of the above-listed parameters which more accurately describes the sediment sample because it uses all values from the size distribution, whereas the graphical measures only use a few interpolated values. By standard convention, computations of size frequency use the midpoint size between each sieve used in the laboratory analysis.

Table D.2. Method of moments taken from Blott and Pye (2001)

Mean	Standard deviation	Skewness	Kurtosis
$\bar{x}_\phi = \frac{\Sigma f m_\phi}{100}$	$\sigma_\phi = \sqrt{\frac{\Sigma f (m_\phi - \bar{x}_\phi)^2}{100}}$	$Sk_\phi = \frac{\Sigma f (m_\phi - \bar{x}_\phi)^3}{100 {\sigma_\phi}^3}$	$K_\phi = \frac{\Sigma f (m_\phi - \bar{x}_\phi)^4}{100 \sigma_\phi^4}$

Sorting (σ_ϕ)		Skewness (Sk_ϕ)		Kurtosis (K_ϕ)	
Very well sorted	<0·35	Very fine skewed	>+1·30	Very platykurtic	<1·70
Well sorted	0·35–0·50	Fine skewed	+0·43 to +1·30	Platykurtic	1·70–2·55
Moderately well sorted	0·50–0·70	Symmetrical	−0·43 to +0·43	Mesokurtic	2·55–3·70
Moderately sorted	0·70–1·00	Coarse skewed	−0·43 to −1·30	Leptokurtic	3·70–7·40
Poorly sorted	1·00–2·00	Very coarse skewed	<−1·30	Very leptokurtic	>7·40
Very poorly sorted	2·00–4·00				
Extremely poorly sorted	>4·00				

Sediment grain sizes are presented on data sheets that incorporate the raw data, percentages by size, standard moment and graphical measures, and graphs of cumulative and frequency distributions. The overall sediment classification is also provided for each sample using both Wentworth classification and the Unified Soil Classification System (USCS). Class limits distinguishing sand sizes differ between the two systems (Table 1). The Wentworth system provides measures of sorting, skewness, and kurtosis, which provide details about the shape of the frequency distribution. The USCS system classifies sediment based on two letters, the first of which represents the size of the dominant grain (all samples in this study tested as "S" for sand) and the second representing either the grading of the sediment [either poorly graded (P) or well graded (W)] or the plasticity of the sediment [either low (M) or high (C)], depending on the amount of fine-grained material in the sample. An example of a USCS classification for poorly graded sand is SP. If >12 percent of the sample (calculated by combining the percent mud with the percent retained on a No. 230 sieve) passes a No. 200 sieve, the classification would be SM for low plasticity silty sand, and SC for high plasticity clayey sand. If the percentage passing a No. 200 sieve is between 5 and 12 percent, the sample requires a duel symbol (i.e., SP-SM). Results from the sediment analysis were compiled in the software, MATLAB, to produce composite statistics for individual cores. MATLAB was also used to create colored contour maps of composite grain size, percent mud, and percent shell using linear interpolation. Grain-size statistics from Phase 1 are modified from those previously reported to include the finest fraction in the moment calculations (>4.0 φ); generally the change in mean grain size was <0.010 mm.

Table D.3. Sediment size classifications. [Source: USACE (2002) Coastal Engineering Manual EM1110-2-1100, Part III, Table III-1-2, pg. III-1-8]

Table III-1-2
Sediment Particle Sizes

ASTM (Unified) Classification[1]	U.S. Std. Sieve[2]	Size in mm	Phi Size	Wentworth Classification[3]
Boulder		4096.	-12.0	
		1024.	-10.0	Boulder
	12 in. (300 mm)	256.	-8.0	
Cobble		128.	-7.0	Large Cobble
		107.64	-6.75	
		90.51	-6.5	Small Cobble
	3 in. (75 mm)	76.11	-6.25	
		64.00	-6.0	
		53.82	-5.75	
		45.26	-5.5	Very Large Pebble
Coarse Gravel		38.05	-5.25	
		32.00	-5.0	
		26.91	-4.75	
		22.63	-4.5	Large Pebble
	3/4 in. (19 mm)	19.03	-4.25	
		16.00	-4.0	
		13.45	-3.75	
		11.31	-3.5	Medium Pebble
		9.51	-3.25	
Fine Gravel	2.5	8.00	-3.0	
	3	6.73	-2.75	
	3.5	5.66	-2.5	Small Pebble
	4 (4.75 mm)	4.76	-2.25	
	5	4.00	-2.0	
Coarse Sand	6	3.36	-1.75	
	7	2.83	-1.5	Granule
	8	2.38	-1.25	
	10 (2.0 mm)	2.00	-1.0	
	12	1.68	-0.75	
	14	1.41	-0.5	Very Coarse Sand
	16	1.19	-0.25	
Medium Sand	18	1.00	0.0	
	20	0.84	0.25	
	25	0.71	0.5	Coarse Sand
	30	0.59	0.75	
	35	0.50	1.0	
	40 (0.425 mm)	0.420	1.25	
	45	0.354	1.5	Medium Sand
	50	0.297	1.75	
	60	0.250	2.0	
	70	0.210	2.25	
Fine Sand	80	0.177	2.5	Fine Sand
	100	0.149	2.75	
	120	0.125	3.0	
	140	0.105	3.25	
	170	0.088	3.5	Very Fine Sand
	200 (0.075 mm)	0.074	3.75	
	230	0.0625	4.0	
Fine-grained Soil:	270	0.0526	4.25	
Clay if PI $\geq$ 4 and plot of PI vs. LL is on or above "A" line and the presence of organic matter does not influence LL.	325	0.0442	4.5	Coarse Silt
	400	0.0372	4.75	
		0.0312	5.0	
		0.0156	6.0	Medium Silt
		0.0078	7.0	Fine Silt
		0.0039	8.0	Very Fine Silt
Silt if PI < 4 and plot of PI vs. LL is below "A" line and the presence of organic matter does not influence LL.		0.00195	9.0	Coarse Clay
		0.00098	10.0	Medium Clay
		0.00049	11.0	Fine Clay
		0.00024	12.0	
(PI = plasticity limit; LL = liquid limit)		0.00012	13.0	Colloids
		0.000061	14.0	

[1] ASTM Standard D 2487-92. This is the ASTM version of the Unified Soil Classification System. Both systems are similar (from ASTM (1994)).
[2] Note that British Standard, French, and German DIN mesh sizes and classifications are different.
[3] Wentworth sizes (in mm) cited in Krumbein and Sloss (1963).

6.0 OFFSHORE BORINGS

Collectively, CSE obtained 77 cores from 82 proposed locations in the search area during Phases 1 and 2. The five sites that were unsuccessful (9, 14, 16, 26, and 40) contained very coarse shell deposits near the sediment surface, hindering significant penetration by CSE's coring system. Phase 1 core locations generally followed a 2,000-ft grid, then began to fill in the grid to a 1,000-ft resolution. Phase 2 borings focused on bathymetric highs and areas of Phase 1 borings which appeared to contain sediment more suitable for beach nourishment purposes. The average recovery for the 77 obtained borings was 7.8 ft. There were 32, 22, and 7 cores longer than 8 ft, 9 ft, and 10 ft (respectively). Areas which showed poor recovery generally possessed a very coarse fraction at the bottom of the core, which prevented further penetration of the core tube (e.g., cores 25, 35, 36). From the 77 borings, 212 sediment samples were obtained and analyzed for grain size, silt/clay content, and shell content.

Results of the sediment sample analysis showed mean grain size ranged from 0.115 mm to 3.087 mm (0.404 standard deviation), and collectively averaged 0.406 mm. Ninety-eight (98) samples (46 percent) showed a mean grain size <0.250 mm, which classifies as fine sand under the Wentworth Classification system. Sixty-eight samples (32 percent) classified as medium sand (0.250–0.500 mm), and the remaining 46 samples (22 percent) classified as coarse sand or larger (0.500 mm). Under the USCS, 150 samples (71 percent) classified as fine sand (0.075–0.425 mm), 58 samples (27 percent) classified as medium sand (0.425–2.0 mm) and 4 samples (2 percent) classified as coarse sand (2 mm).

Samples were wet-sieved for silt/clay content using a No. 230 sieve (4.0 phi). Silt/clay content ranged from 0.3 percent to 30.8 percent, and averaged 3.0 percent. Of the 205 samples analyzed for silt/clay, 120 samples (59 percent) contained less than 2 percent silt/clay, while 34 samples (17 percent) contained more than 5 percent silt/clay.

Shell content (CaCO3) ranged from 1.9 to 75.5 percent, and averaged 18.8 percent for all samples. Shell content varied from fine shell hash (sand-sized shell fragments) to very coarse, large shells (e.g., oyster, scallop, etc). Lenses of coquina-like unconsolidated shells consisting of high concentrations of Donax sp (small, thin-walled surf zone clam) were also found in a number of samples. Overfill factors (aka overfill ratios), RA, were calculated using USACE Automated Coastal Engineering System (ACES) Version 1.07f. Overfill ratios are used to estimate the quantity of borrow material needed to perform like a given quantity of native beach material based on the mean grain size and sorting (standard deviation) of the native and fill material. The selection of "native" grain size and sorting is somewhat problematic where a broad spectrum of grain sizes exists across the littoral profile. For example, if the beach sampling plan emphasizes subaerial samples and omits offshore samples, the "native" size distribution is likely to be somewhat coarser. Addition of offshore samples tends to lower the mean grain size. If a beach has been nourished recently, the "native" sediment distribution is likely to reflect the quality of the borrow material.

The first scenario (RA1) represents a composite grain-size distribution of all 34 beach stations (136 samples) collected along Edisto Beach. The mean grain size and sorting for this scenario was 0.404 mm and 0.397 mm (respectively). The second scenario (RA2) uses a composite distribution from stations 1–8 and 30–34. These stations are outside of the 2006 project area and show less influence of the nourishment placed during that project. The mean grain size and sorting for this scenario is 0.336 mm and 0.350 mm (respectively). The two scenarios do not incorporate any offshore samples which, if available, would probably lower the overall mean grain size.

Overfill ratios for the 212 core samples vary from 1.00 to >10.0. Any RA values greater than 10.0 were given a value of 10.0. In general, RA values <1.50 are favored for nourishment purposes; however, these values are dependent on the selection of a native grain size. It is important to note that RA values do not directly address silt/clay or shell concentration, and low RA values may not always represent compatible material.

7.0 CORE COMPOSITE STATISTICS

Sample statistics were weighted by length and combined for each core. These statistics were used to produce isopach maps modeling the grain size, mud content, shell content, and RA values over the search area. Generally, very coarse material is present at the northern end (landward) of the borrow area, and finer material is present seaward and to the east of the shoal. High mud content is present in the eastern extreme of the search area. Shell content generally increases with mean grain size, with large shell fractions present in the northeastern portion of the search area. The southeast end of the search area shows very little shell content and mostly fine-grained material. Overfill ratios were calculated for each core based on the composite grain size distribution for each core's entire length of recovery and for both native sediment scenarios. In general, lower overfill ratios are present in the northern and western regions of the search area, with high values in the southern and central-eastern areas. Due to the exponential nature of overfill ratios, distinguishing small differences between potentially compatible cores is difficult with an isopach map; however, it does provide a general idea of potential borrow areas. Four speculative borrow areas were evaluated to determine the potential availability of up to 20 million cubic yards of accessible compatible material. Each area was generally selected based on sediment compatibility, including overfill ratios, silt/clay, and shell content, as well as operational considerations. The theoretical borrow areas are shown in Figures D.3 and D.4. The composite grain-size distribution (weighted by core length) for all samples within each borrow area was used to calculate overfill ratios for each area.

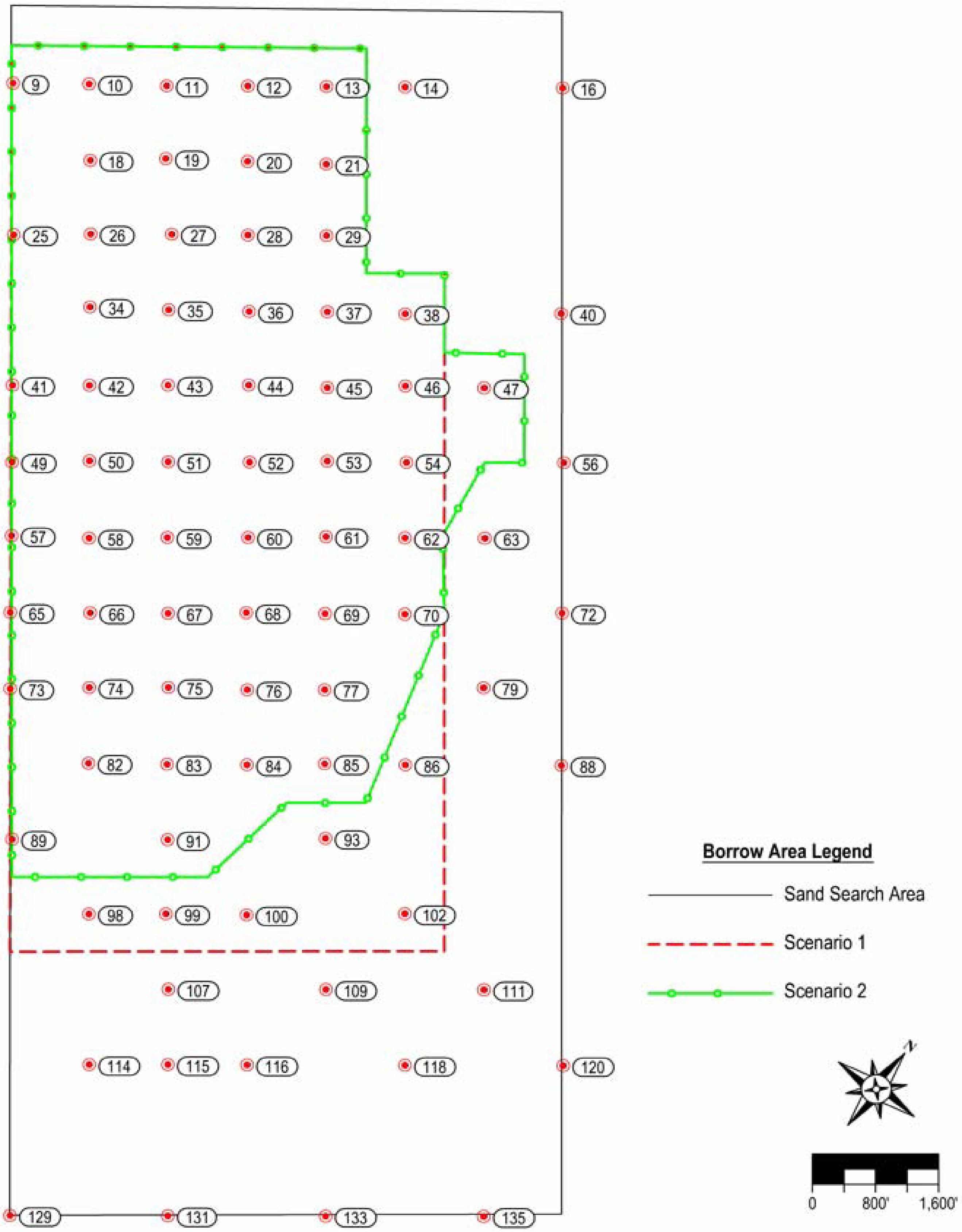


Figure D.3. Two scenario borrow area delineations within the sand search area.

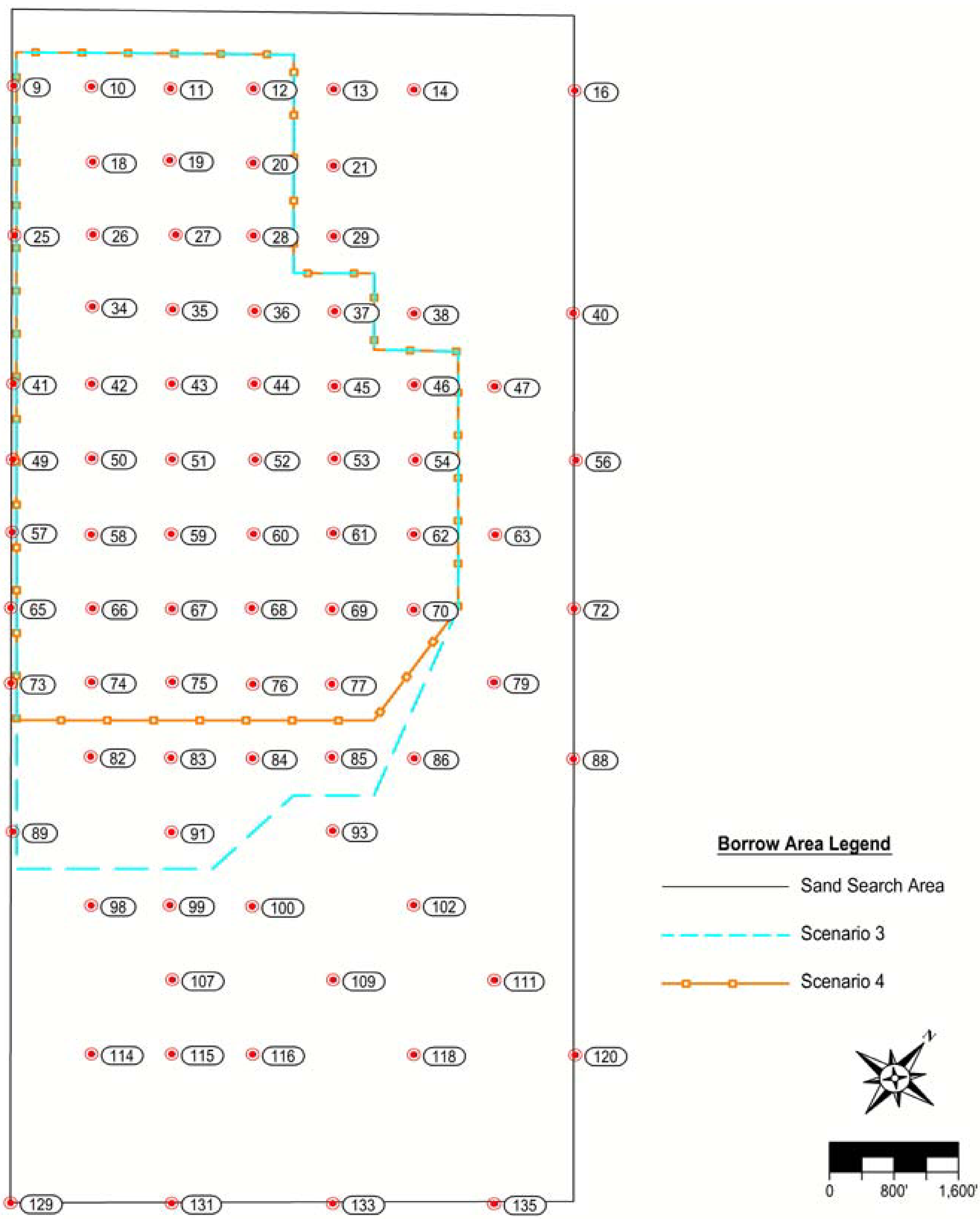


Figure D.4. Two scenario borrow area delineations within the sand search area.

This method acts to combine all samples within an area to produce one grain-size distribution from which an overfill ratio is calculated. Grain-size distributions from each sample within an area were multiplied by the length of core for which that sample represents. The weighted distributions from all samples within the area were then added by class and divided by the total length of all samples within the area to produce a single composite, grain-size distribution. This method acts to treat the entire area up to the depth of core recovery as one sample. For the presented borrow area scenarios, this method produces a lower RA value than a linear average of the core composite overfill ratios. The results are shown in Table 2. The composite overfill ratio for the entire sand search area is 1.34 and 1.13 for native beach scenarios RA1 and RA2 (respectively). The lower RA values for scenario RA2 reflect the finer native mean grain size used for the “native” beach. RA values for the four speculative borrow areas ranged from 1.17 to 1.34 for the RA1 scenario and 1.03 to 1.05 for the RA2 scenario. The linear average overfill ratios calculated from the core composite RA2 scenario ranged from 2.44 to 3.02. The overfill ratios decreased with the exclusion of cores in the southern portions of the search area which contained material finer than what is presently on the subaerial beach. Overfill ratios also decreased with the inclusion of cores in the northeastern portions of the borrow area which contained coarse material, usually containing a significant shell portion. The potential volume of borrow material under the four scenarios ranges from ~12 million cubic yards to ~18 million cubic yards (Table 2). The entire sand search area contains potentially almost 30 million cy if excavated to an average of ~7.7 ft. An isopach map of compatible sediment thickness is shown in Figure 15. The criteria for determining compatible material was an RA value of ~1.20 or less, with mud content <5.0 percent and without very coarse shell material. In certain situations, samples with RA values greater than 1.20 were included if the composite grain-size distribution for the core appeared compatible. Data are reported in Table 2.

Table D.4. Potential borrow areas (scenarios), respective volumes, and composite RA's for applicable cores (two native grain-size scenarios.

Edisto Beach Sand Search Area Core Overfill Ratios									
	R_{A1}: Un = 1.308 φ, Sn = 1.334 φ				R_{A2}: Un = 1.575 φ, Sn = 1.515 φ				
Potential Area (number of cores within area)	Cores Representing Potential Borrow Area	Area (acres)	Average Recovery Depth (ft)	Volume (cy) Area x Average Recovery	$U_{b\,(phi)}$	$S_{b\,(phi)}$	R_{AL}	R_{A1}	R_{A2}
Entire Search Area	All obtained cores	2,410	7.7	29,938,627	1.774	1.660	4.02	1.34	**1.13**
Scenario 1 (58)	10 11 12 13 18 19 20 21 25 26 27 28 29 34 35 36 37 38 41 42 43 44 45 46 49 50 51 52 53 54 57 58 59 60 61 62 65 66 67 68 69 70 73 74 75 76 77 82 83 84 85 86 89 91 93 98 99 100 102	1,443	7.7	17,925,908	1.523	1.722	3.02	1.21	**1.05**
Scenario 2 (53)	10 11 12 13 18 19 20 21 25 26 27 28 29 34 35 36 37 38 41 42 43 44 45 46 47 49 50 51 52 53 54 57 58 59 60 61 62 65 66 67 68 69 70 73 74 75 76 77 82 83 84 85 89 91	1,269	7.6	15,559,632	1.418	1.733	2.65	1.17	**1.04**
Scenario 3 (48)	10 11 12 18 19 20 25 26 27 28 34 35 36 37 41 42 43 44 45 46 49 50 51 52 53 54 57 58 59 60 61 62 65 66 67 68 69 70 73 74 75 76 77 82 83 84 85 89 91	1,138	7.8	14,320,592	1.516	1.662	2.82	1.19	**1.03**
Scenario 4 (42)	10 11 12 18 19 20 25 26 27 28 34 35 36 37 41 42 43 44 45 46 49 50 51 52 53 54 57 58 59 60 61 62 65 66 67 68 69 70 73 74 75 76 77	955	7.8	12,017,720	1.473	1.679	2.44	1.17	**1.03**

8.0 BEACH SAMPLES

Beach samples collected at 34 stations along Edisto Beach (Fig 4) were used to determine the existing condition of the beach and to compare sediment quality with the offshore sediments in the sand search area. The samples along the beach reflect conditions after the 2006 renourishment between Edisto Beach State Park and groin 27 at the southernmost tip of the island (CSE 2006). Each station involved four grab samples – one each from the toe of the dune, berm, beach face, and low tide swash zone. A total of 136 samples were collected in December 2007 and analyzed in a similar manner as the core samples (without measuring mud content). Table 8 lists sediment statistics and descriptions for the beach samples.

The composite mean grain size of all samples was 0.404 mm (medium sand). Mean grain size along the beach profile is often a function of energy, with coarsest sediments found in the most energetic environments. In the case of typical South Carolina beaches, the beach face is subject to the most wave energy, and grain size is greater than at the dune, top of berm, and low-tide terrace. The composite grain sizes by profile location for all samples were:

- 0.373 mm for the toe of the dune.
- 0.420 mm for the berm.
- 0.462 mm for the beach face.
- 0.367 mm for the low-tide terrace.

Shell content for beach samples ranged from 2.9 percent to 78.1 percent, with an average of 24.8 percent. Typically, shell material present in the beach samples was relatively fine, with little shell >2 mm (average of 6.6 percent by weight for all samples). A few samples contained greater portions of large shells. Generally, shell content was greater at the beach face and low-tide terrace than at the dune and berm.

The results of the beach samples are consistent with previous sediment data for Edisto Beach (CSE 1992, 2003, 2006). Edisto Beach tends to have more shell and is coarser than most South Carolina beaches because of several factors (CSE 2006):

• Updrift sediment supply is derived from eroding marsh deposits along Edingsville Beach which yield high concentrations of oyster shells and mud.

• The first nourishment project in 1954 excavated marsh deposits in the lagoon on the landward side of the island. Muddy sediments eroded rapidly, leaving a lag of shells derived from the marsh.

• Groin construction in the 1950s, 1960s and 1970s created groin cells, which trapped and retained fillets of coarse sediment, including high concentrations of oyster shells and shell hash.

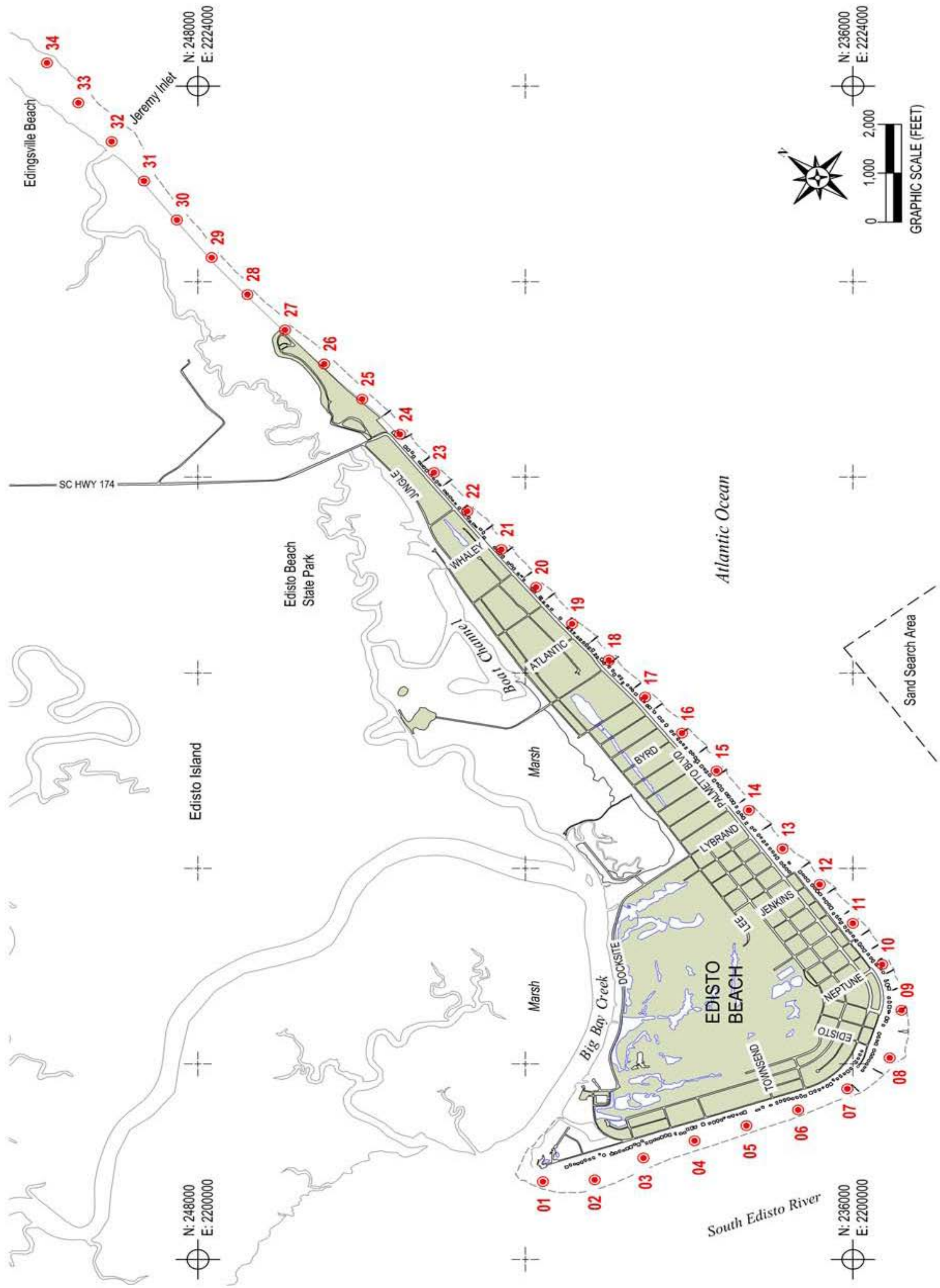


Figure D.5. Locations of beach samples obtained in December 2007. At each location, four samples were taken along the width of the profile covering the toe of the dune, berm, beach face, and low-tide terrace.

9.0 OTHER POTENTIAL SAND REOURCES

As Phase 3 of this project, CSE performed bathymetric survey from roughly the North Edisto River and Seabrook Island in the north to the South Fork Edisto River and Pine Island in the south. This area measures approximately 52.5 square miles in size. Information from this survey and historic information researched by CSE was used to locate proposed future borings which may determine the location of additional sources to be used for possible borrow for beach nourishment. These areas will be used only if sand is required in addition to the material available in the designated borrow area. Possible boring locations are shown on Figure D.6.

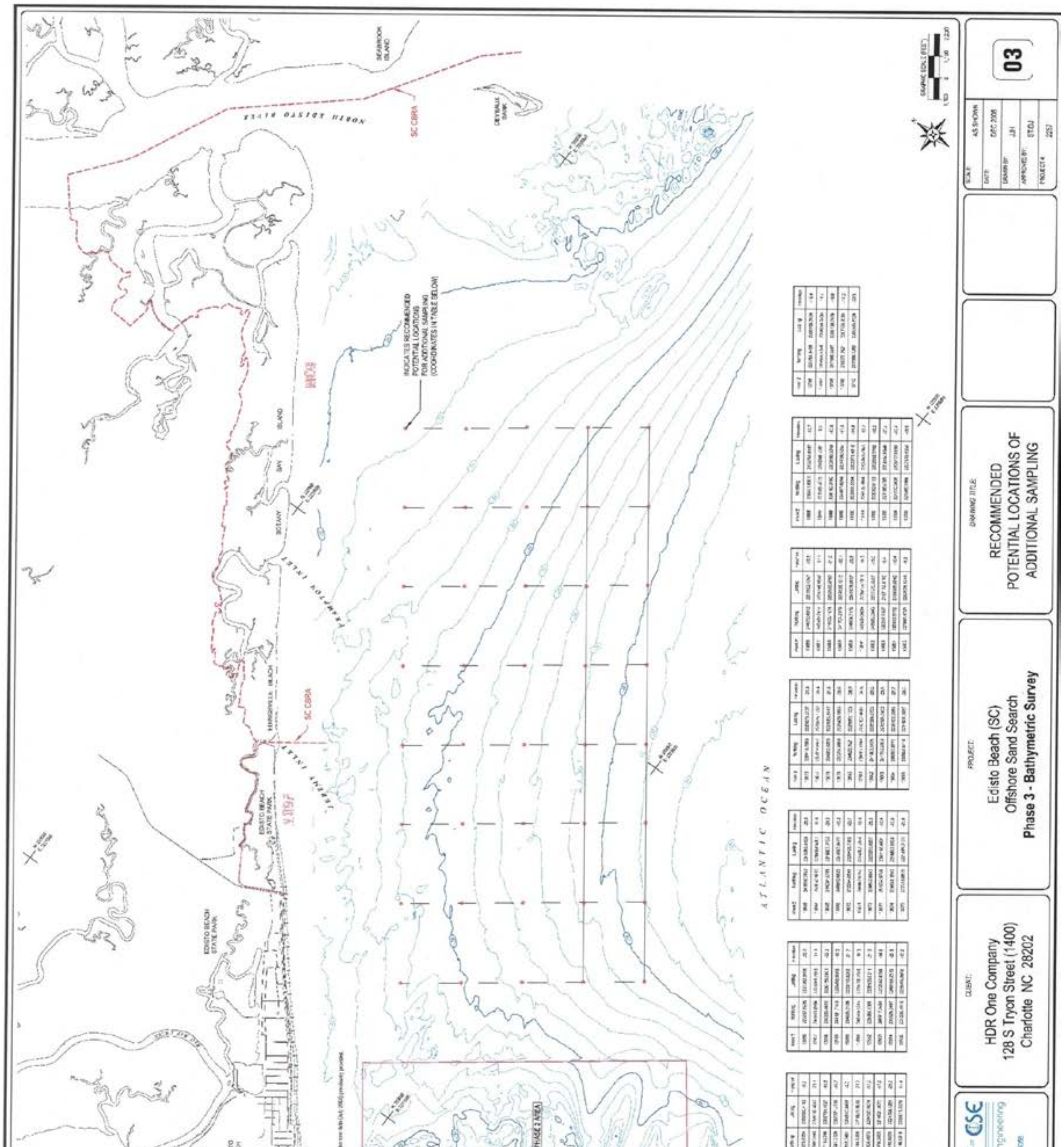


Figure D.6. Proposed future boring locations offshore of Edisto Beach.

10.0 VOLUME CALCULATION

The Surface-Water Modeling System (SMS) was used to estimate borrow volumes. Boreholes were used in identifying the vertical boundaries of the potential borrow sources. The composition and thickness of overburden were examined and borrow areas were identified based on depth of suitable material. Vertical buffers must be delineated between suitable and non suitable sediments, which cannot be included in the source's available volume. A one foot vertical buffer was adopted in the study. Isopach map of the deposit was prepared to determine the volume of the proposed borrow materials. An isopach map is a contour map showing the thickness of a deposit between two physical or arbitrary boundaries. SMS was used to define the upper boundary of the deposit by the surface of the sea bottom and the lower boundary was created by interpolating the scatter borehole data to a uniform grid with a resolution of 20 m. The removal depth followed the borehole surface created from the borehole scatter data set.

Due to the dredging process, it may not be practical to dredge the full depth of the borrow area. A vertical buffer of 1-foot was considered to accommodate the inaccuracies during dredging. The borrow area volumes were calculated for the full borrow depth and the borrow area with a 1-foot buffer. Based on previous experience with hopper dredges, the 1-foot buffer is reasonable to account for the dredging process. The 1-foot buffer was used to determine the quantities of borrow material available. The surface area and volumes of available material in each borrow area scenario with the vertical buffer are shown in table D..

Table D.5. Edisto Borrow Area Footprint and Volumes

Borrow Area	Average Depth (feet)	Footprint Area (acres)	Volume (mcy) 1' Buffer
Scenario A	6.9	650	7.2
Scenario B	6.8	500	5.5
Scenario C	6.3	485	4.9
Scenario D	6.7	395	4.3

11.0 COMPATIBILITY ANALYSIS

A compatibility analysis involves the comparison of the grain size distribution characteristics of the material existing on the active profile of the native or reference beach and the material available from the proposed borrow area. The native beach and borrow sediments were analyzed using standard sieving techniques. Based on the size distributions of the two materials, estimates can be made of the amount of over-filling required to construct a given design beach profile.

Wave action tends to distribute the material across this active beach profile in discrete size increments. The active beach profile is that portion of the profile regularly affected by wave action and generally extends from the crest of the beach berm seaward to water depths of approximately 24 feet. Samples of the native beach material are collected at uniform depth intervals from the crest of the beach berm seaward to water depths of about 30 feet and the size characteristics of each sample determined by standard sieve analyses. The size characteristics of the individual samples are mathematically mixed to determine composite mean and composite standard deviation of the material that is on the active beach profile.

12.0 COMPATIBILITY REQUIREMENT (CRITERIA)

The Charleston District guideline with regard to the percentage of fine-grained sediments is that borrow areas containing more than 10 percent fines are generally considered to be incompatible for placement on the beach due to potential problems with turbidity and siltation during placement.

13.0 NATIVE BEACH CALCULATIONS

The native beach composites were generated to reflect variations in sediment characteristics across the beach profile through varied energy zones, along the beach, at depths within the active profile. Surface samples were combined into one composite average grain-size distribution by summing the weights retained on each sieve interval and then dividing by the number of samples. The composite weight for a given size is:

$$w_{\text{composite}} = (w_{S1} + w_{S2} + w_{S3} + \ldots\ldots + w_{Sn})/n$$

where:

$w_{\text{composite}}$ = composite weight for a specific sieve
w_{Sn} = sediment weight retained on a specific sieve for each sample
n = number of samples

An analysis was performed with the grain size results of the samples taken to determine the native beach quality values. The values of key criteria was determined for the purpose of comparing potential sources of borrow material. The analysis determined the percent finer than then #4 sieve, the % finer than then #10 sieve, the percent finer than then #200 sieve, and the shell content.

14.0 OVERFILL RATIO

The suitability of the borrow material for placement on the beach is based on the overfill ratio. The overfill ratio is computed by numerically comparing the size distribution characteristics of the native beach sand with that in the borrow area and includes an adjustment for the percent of fines in the borrow area. The overfill ratio is primarily based on the assumption that the borrow material will undergo sorting and winnowing once exposed to waves and currents in the littoral zone, with the resulting sorted distribution approaching that of the native sand. Since borrow material will rarely match the native material exactly, the amount of borrow material needed to result in a net cubic yard of beach fill material will generally be greater than one cubic yard. The excess material needed to yield one net cubic yard of material in place on the beach profile is the overfill ratio. The overfill ratio is defined as the ratio of the volume of borrow material needed to yield one net cubic yard of fill material. For example, if 1.5 cubic yards of fill material is needed to yield one net yard in place, the overfill factor would equal 1.5.

The overfill criteria developed by James (1975) is the method used in the Automated Coastal Engineering System (ACES). The procedure is also described in the U.S. Army Coastal Engineering Manual EM-1110-2-1100 Part V (July 2003).

The equilibrium slope method by Pilarczyk, van Overeem and Bakker (1986) bases the recharged profile on the present native profile. However, if the grain size of the fill material is different from the native material, the profile steepness is altered.

The Dean's equilibrium method (Dean, 1991) determines the volume of recharged sand of a given grain size to increase the width of dry beach by a given amount. Dean proposed that beach profiles develop a characteristic parabolic equilibrium profile.

The Krumbein and James Method is only applicable if the native material is better sorted than the fill material. If the fill material is better sorted than the native material, this method simply does not apply. Secondly, the Krumbein and James Method assumes that the portion of the fill material retained on the beach after sorting by waves and current will have exactly the same size distribution of the native material. This implies that both the fine and coarse portion of the fill will be lost. This feature is not consistent with the knowledge of sediment transport process as the coarser portion of the fill will likely remain on the beach without being carried away by waves and currents (Dean, 1974; also Dean and Dalrymple, 2002). The overfill ratio by the Krumbein and James Method will tend to be overestimated. Dean (1974) addressed the above shortcomings by assuming that only the finer portion of the fill will be winnowed away by prevailing wave condition leaving the mean diameter of altered distribution of fill material to be at least as large as the mean diameter of native material. Dean defines the overfill ratio as the required replacement volume of fill material to obtain one unit of compatible beach material and uses the 'phi' unit to describe the size of sand particle.

The overfill ratio for the Native or Reference Beach was compared to the borrow area material was calculated by all 4 methods. The Equilibrium Slope Method (ESM) are considered to be the most accurate method base in the case of Edisto Beach. Based on these methods, the overfill ratio for is varied between 1.28 and 1.51. Any overfill ratio value of 1.5 or less with a fine content of less than 10% is considered acceptable for use as beach renourishment. The overfill ratio for each borrow area configuration is shown in Table D.6.

Table D.6. Edisto Beach Overfill Ratios.

	MEAN (phi)	STD DEV (phi)	Silt Correction Factor	Overfill Ratio (Berm Height=7' Berm Width=50' Significant Wave Height=8') Aces	EPM	ESM	Dean Method
Native Beach	1.31	1.33	**NA**	**NA**	**NA**	**NA**	**NA**
All	1.85	1.12	1.012	2.26	2.29	1.35	1.20
Scenario 1	1.61	1.27	1.006	1.36	1.62	1.22	1.15
Scenario 2	1.50	1.32	1.005	1.19	1.37	1.17	1.10
Scenario 3	1.60	1.32	1.005	1.37	1.60	1.22	1.15
Scenario 4	1.57	1.29	1.004	1.29	1.52	1.20	1.10
Scenario A	1.73	1.31	1.004	1.51	1.93	1.28	1.20
Scenario B	1.71	1.33	1.004	1.16	1.88	1.27	1.20
Scenario C	1.67	1.29	1.004	1.43	1.77	1.25	1.15
Scenario D	1.71	1.25	1.004	1.549	1.88	1.27	1.20

ACES - Automated Coastal Engineering System

EPM - Equilibrium Profile Method

ESM - Equilibrium Slope Method

15.0 RESULTS

The borrow area scenarios with “letter” designations were selected to reduce the area surface area and the cost of environmental and archeological investigations. Based on the analysis of the overfill ratio and the grain size analysis borrow areas Scenario A was selected as the source of borrow material. The percent passing the #200 sieve is less than 10 percent for the proposed borrow area. The grain size distributions for the native beaches and the borrow areas are shown in Table D.7. A total of 7.2 million cubic yards of material is available within the proposed borrow area. The volume of available material and the footprint area of each borrow area is shown in Table D.7.

Table D.7. Edisto Grain Size Comparison.

	MEAN (phi)	STD DEV (phi)	% PASSING #5	%PASSING #10	% PASSING #200	% PASSING #230	% VISUAL SHELL
	-	-	-	-	-	-	-
Native Beach	**1.31**	**1.33**	**97.8**	**93.5**	**0.1**	**0.0**	**26.9**
	-	-					
All	**1.85**	**1.12**	**95.3**	**91.0**	**1.2**	**0.5**	**17.6**
Scenario 1	**1.61**	**1.27**	**94.3**	**89.3**	**0.6**	**0.2**	**20.1**
Scenario 2	**1.50**	**1.32**	**93.9**	**88.6**	**0.5**	**0.2**	**21.3**
Scenario 3	**1.60**	**1.27**	**94.7**	**89.9**	**0.5**	**0.2**	**19.7**
Scenario 4	**1.57**	**1.29**	**94.5**	**89.6**	**0.4**	**0.2**	**20.4**

Scenario A	**1.73**	**1.31**	**94.7**	**90.0**	**0.4**	**0.2**	**18.8**
Scenario B	**1.71**	**1.33**	**94.4**	**89.6**	**0.4**	**0.2**	**19.0**
Scenario C	**1.67**	**1.29**	**93.9**	**89.0**	**0.4**	**0.2**	**18.9**
Scenario D	**1.71**	**1.25**	**94.3**	**89.4**	**0.4**	**0.2**	**18.3**

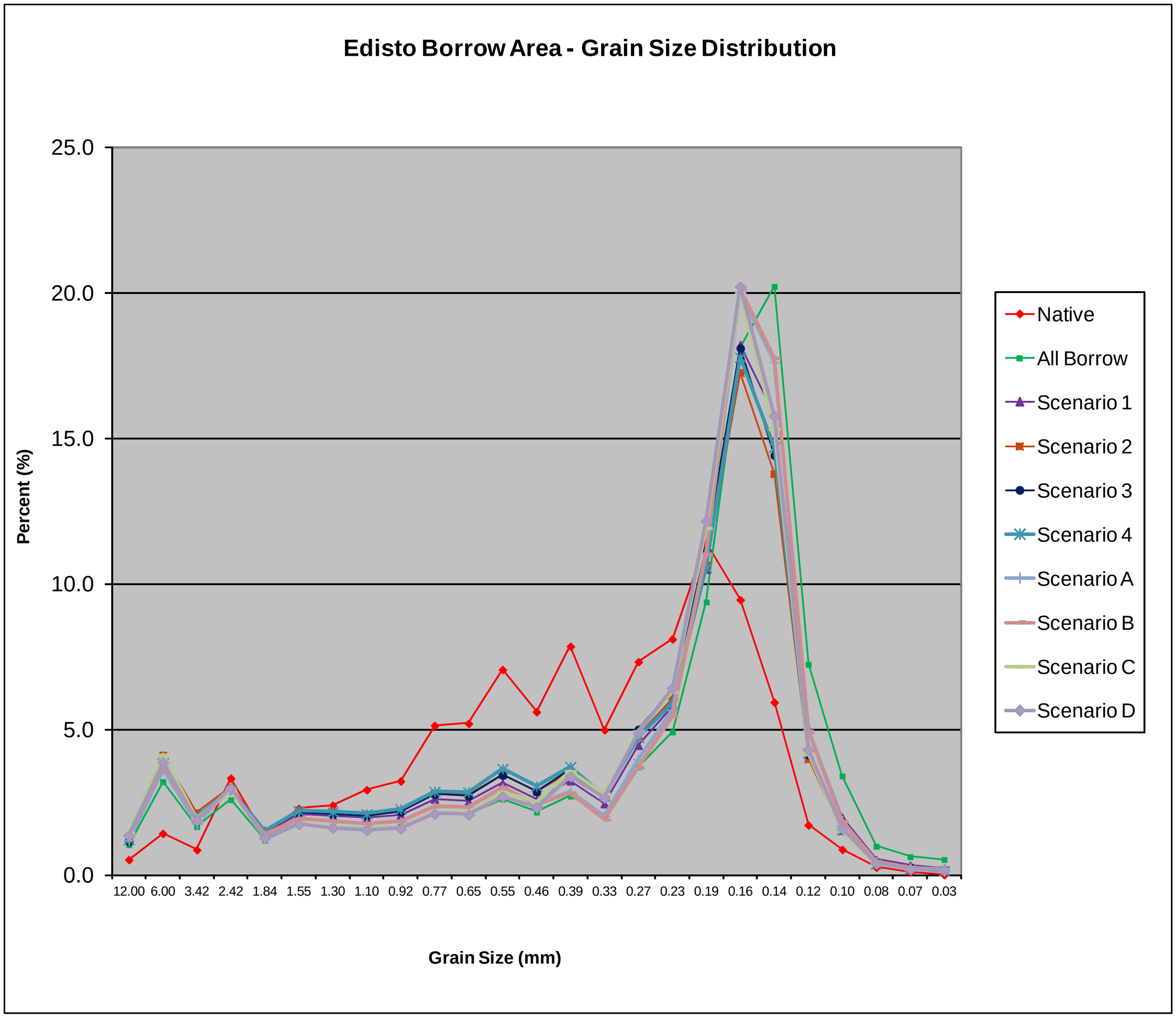


Figure D.7. Edisto Beach Grain Size Distribution for Borrow Area Scenarios and Native Beach.

16.0 CONCLUSION

Based on the total estimated volume in the borrow areas, including the 1-foot vertical buffer, there is an adequate quantity of suitable beach quality material to complete the full 50-year life of the project. There is approximately 7.2 million cubic yards of suitable borrow material available in the proposed borrow area, Scenario A. This volume does not include any recharge of these areas. The area to be used for borrow will be further defined during the Preconstruction, Engineering, and Design phase of this project.

Additional borings and/or geophysical surveys will be performed as necessary to better delineate the borrow area boundaries and material types.

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EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX E

BORROW AREA IMPACT ANALYSIS

BORROW AREA IMPACT ANALYSIS

FOR EDISTO BEACH, SC

Introduction

Edisto Island is located on the coast of South Carolina south of Charleston. The town of Edisto Beach is located on the southern tip of Edisto Island at the South Edisto River Inlet (Figure 1). The offshore area of Edisto Beach was investigated to identify sites that may be appropriate for use as borrow material source for beach nourishment at Edisto Beach. The estimated maximum total project volume is 3.4 Mcy needed for 50 years of nourishments.

Modifications of offshore bathymetry by removal of large quantities of sediment alter the local wave field, which in turn may modify the equilibrium planform of the leeward beach. These effects as well as the impact on sediment dynamics near the sediment removal area have become of concern as the extraction of offshore sediment for beach nourishment, construction materials, and other purposes has increased (Bender and Dean, 2003). The Coastal Modeling System CMS-WAVE was used to estimate wave transformation change in the study area and assess potential impacts along the Edisto Beach shorelines.

An initial investigation of the potential impacts of multiple borrow area scenario was conducted in 2009 for the 50-year project life for the Edisto Island Feasibility study (USACE, 2009). The present study is an update to the initial study and the same bathymetric and forcing wave data were adopted. The CMS-WAVE model grid and the synthesized forcing wave climate were modified. The impact of a final refined borrow area scenario was assessed with the modified wave model grid and synthesized forcing conditions.

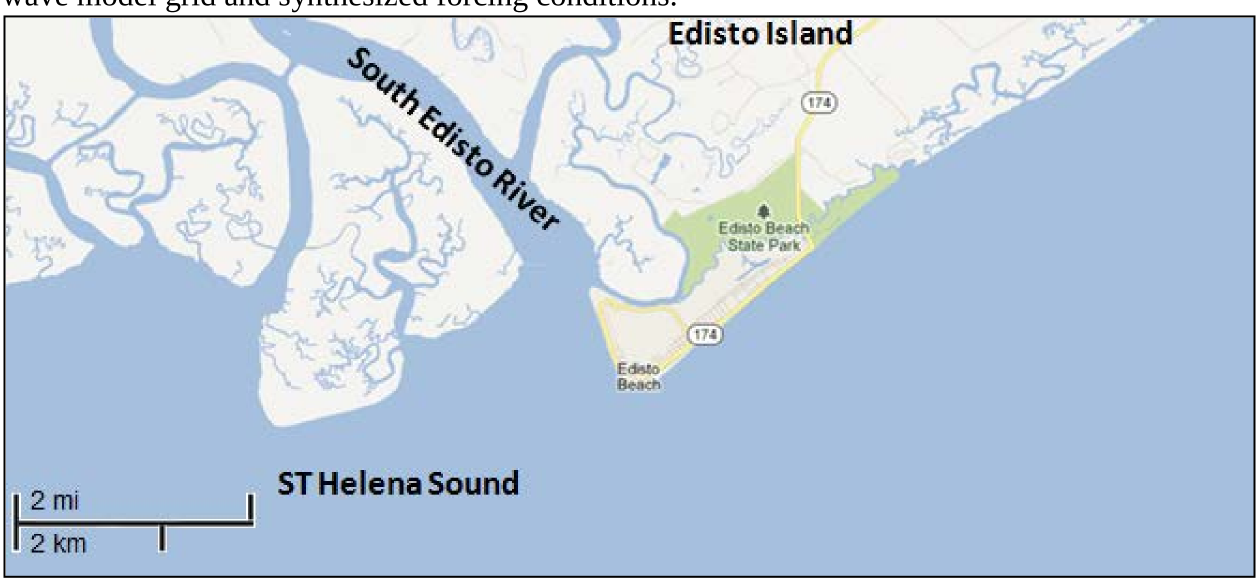
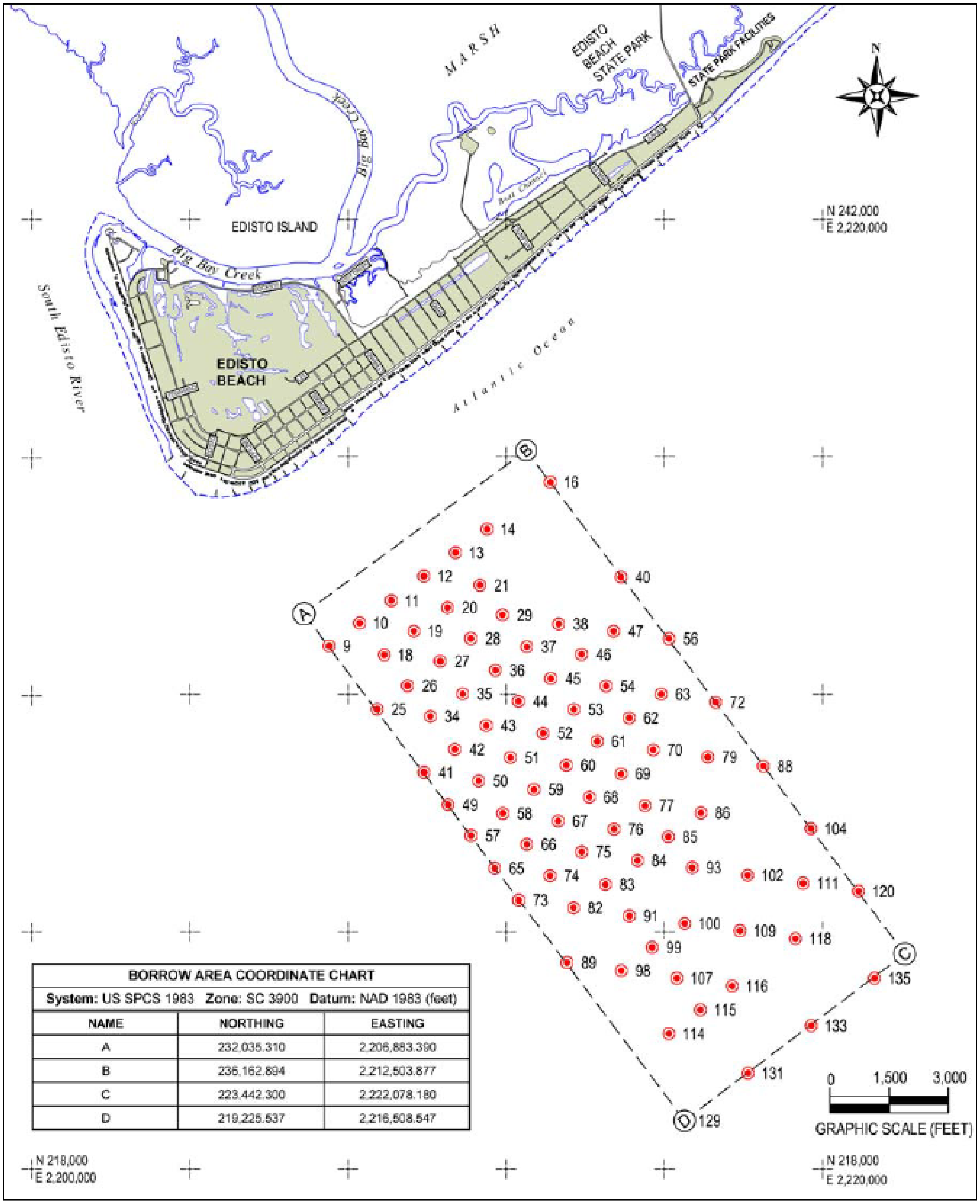


Figure 1- Edisto Beach location map

Potential Borrow Area

USACE (2009) stated that the sand search area targeted the seaward shoal of South Edisto River Inlet at the southern end of Edisto Beach. The shoal is part of the ebb-tidal delta of St Helena Sound and is known to contain mixed sand and shell sediments (in some areas) that are similar to the native beach. The search area encompassed an area 7,000 ft by 16,000 ft (~4 square miles) paralleling the north side of the main channel of South Edisto River Inlet. Figure 2 shows the sand search area and the 77 borings obtained within the proposed borrow area (CSE 2008). The initial study (USACE, 2009) investigated seven borrow area scenarios. A revised borrow area A scenario is examined in this study.

There are some limits on the lateral and vertical extent of borrow material sites. Boreholes were used in identifying the vertical boundaries of the potential borrow sources. The composition and thickness of overburden should be examined and borrow areas should be identified based on depth of suitable material. Vertical buffers must be delineated between suitable and non suitable sediments, which cannot be included in the source's available volume. A one foot vertical buffer was adopted in this study. Lateral buffer areas around sensitive environmental or cultural resources, or around known obstructions, must also be excluded from the source's available volume. A 0.25 mile buffer was delineated on the north, west and east sides of the proposed borrow area. Two circular exclusion areas, of 1500 ft radius, were used to exclude two prehistoric sites found during cultural/hardbottom survey. Figure 3 shows the locations of boreholes offshore of Edisto Beach and the footprint of the proposed borrow area A. Also, the figure shows the three sides of the 0.25 mile (about 1300 ft) buffer around the borrow area and the two exclusion circular areas around the prehistoric sites. The potential borrow area covers about 1.0 square miles with potential dredging of about 7.2 Mcy of beach placement material. This amount is more than the estimated maximum total project volume of 3.393 Mcy needed for 50 years of nourishments. The geotechnical analysis describing the details of developing the borrow area limits are available in CSE (2008).



BORROW AREA COORDINATE CHART

System: US SPCS 1983 Zone: SC 3900 Datum: NAD 1983 (feet)

NAME	NORTHING	EASTING
A	232,035.310	2,206,883.390
B	236,162.894	2,212,503.877
C	223,442.300	2,222,078.180
D	219,225.537	2,216,508.547

Figure 2- Sand search grid over the shoals of South Edisto River Inlet

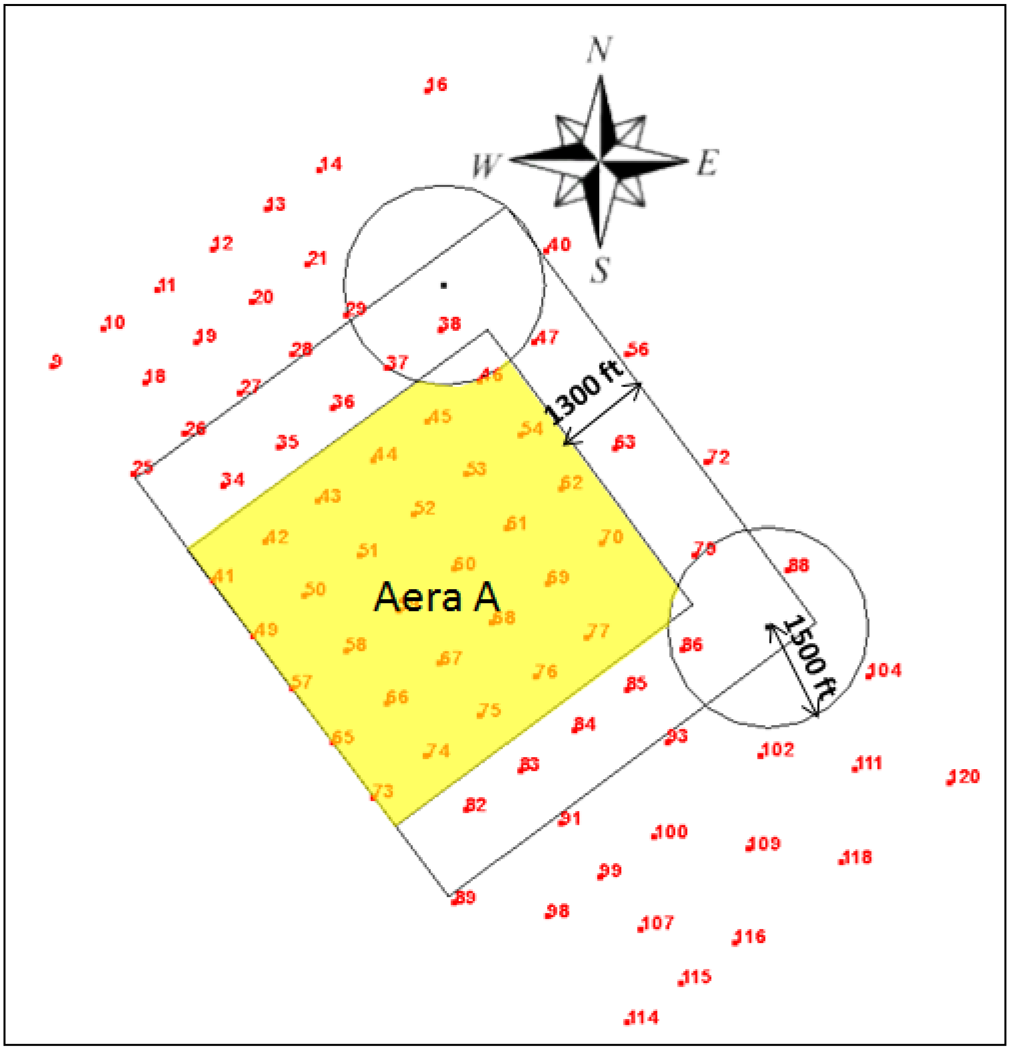


Figure 3- Proposed borrow area, lateral buffers and borehole locations

CMS-WAVE Grid

CMS-WAVE, previously called WABED (Wave-Action Balance Equation Diffraction), is a two dimensional (2D) spectral wave model formulated from a parabolic approximation equation (Mase et al. 2005a) with energy dissipation and diffraction terms. It simulates a steady-state spectral transformation of directional random waves co-existing with ambient currents in the coastal zone. The model operates on a coastal half-plane, implying waves can propagate only from the seaward boundary toward shore. It includes features such as wave generation, wave reflection, and bottom frictional dissipation (Lin et al., 2008).

CMS-WAVE model requires accurate bathymetry data to construct computational grid over which waves propagate and transform. The bathymetry used for the CMS-WAVE grid was the same data set used in the 2009 Edisto initial borrow area impact analysis (USACE, 2009). The data set is referenced to the horizontal UTM NAD83 Zone 17 in meters and to the vertical Mean Tidal Level (MTL) datum which represents the vertical datum of the model. Figure 4 shows the boundaries of the survey data sets.

The CMS-WAVE grid was delineated such as to include Edisto Beach, anticipated offshore borrow areas and the offshore Wave Information Studies (WIS) 63356 station. The grid boundaries should be located away from the study area, to eliminate boundary effects, and should ensure accurate development and propagation of the modeled parameters. Therefore, the Western wave grid boundary, used in the initial wave impact analysis, was extended to include more of the St Helena Sound area. Accordingly, the Edisto Beach and the proposed borrow area were centered within the alongshore extent of the model grid. The grid extends about 37.5 km along the shoreline and 30.3 km offshore (Figure 5). The offshore grid boundary includes WIS station 63356. The computational grid was constructed with 433818 cells and with resolution of 80 m in the offshore area. The resolution was increased to 40 m in the nearshore area and in the offshore proposed borrow site vicinity to adequately resolve wave energy propagation in the area. The grid origin was selected such as to resolve the details of the proposed borrow area. Also, the previous initial grid orientation was modified from 127.5 to 126.6 deg (counterclockwise from East) to match the orientation of the revised proposed borrow area. The modified orientation, location and resolution of the grid were designed to optimize the accuracy of the anticipated dredged borrow volume (Figure 6). The bathymetry of the CMS-WAVE grid was obtained by interpolating the scatter survey data to the grid cells as shown in Figure 7.

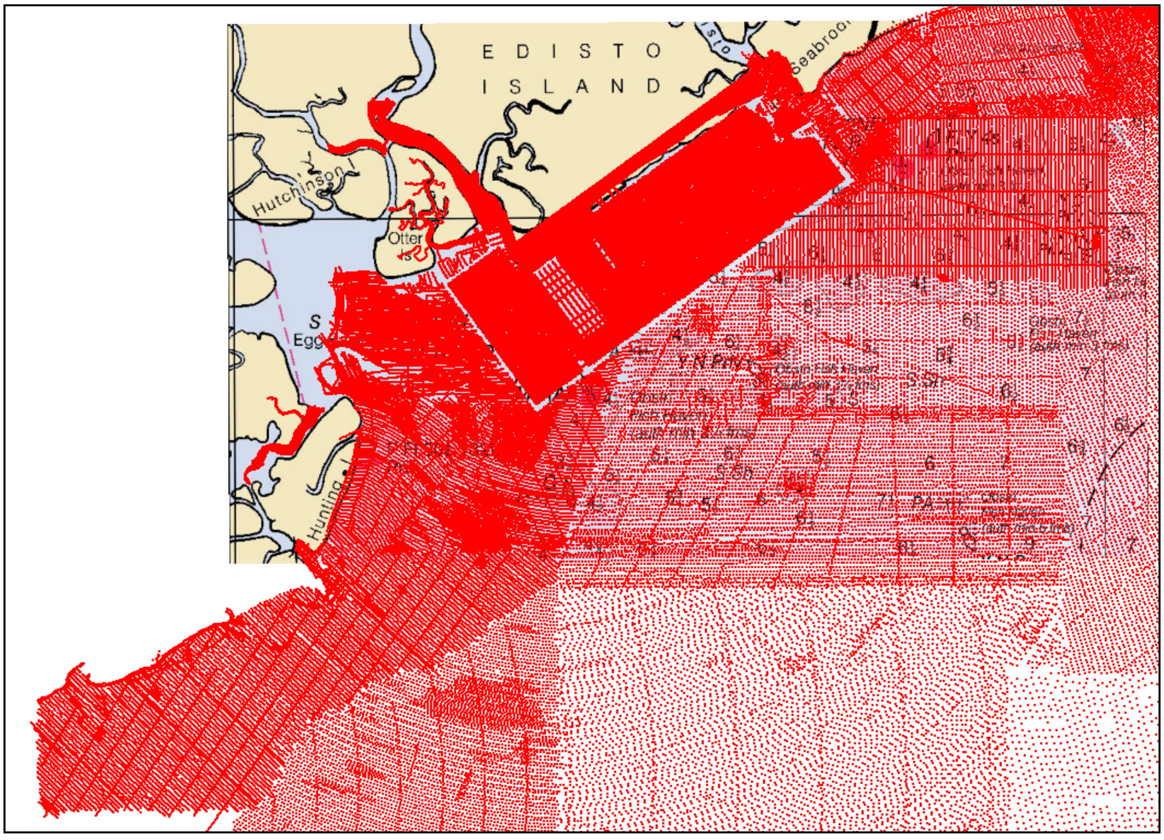


Figure 4- Scatter data coverage

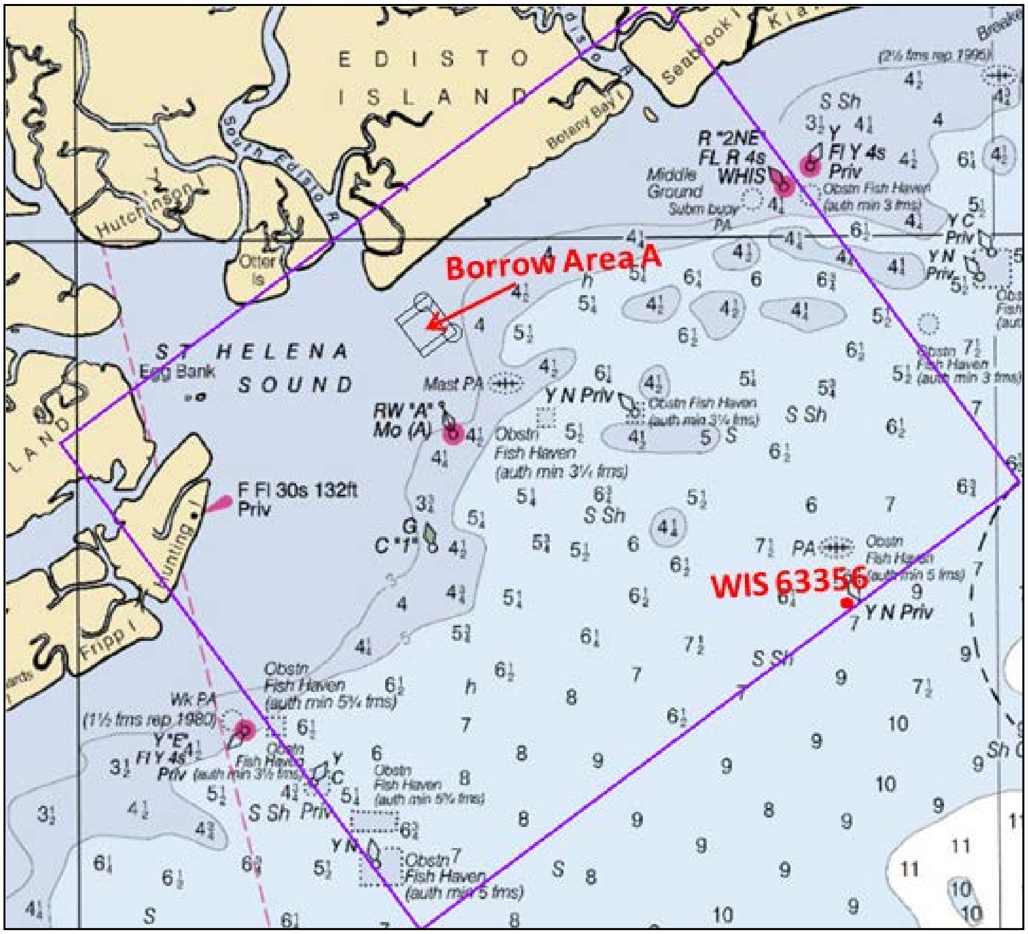


Figure 5- Extent of CMS-WAVE grid

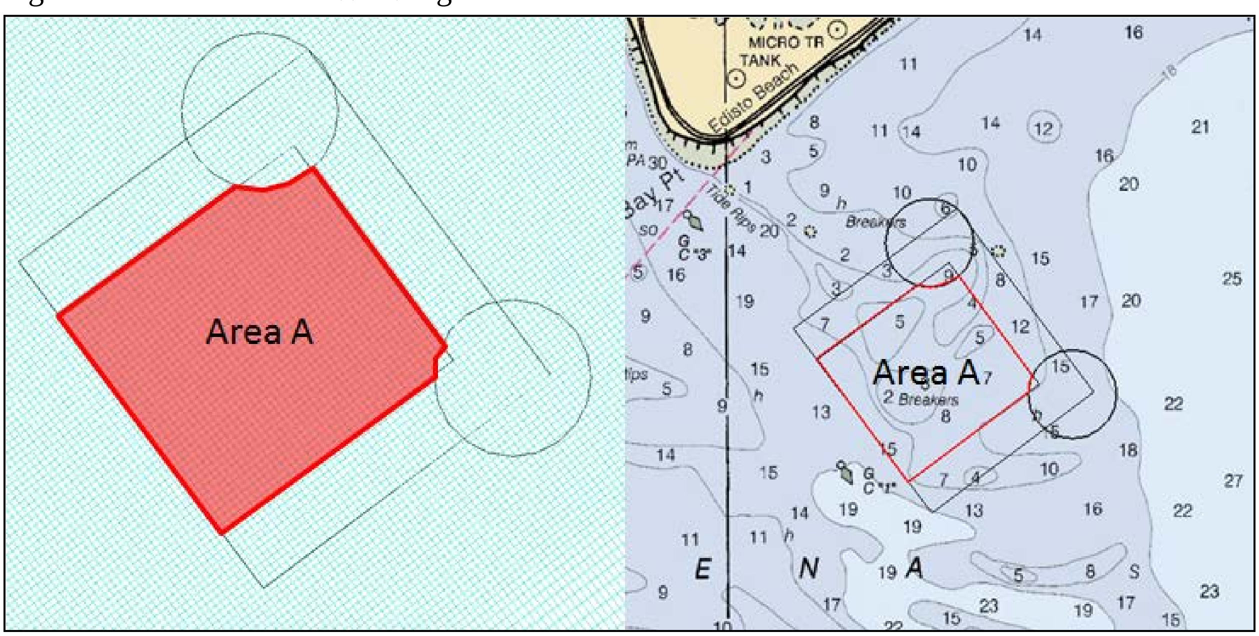


Figure 6- CMS-WAVE grid details within borrow area A

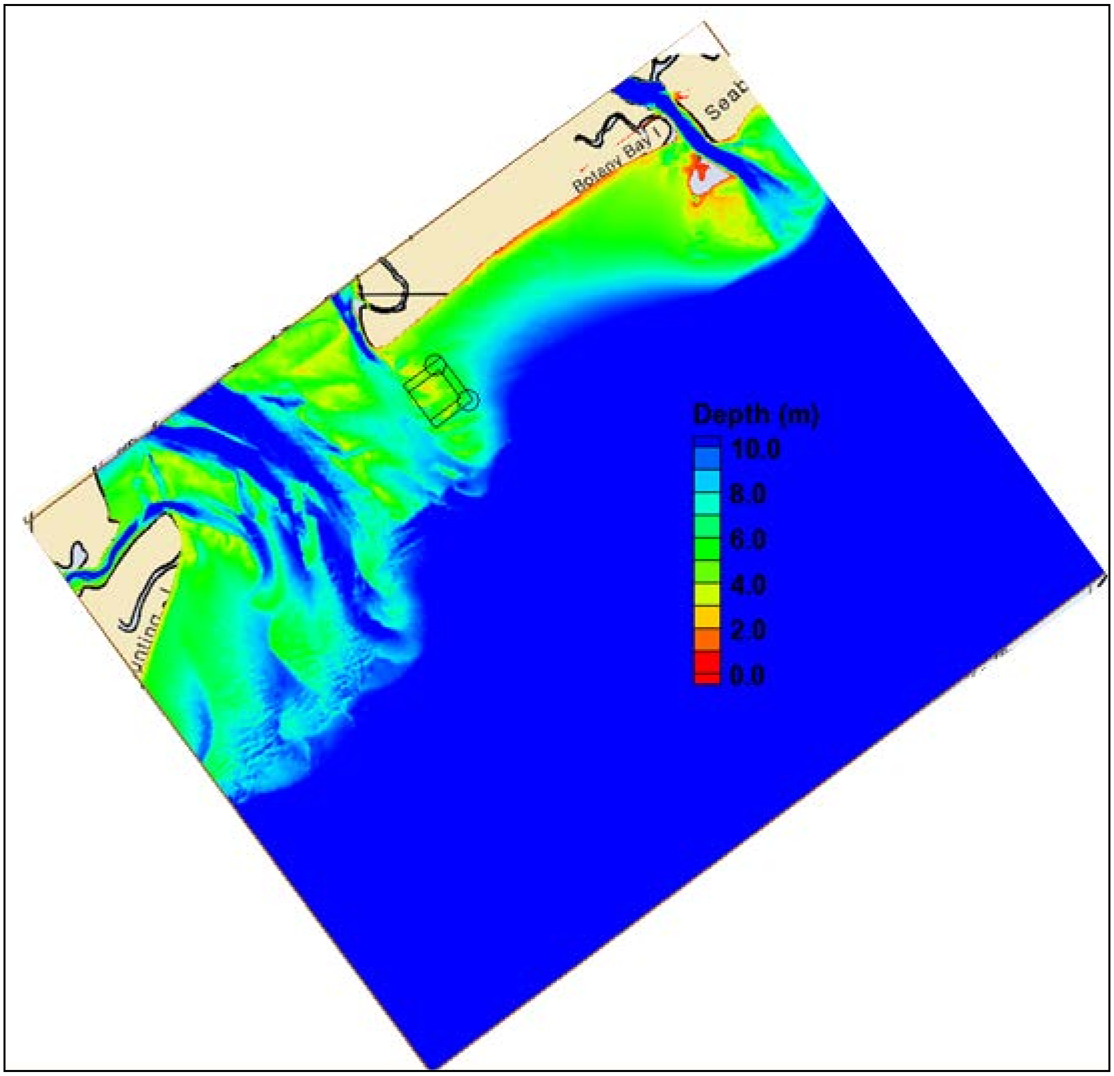


Figure 7- CMS-WAVE grid bathymetry

CMS-WAVE Forcing Conditions

CMS-WAVE was forced with directional wave spectra at the offshore grid boundary. The offshore wave climate provides representative wave boundary conditions. The model was not forced with wind or current fields which are optional.

Wave data used to determine the offshore wave conditions was obtained from the WIS Station 63356 located at Latitude of 32.333° N and Longitude of 80.083° W in 13 m depth. The WIS project produces a high quality online database of hindcast nearshore wave conditions from 1980-1999. The hindcast wave conditions were produced using the latest updated version of the numerical ocean wave generation and propagation model WISWAVE along with wind fields produced by Oceanweather Inc. All Atlantic WIS products, prior to 11/15/2011 (hourly interval), dependent on the parabolic fit wave period, and the wave direction contained errors that were corrected during 2012 (http://wis.usace.army.mil/fix_ATL.shtml). The present study adopted the updated 3-hour interval corrected WIS data.

Figure 8 shows the wave rose diagram of wave height versus wave direction percent occurrence at WIS station 63356 during 1980-1999. The figure shows that waves come mainly from the South East quadrant. Table 1 shows the percent occurrence of heights and periods of all directions at WIS station 63356. It can be seen from the table that wave heights generally range between 0.5-4 m and wave periods range between 5 -10 sec. Also the WIS station mean-maximum summary table (http://wis.usace.army.mil/products.html?staid=63356&lat=32.33300&lon=-80.08300&dep=13), which states the maximum monthly wave height and period during the 20 years of hindcast, was examined. The maximum wave height and period were 8.23 m and 16.01 s respectively. From these statistics, a set of discrete conditions were selected for simulations. The wave height range was defined at 0.5-m intervals from 0.0 m to 2.0 m and at 2 m interval to 10.0 m. The wave period range was 0 to 16 sec at a 3 sec interval. The wave directions were incremented every 22.5 deg. Significant wave height, wave period and vector mean wave direction (degrees clockwise from True north) were adopted in the analysis.

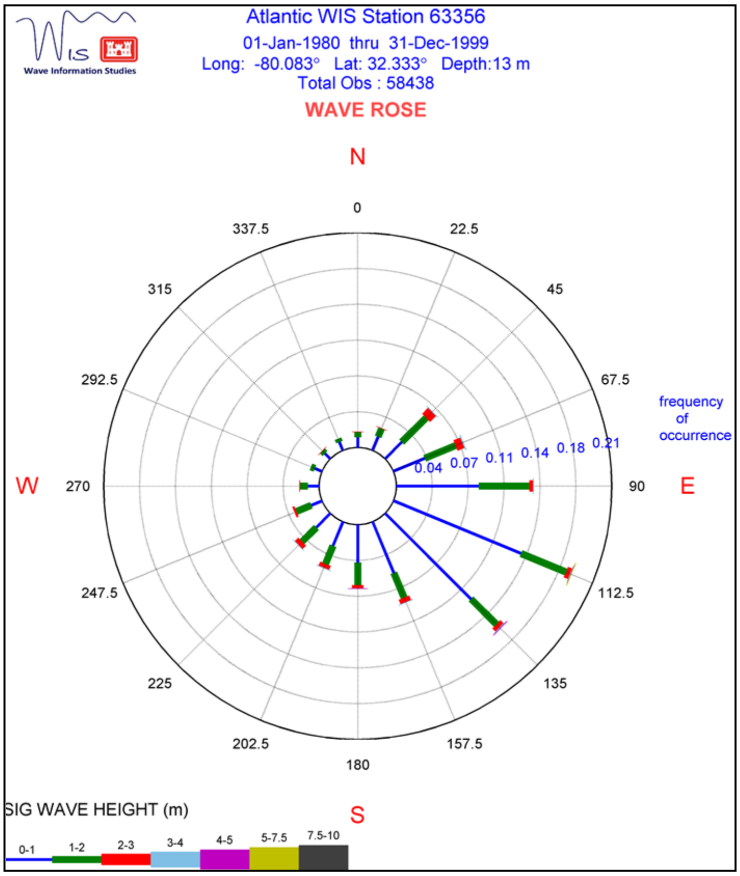


Figure 8- Waverose diagram at WIS station 63356

Table 1- Percent occurrence of wave heights and periods of all directions at WIS station 63356

ATLANTIC WAVE HINDCAST : ST63356_v01
ALL MONTHS FOR YEARS PROCESSED : 1980 - 1999
STATION LOCATION : (-80.08 W / 32.33 N)
DEPTH : 13.0 m

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
FOR ALL DIRECTIONS

NO. CASES : 58437
NO. CALMS : 238

HEIGHT IN METERS	PARABOLIC FIT OF PEAK SPECTRAL WAVE PERIOD (IN SECONDS) <5.0	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-11.9	12.0-13.9	14.0-15.9	16.0-LONGER	TOTAL
0.00-0.10	.	.	.	.	.	.	.	.	.	.	407
0.10-0.49	4298	900	2255	2385	1213	728	438	215	87	47	12566
0.50-0.99	26021	5588	6295	4500	2375	1088	886	342	150	46	47291
1.00-1.49	11051	4907	2880	2214	1692	874	621	465	82	39	24825
1.50-1.99	1052	3780	1955	903	624	474	244	177	83	47	9339
2.00-2.49	136	412	1343	761	364	212	119	102	100	58	3607
2.50-2.99	.	8	318	265	304	186	112	49	35	8	1285
3.00-3.49	.	.	6	46	68	138	68	25	27	5	383
3.50-3.99	.	.	.	.	5	35	42	10	22	5	119
4.00-4.49	.	.	.	.	.	3	22	13	11	3	52
4.50-4.99	.	.	.	.	.	.	1	11	5	10	27
5.00-5.99	.	.	.	.	.	.	5	17	18	.	40
6.00-6.99	.	.	.	.	.	.	.	8	1	.	9
7.00-7.99	.	.	.	.	.	.	.	.	3	.	3
8.00-8.99	.	.	.	.	.	.	.	.	3	.	3
8.00+	.	.	.	.	.	.	.	.	3	.	3
TOTAL	42558	15595	15052	11074	6645	3738	2558	1434	627	268	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 8.2 MEAN TPP(SEC) = 5.9 FINITE

The regional shore line adopted in the study is approximately oriented at 53.4 deg clockwise from North as shown in Figure 9. Statistics were performed for onshore wave direction bands only (67.5 deg-225.5 deg) and other waves were considered as directed offshore and were not considered in the analysis. The wave data was analyzed between 67.5 deg and 225.5 deg directions in 22.5-deg bins.

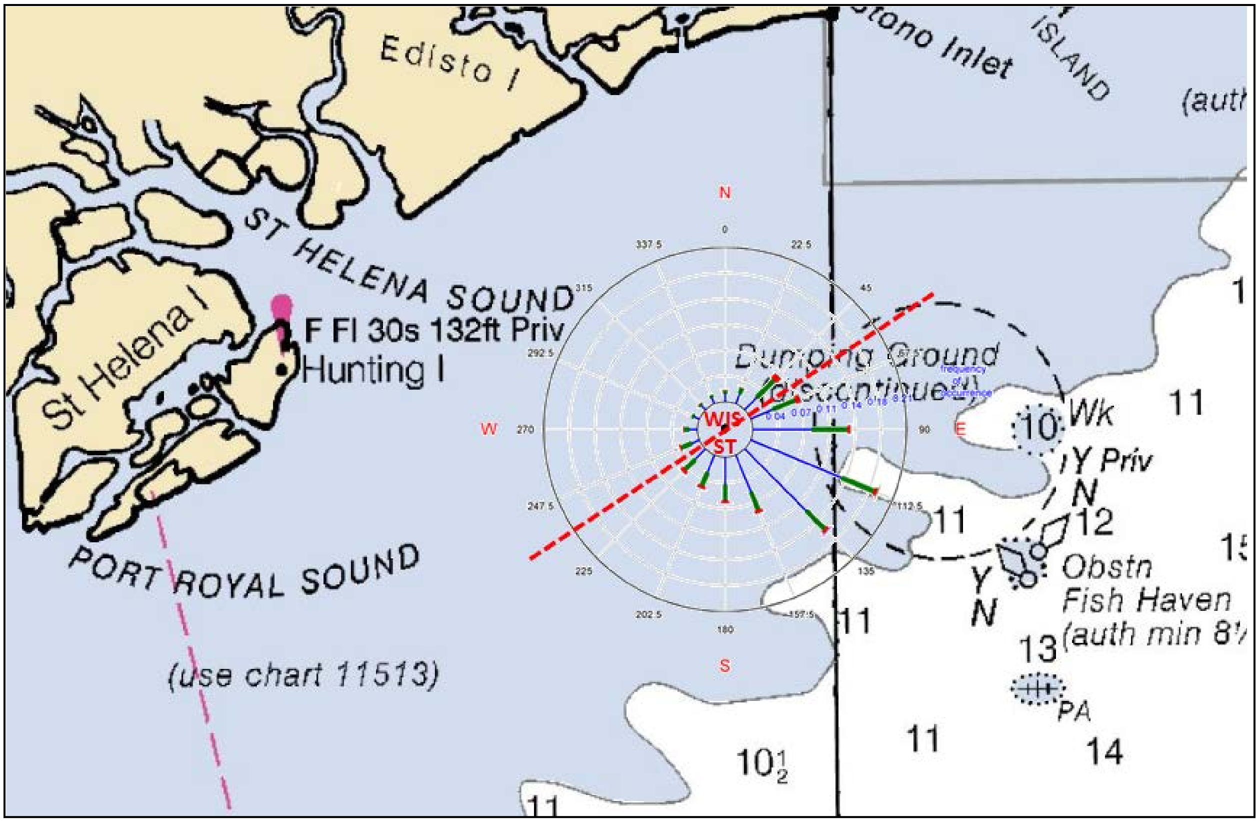


Figure 9- Orientation of regional shoreline and onshore wave bands

The 20 years hindcast record was used to develop a binned approach based on joint probability of wave direction, period and height. MATLAB routine was used to calculate the joint probability of wave direction, period and height. Table 2 shows the selected direction-period-height bins used to synthesize the wave climate. The total number of occurrences from the selected bins was 43781 which represent about 75% of the total waves (58437) at WIS station 63356.

Table 2- Selected wave bins

Bin	Wave Direction (deg, from North)	Wave Period (sec)	Significant Wave Height (ft)
1	67.5 – 90.0	3.0 - 6.0	0.00 - 0.50
2	90.0 - 112.5	6.0 - 9.0	0.50 - 1.00
3	112.5 – 135.0	9.0 - 12.0	1.00 - 1.50
4	135.0 - 157.5	12.0 - 15.0	1.50 - 2.00
5	157.5 - 180.0	15.0 - 18.0	2.00 - 4.00
6	180.0 - 202.5		4.00 - 6.00
7	202.5 - 225.0		6.00 - 8.00

The frequency of occurrence of all possible height-period-direction combinations was estimated. The number of populated wave bin combinations listed in table 2 is 178. For each wave bin, representative wave conditions with percent of occurrence more than 0.5 were selected to represent the normal or the most commonly occurring conditions in the wave climate for this study. Accordingly, 35 wave conditions with total percent of occurrence of about 60 were selected to represent the prevailing wave climate in the study area (Table 3). The Mean-Max summary table for WIS station 63356 was used to extract severe wave conditions. Two wave conditions with extreme wave height and period values were selected to represent storm conditions as shown in Table 3. Wave condition 36 occurred during September 1999 which represents Hurricane Floyd. Wave condition 37 occurred during September 1996 which represents Hurricane Fran. The selected extreme wave conditions had rare occurrences during the hindcast period of 20 years and consequently the percent of occurrence for the two extreme conditions was negligible and is not listed in the table.

Table 3- Representative wave conditions at WIS station 63356

Wave Condition	Wave Direction (deg, from North)	Wave Period (sec)	Wave Height (m)	Percent of Occurrence
1	123.75	4.5	0.75	5.79
2	123.75	7.7	0.75	4.91
3	101.25	4.5	0.75	4.09
4	101.25	7.5	0.75	3.60
5	146.25	4.5	0.75	3.18
6	123.75	7.5	0.25	3.04
7	168.75	4.5	0.75	2.83
8	78.75	4.5	0.75	2.42
9	191.25	4.5	0.75	2.23
10	146.25	7.5	0.75	2.16
11	101.25	7.5	1.25	2.07
12	213.75	4.5	0.75	1.84
13	101.25	4.5	1.25	1.73
14	78.75	4.5	1.25	1.61
15	123.75	4.5	1.25	1.50
16	101.25	7.5	0.25	1.39
17	123.75	7.5	1.25	1.36
18	191.25	4.5	1.25	1.12
19	146.25	4.5	1.25	1.10
20	146.25	7.5	0.25	1.08
21	168.75	4.5	1.25	1.07
22	213.75	4.5	1.25	1.04
23	123.75	4.5	0.25	0.93
24	78.75	7.5	0.75	0.92

25	146.25	7.5	1.25	0.86
26	168.75	7.5	0.75	0.76
27	78.75	7.5	1.25	0.74
28	101.25	10.5	0.75	0.68
29	101.25	7.5	1.75	0.68
30	168.75	4.5	0.25	0.61
31	78.75	4.5	0.25	0.60
32	123.75	7.5	1.75	0.58
33	168.75	7.5	1.25	0.54
34	146.25	4.5	0.25	0.52
35	78.75	4.5	1.75	0.51
36	128	15.47	8.23	Hurricane Floyd
37	120	14.24	5.62	Hurricane Fran

The Surface-Water Modeling System (SMS) (Zundel, 2005) includes the capability to generate incident spectra using a TMA one dimensional shallow-water spectral shape (named for the three data sets used to develop the spectrum: TEXEL storm, MARSEN, and ARSLOE) (Bouws et al. 1985) and a $\cos^{nn}\alpha$. . To generate a TMA spectrum, the following parameters must be specified: peak wave period (*Tp*), wave height, water depth, and a spectral peakedness parameter (γ). The directional distribution of the spectrum is specified with a mean direction and a directional spreading coefficient (*nn*). The energy in the frequency spectrum is spread proportional to $\cos^{nn}(\alpha-\alpha_m)$, where α is direction of the spectral component and α_m is the mean wave direction (Smith et al, 2001). For each of the selected 37 wave conditions, TMA wave spectra were implemented by SMS software.

Figure 10 shows an isopach map of the deposit to determine the volume of the proposed borrow materials. An isopach map is a contour map showing the thickness of a deposit between two physical or arbitrary boundaries. In this case, the upper boundary of the deposit is defined by the surface of the sea bottom and can be delineated by bathymetric data. The lower boundary is the borehole depth which is created by interpolating the scatter borehole data to a uniform grid with a resolution of 20 m. The removal depth is to follow the borehole surface created from the borehole scatter data set. The dredged borrow area provides an estimated volume of 7.2 Mcy of beach placement material.

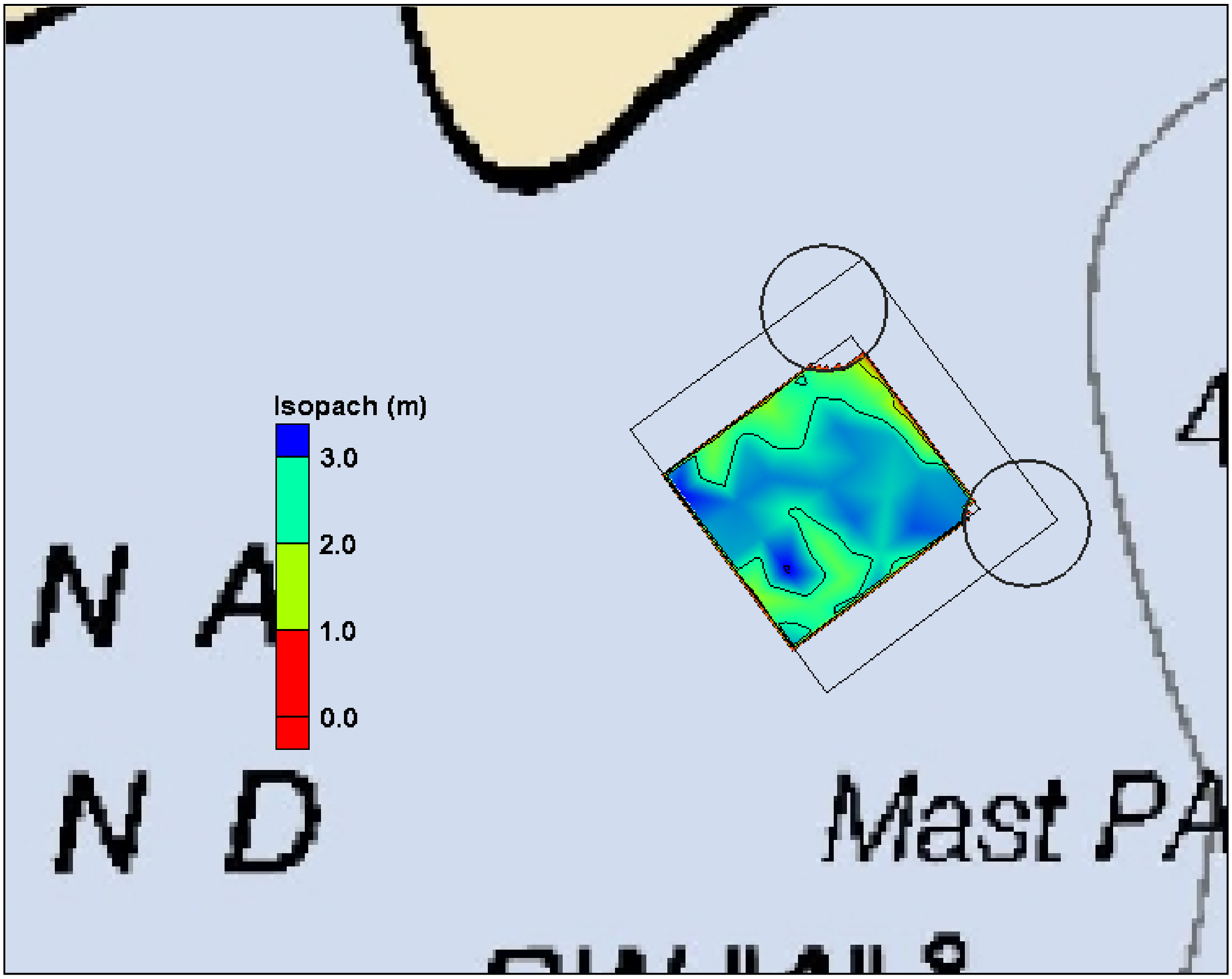


Figure 10- Borrow area isopach

The existing grid bathymetry was modified to incorporate the proposed dredged depths. Figure 11 shows the modified bathymetry of the CMS-WAVE grid at the proposed borrow sites. Therefore the only difference between the before- and the after-dredge CMS-WAVE grids was within the borrow area boxes shown in the figure.

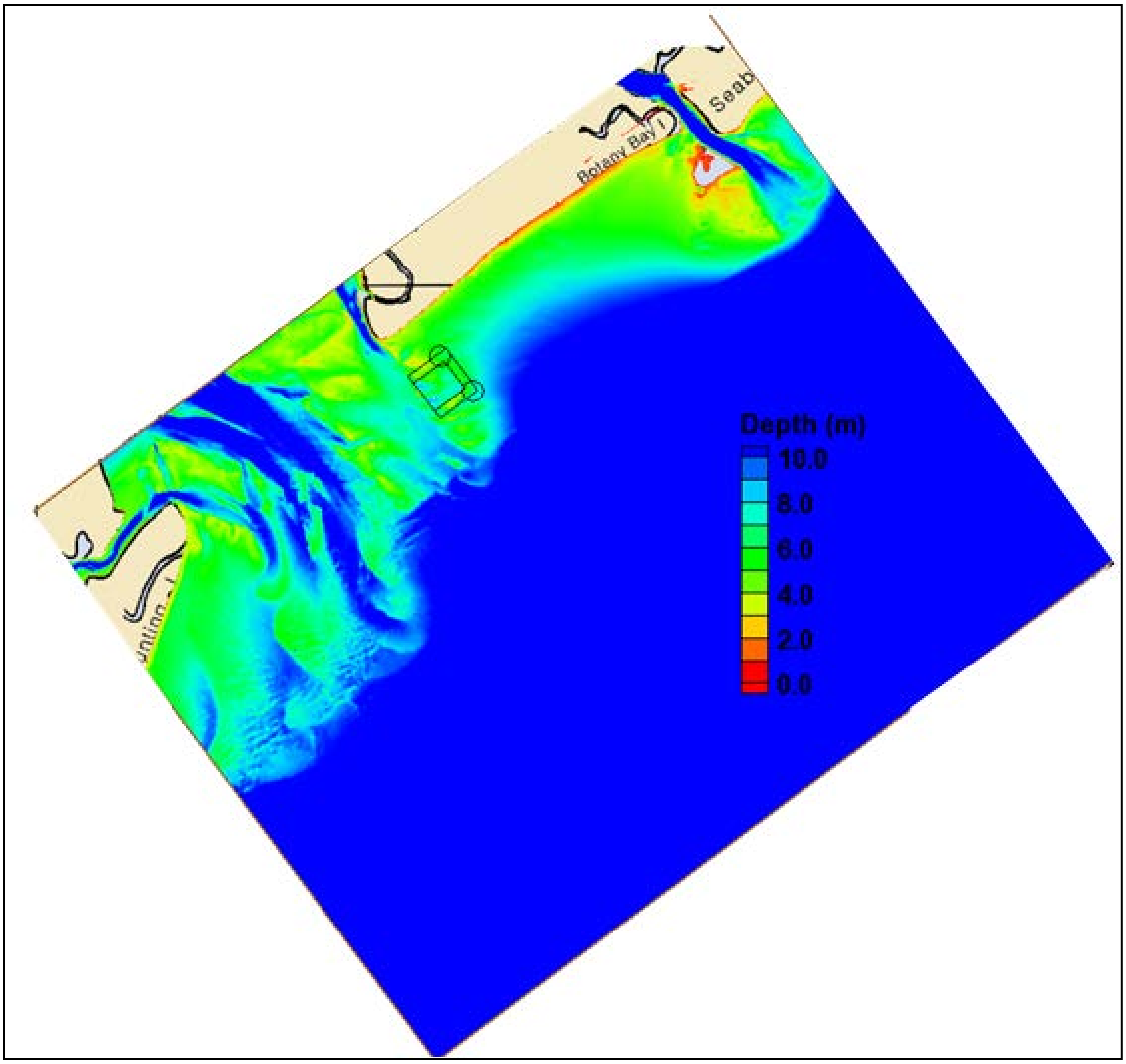


Figure 11- CMS-WAVE grid bathymetry after excavating the proposed borrow area

Wave Model Simulations

CMS-WAVE model simulations were conducted with and without the borrow area excavation to investigate the potential for adverse effects of mining on the wave climate along Edisto Beach shorelines. CMS-WAVE simulations for the synthesized 37 wave conditions were conducted for the existing and after dredging the borrow area grids to investigate the impact of dredging on wave climate in the study area.

This analysis was conducted based upon the assumption of fully excavating the entire borrow area. This extreme borrow area removal is a highly unlikely scenario because the total estimated volume requirements of the project are approximately 3.4 Mcy whereas the simulated excavated volume is approximately 7.2 Mcy. Furthermore, excavation of the borrow area is scheduled to take place periodically over the nourishment project life of 50 years. Therefore, the investigated scenario represents a worst case condition.

When wave angles deviate by about 60 deg or more from perpendicular to the seaward boundary, such model-induced energy losses are usually significant (Thompson, et. al., 1999). Wave conditions within Bin 1 and 7 deviate by 64.75 deg and 70.25 deg from perpendicular to the seaward boundary but since only qualitative comparison of wave height is being investigated in this study, Bin 1 and 7 cases were not rerun with rotated grids.

Wave conditions 1 thru 5 represent about 21.5% of the modeled wave climate with wave height of 0.75 m and South East wave direction. Figure 12 shows the difference in wave height due to excavating the proposed borrow area for wave condition 1 which can be considered representative of the most prevailing wave climate in the area with percent of occurrence of 5.79. The wave height difference was estimated by subtracting the existing wave height values from the excavated borrow area wave height values. The positive wave height difference (cool colors) indicates wave height increase and the negative wave height difference (warm colors) indicates wave height decrease. The arrows in the figure represent the existing wave direction. The figure shows that dredging the borrow areas has minimal change on the wave climate with maximum wave height change of less than 10 cm in the borrow area vicinity. The change in wave height, due to the borrow area excavation, for the 35 prevailing wave conditions was examined and the maximum increase of wave height was about 25 cm within the offshore borrow area vicinity except for wave conditions 29 and 32. The maximum increase of wave height for wave conditions 29 and 32 was about 50 cm and 60 cm respectively within the borrow area. Figure 13 shows the difference in wave height, due to excavating the proposed borrow area, for wave condition 29 with input wave height of 1.75 m, wave period of 7.5 s and wave direction of 101.25 deg. Figure 14 shows the difference in wave height, due to excavating the proposed borrow areas, for wave condition 32 with wave height of 1.75 m, wave period of 7.5 s and wave direction of 123.75 deg. The percent of occurrence of wave conditions 29 and 32 is 0.68 and 0.58 respectively.

Figures 15 and 16 depict wave height change of more than 5 cm in front of the Edisto Beach shorelines. Figure 15 shows that the impact zone of the borrow area significantly increased due to the increase in the wave period (wave conditions 15 and 17). The figures show that the wave height increase never exceeded 25 cm within the nearshore area between the Edisto Beach shorelines and the borrow area. Also, the figures show the shift in the impact zone due to the variations in the spectral wave approach. In addition, the change in wave height was confined within the borrow area and in the nearshore area in front of Edisto Beach and did not extend to the West toward St. Helena Sound or to the East toward Edisto State Park Beach.

Figures 17 and 18 show the wave height change due to excavating the proposed borrow area for wave cases 36 (Hurricane Floyd) and 37 (Hurricane Fran) which represent extreme weather conditions during the 20 years with very rare occurrences. Inclusion of the water level is important for the extreme wave events because otherwise dissipation from depth-induced wave breaking would be overestimated. Therefore, the wave data might be overestimated since surge values were not included in the analysis. Wave transformation was governed by refraction and breaking in the nearshore shallow area in front of the shorelines. Cross-shore transport impact due to storm is not included in this study.

Figure 19 shows the wave height change at six points in the local vicinity of the borrow area for the prevailing wave conditions (1 thru 35). It can be seen from the figure that the maximum wave height increase within the offshore borrow area was approximately 25 cm except for wave conditions 29 and 32. The maximum observed wave height increase in the borrow area vicinity was about 1.8 m and 2.1 m for wave conditions 36 and 37 respectively. Most of the wave height increase in the proximity of the borrow site occurred along the South Eastern and North Western boundaries of the borrow area, mainly due to wave energy focusing at the borrow areas boundaries.

CMS-WAVE estimated the breaker index at each cell of the grid. Grid cells with active breaking are specified with an index of 1 and nonbreaking cells are specified with an index of 0 (Smith et al., 2001). A Transect was delineated, in front of Edisto Beach shorelines, just seaward of the breaker index of 1 for each cell. Figure 20 shows the change in wave height, before and after dredging the proposed borrow area, along the Transect in front of Edisto Beach. The figure indicates a maximum wave height increase of approximately 10 cm along Edisto Beach shorelines. Also, Figure 18 shows the cumulative average wave height difference along the Transect (excluding the two extreme wave conditions).The cumulative maximum average wave height increase was negligible (about 2 cm) along Edisto Beach shorelines. Figure 21 shows the change in wave direction along the Transect with maximum change of about 4 deg. The maximum change in wave height and direction occurred in front of Edisto Beach, between distances 1000 m and 4000 m along the Transect, due to its proximity to the borrow area site.

The four wave transformation processes associated with offshore bathymetric changes due to borrow pits can include wave refraction, diffraction, reflection and dissipation (Tang, 2002).The nearshore bathymetry has significant limiting effect on the amount of wave energy that reaches the shoreline from a given direction (USACE, 2008). Even during extreme wave events, wave heights were small along the Edisto Beach shoreline. This is mainly due to wave dissipation at the nearshore shallow bathymetry in front of the shorelines which provides sheltering to Edisto beach (Figure 22).

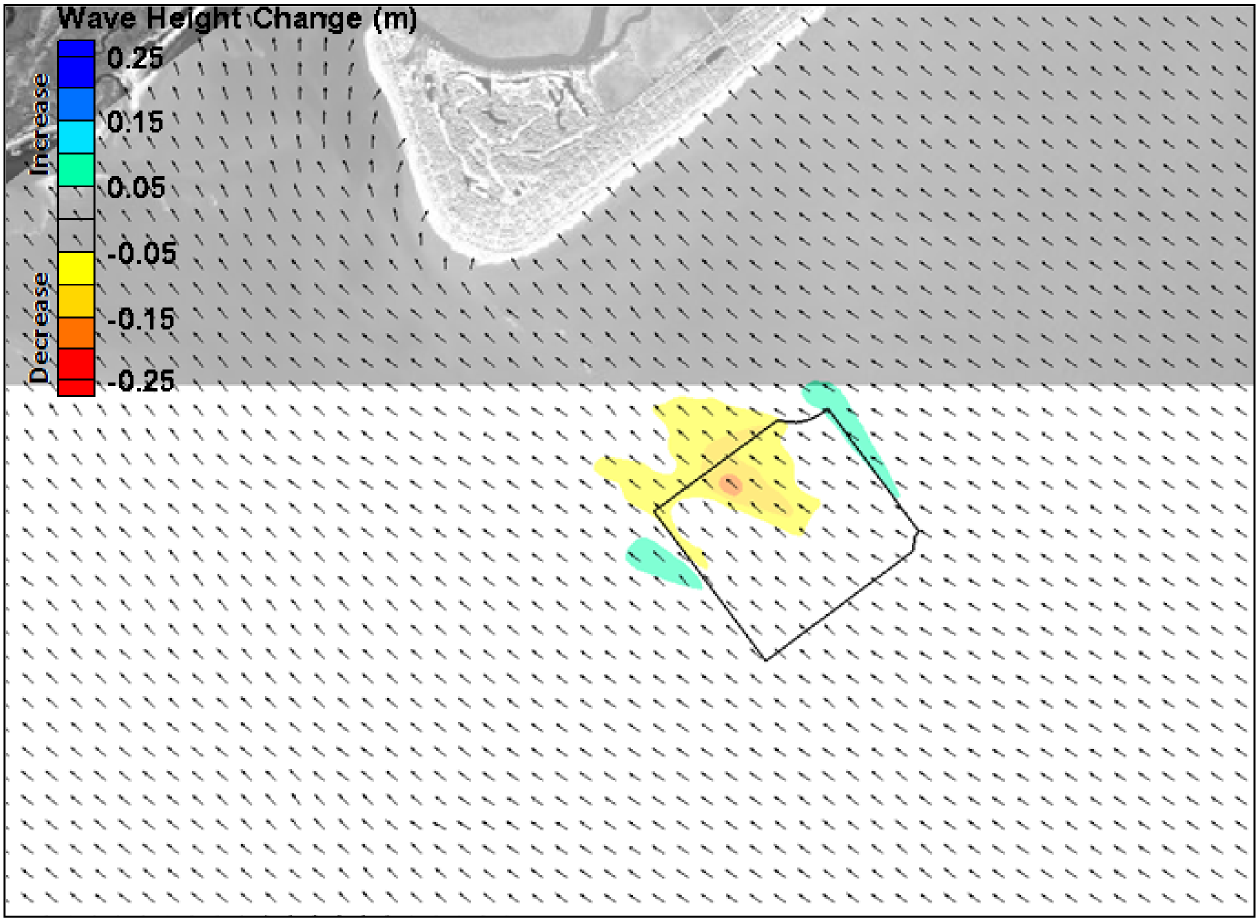


Figure 12- Wave height change for wave condition 1

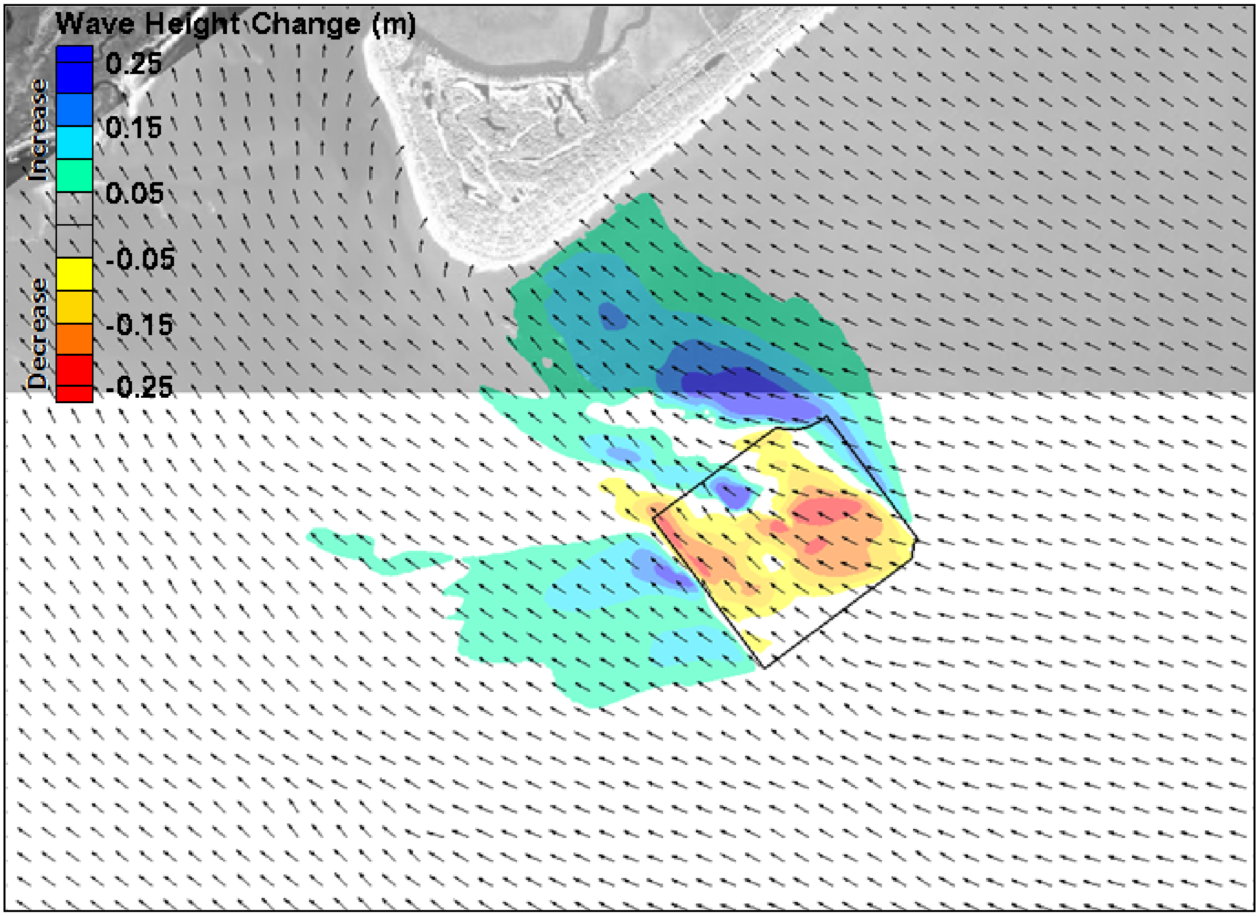


Figure 13- Wave height change for wave condition 29

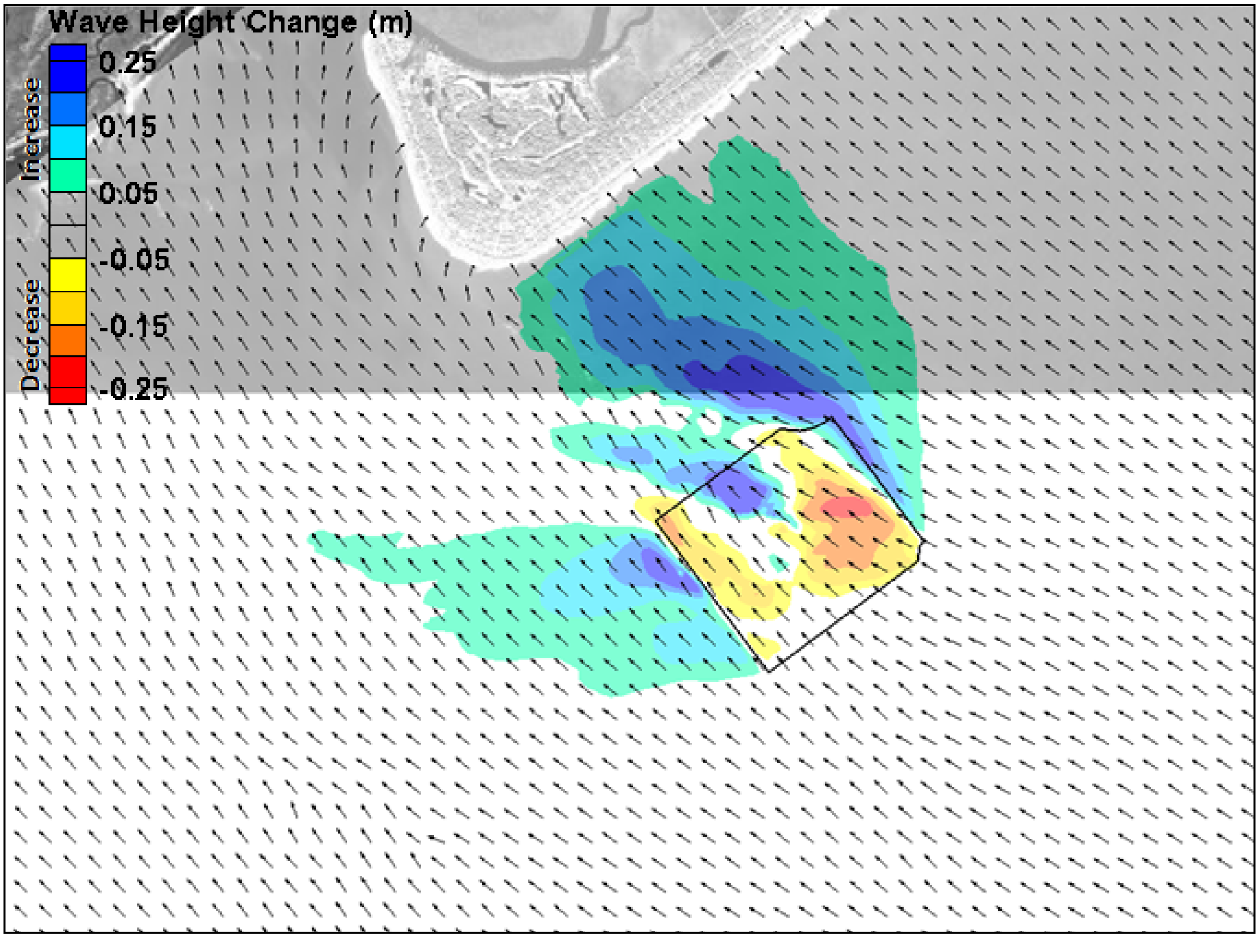


Figure 14- Wave height change for wave condition 32

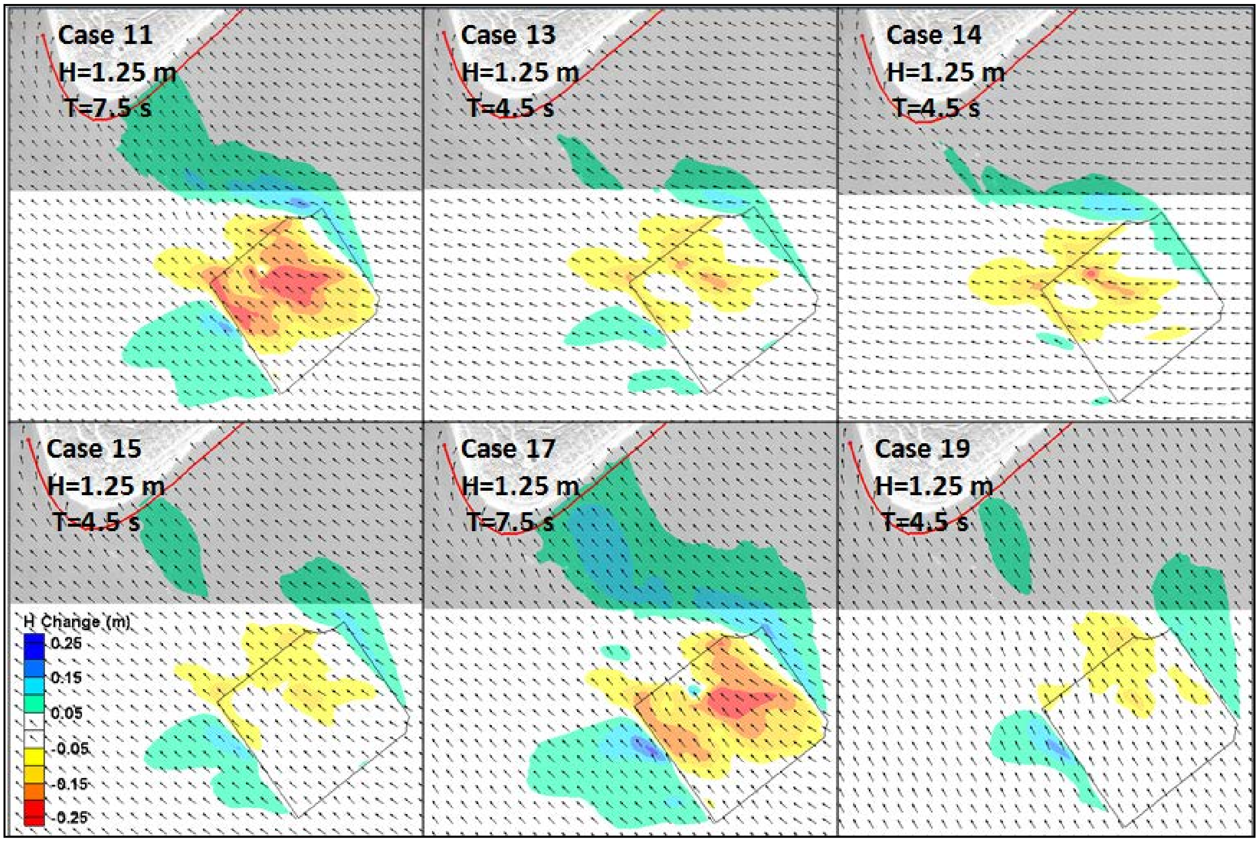


Figure 15- Wave height change for wave condition 11, 13, 14, 15, 17 and 19

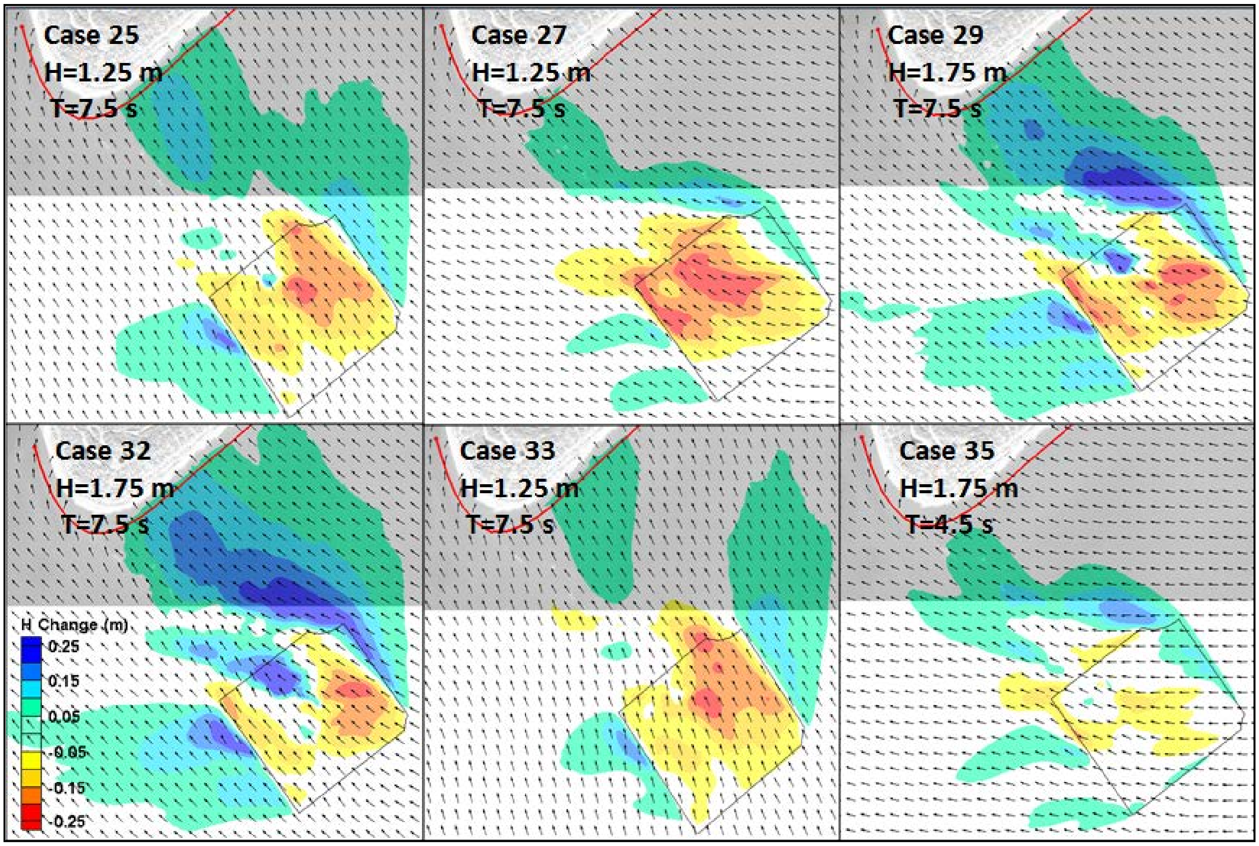


Figure 16- Wave height change for wave condition 25, 27, 29, 32, 33 and 35

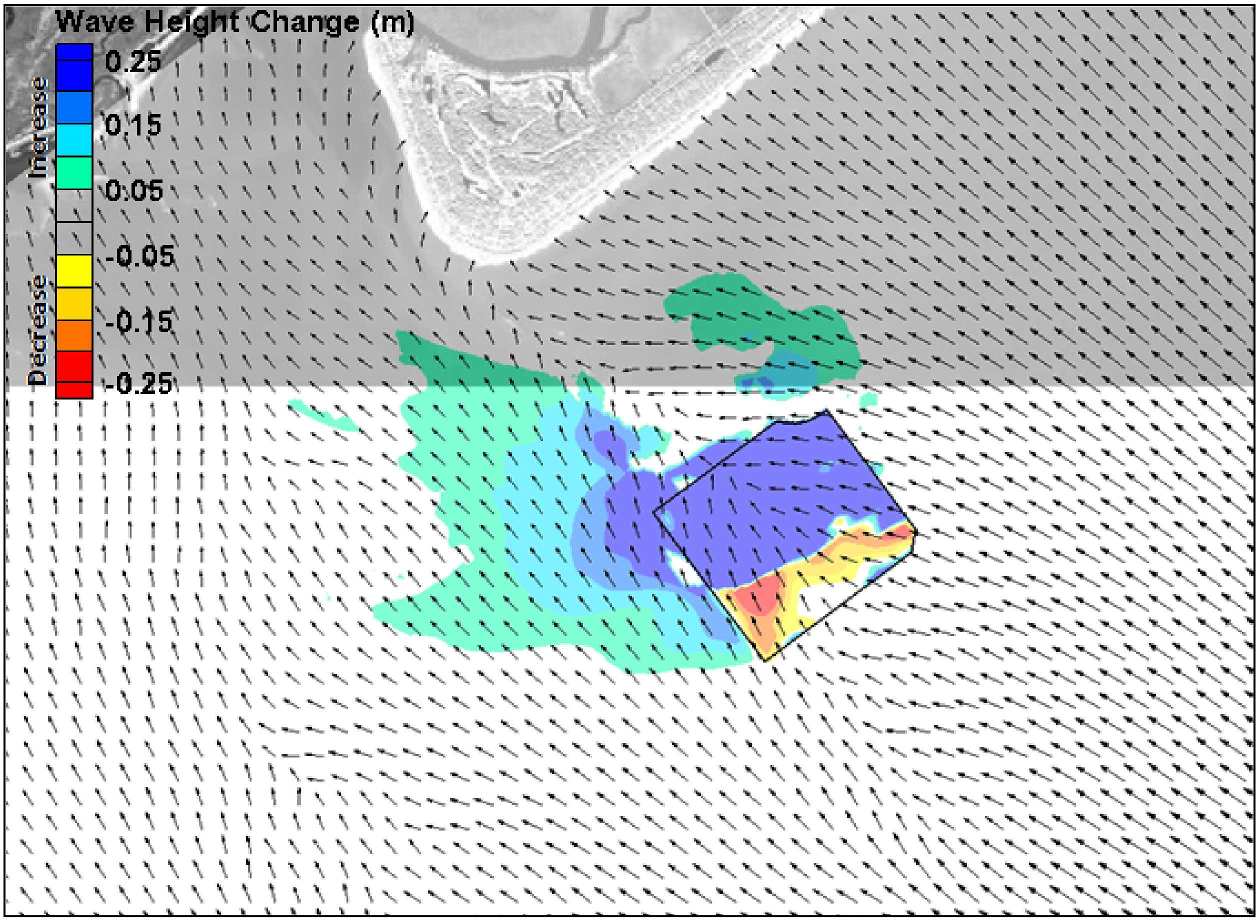


Figure 17- Wave height change for wave condition 36

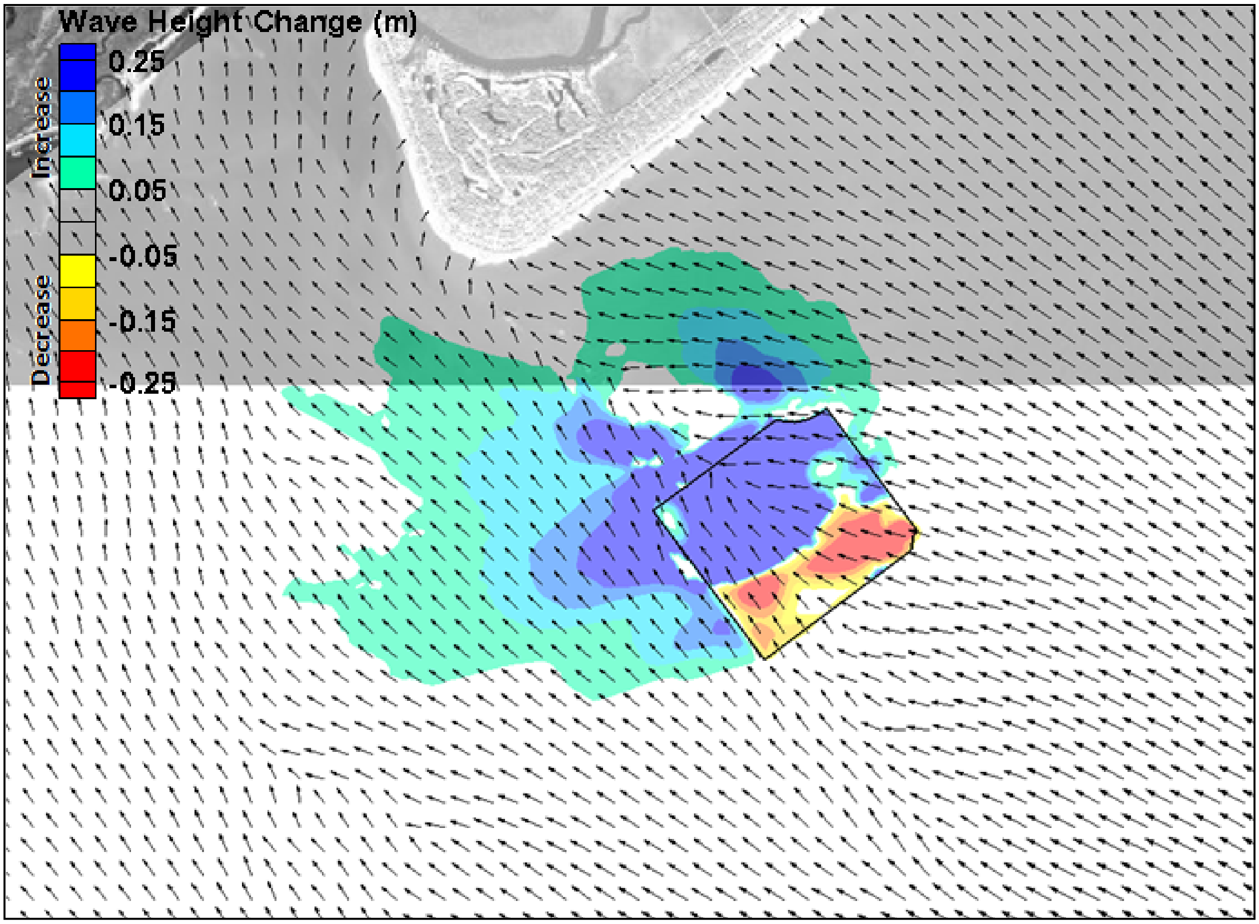


Figure 18- Wave height change for wave condition 37

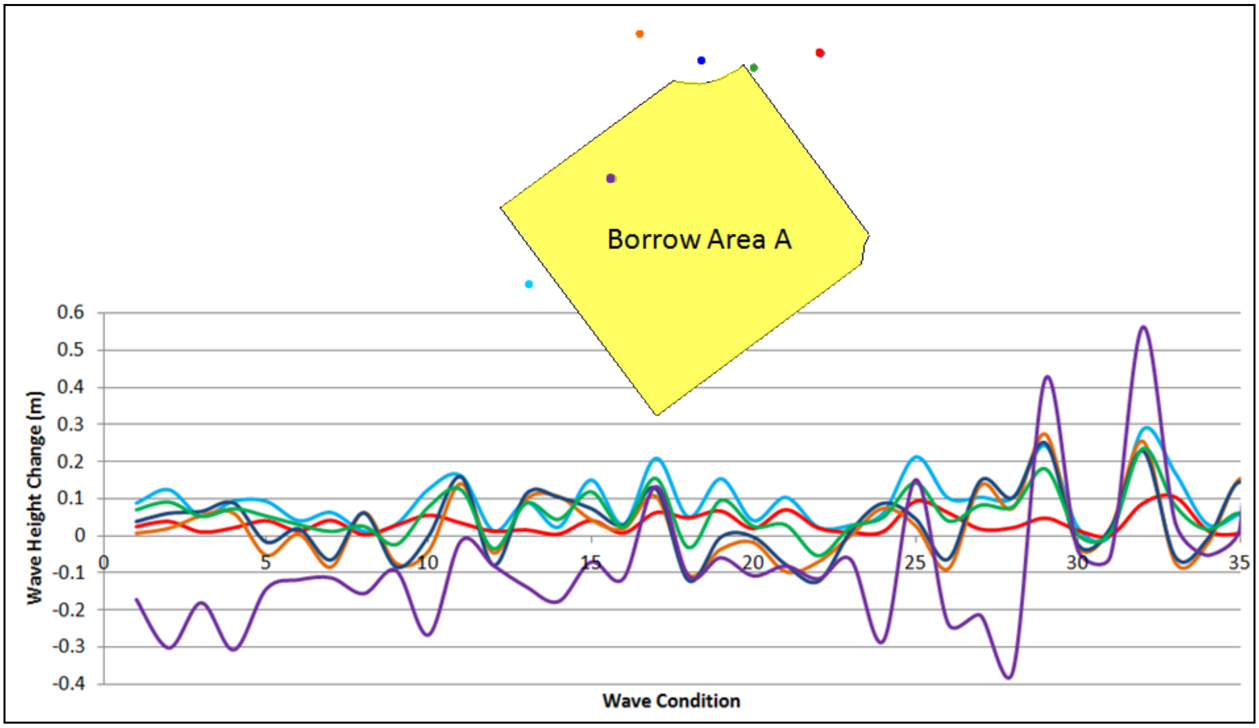


Figure 19-Wave height change at points within the borrow areas vicinity

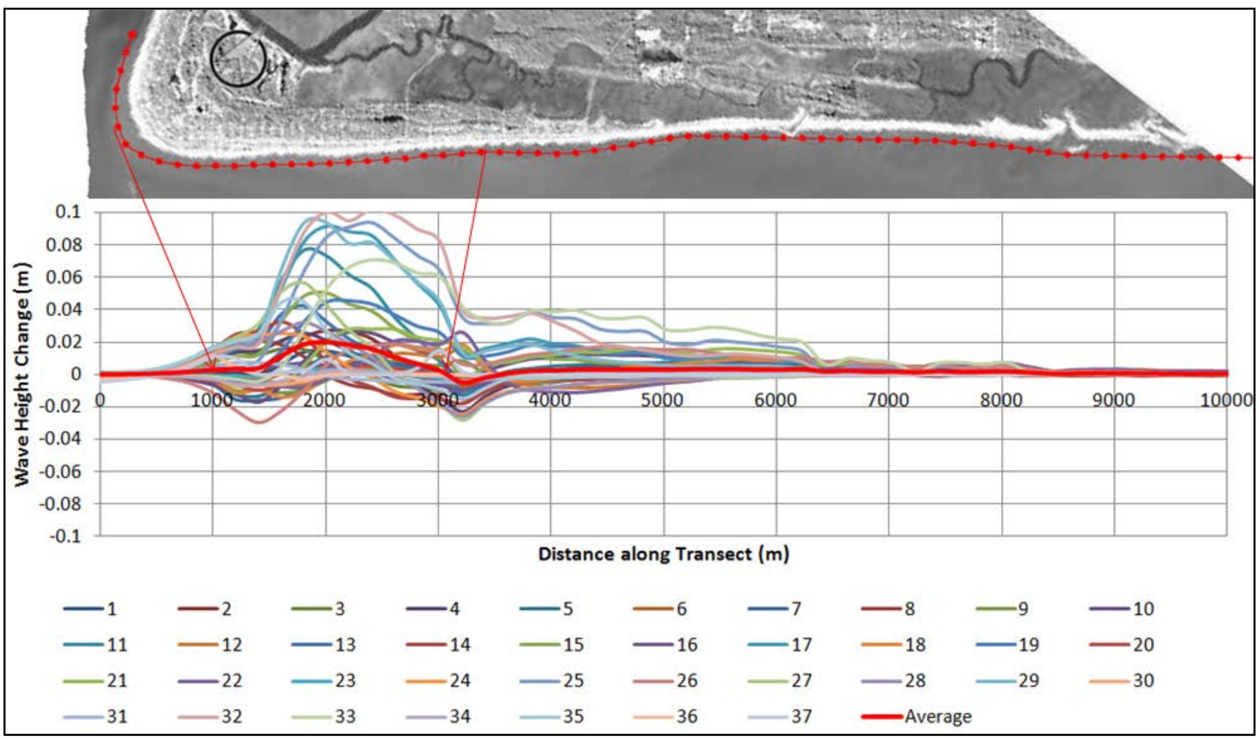


Figure 20-Wave height change along Edisto Beach Transect

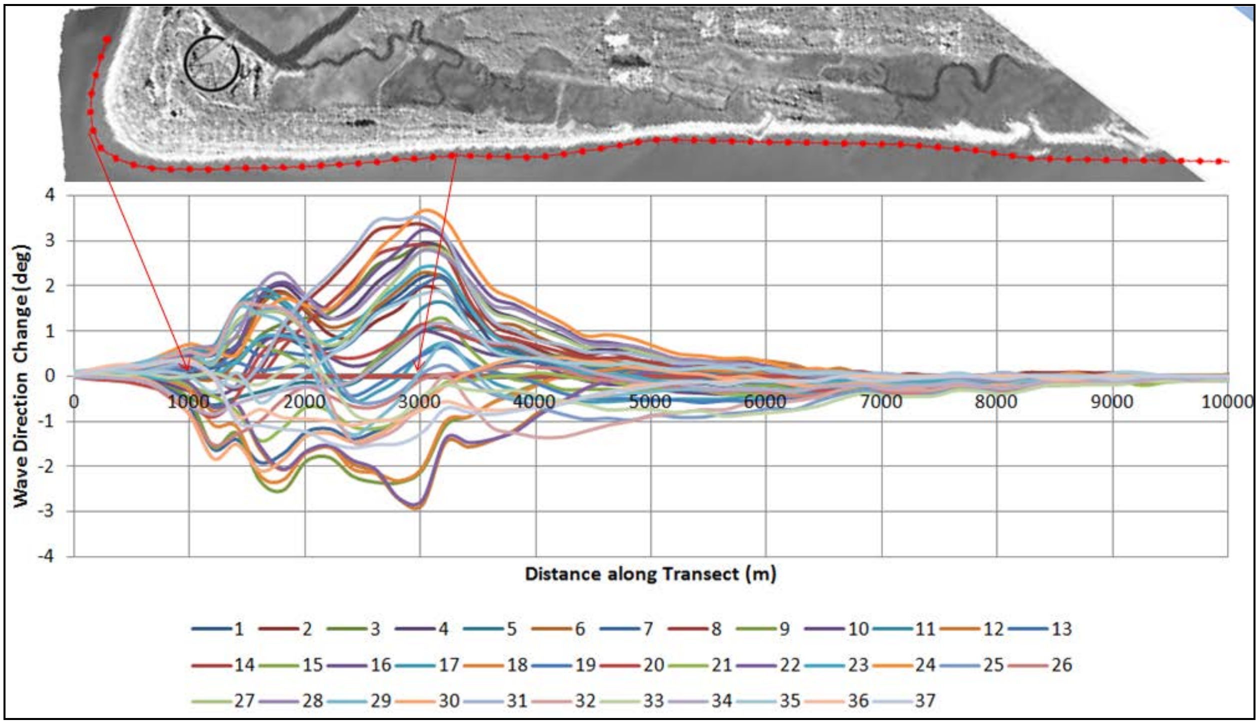


Figure 21-Wave direction change along Edisto Beach Transect

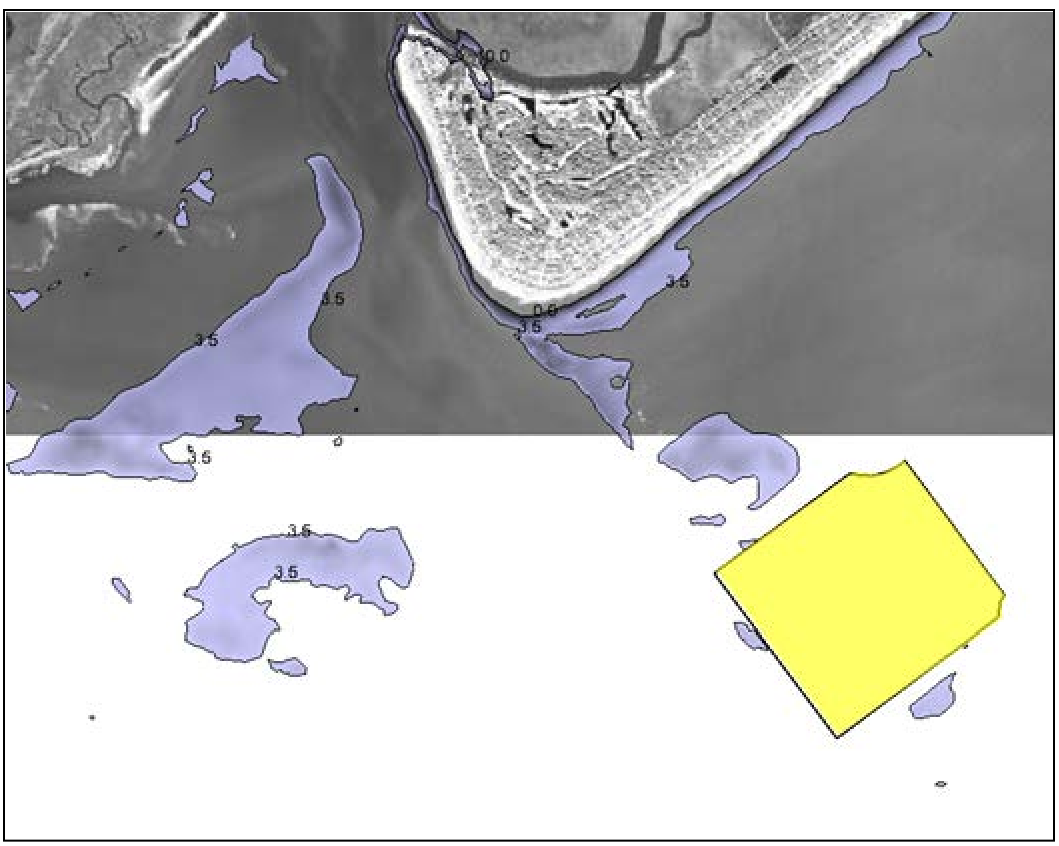


Figure 22-Shoal areas (3.5 m, MTL) in front of Edisto shorelines

Significance of Borrow Area Impacts

The changes in wave height and direction generated at the borrow site may produce corresponding changes in breaking wave height and direction along a broad shadow zone at the shoreline. In turn, changes in breaking wave conditions may potentially alter predicted longshore transport patterns, creating areas of increased erosion or accretion (Olsen, 2007).

USACE (2007) stated that for borrow site studies in Alabama (Byrnes et al., 1999) and New Jersey (Byrnes et al., 2000), the significance of borrow site impacts were evaluated relative to potential error estimates associated with wave height and direction (Rosati and Kraus, 1991). It was concluded that if percent changes in longshore sediment transport caused by offshore sand mining were less than the percent error determined for wave height/direction estimates, the impact was insignificant (Kelley et al., 2001).

Kraus and Rosati (1991) stated that the uncertainty in the longshore transport rate (Q) is defined as:

Uncertainty in Q = Q (wave direction uncertainty + 2.5 wave height uncertainty)

The uncertainty in wave height is greatly amplified compared to the uncertainty in wave angle.

CPE (2007) stated that the error margin of wave direction in the Gulf of Mexico is approximately 10 deg and the root-mean-square difference between WIS hindcast wave height and the measured wave height is 1.2 feet. The largest changes due to excavating borrow area 11 (Panama City Beaches Restoration Project) was 1 foot and 9 deg. Modifications to the wave refraction patterns due to excavation of borrow area 11 were considered minor because the changes to wave height and wave direction were lower than the WIS marginal values. The Gulf of Mexico WIS accuracy values (10 deg and 1.2 ft) are conservative estimate for the WIS Atlantic stations accuracy values (personal communications, Dr. Robert Jensen, ERDC). In this study, the potential longshore transport was not calculated and the change in wave height and direction was used to assess the significance of the borrow area impact. The maximum change of wave height and direction along Edisto Beach shorelines,10 cm and 4 deg, is less than the WIS Atlantic stations accuracy values which indicates that the borrow area impact can be considered insignificant. Olsen (2007) used the Atlantic WIS data to study the impact of borrow area on local wave climate for Bald Head Island NC. The maximum change in wave height of 9 cm along Bald Head Island shoreline was considered insignificant.

Conclusions

CMS-WAVE was used to estimate wave transformation change along Edisto Beach shorelines due to the excavation of proposed borrow area for 50 year nourishment project. WIS station 63356 was used to synthesize the offshore wave climate. Thirty seven simulations were conducted to assess the impact of dredging the borrow areas on wave climate in the study area.

Maximum wave height increase of about 10 cm was observed along Edisto Beach shorelines for the thirty seven wave conditions. Even during extreme weather conditions, maximum wave height increase due to the borrow area excavation was small along Edisto Beach shoreline. The cumulative average wave height increase was also negligible. The maximum change in wave direction along Edisto Beach shorelines was about 4 deg.

The change in wave height was mainly localized within the borrow area and in the nearshore area in front of Edisto Beach and did not extend to the West toward St. Helena Sound or to the East toward Edisto State Park Beach. Maximum increase of wave height of less than 25 cm was observed in the offshore borrow areas vicinity for wave conditions 1 thru 35 except wave conditions 29 and 32. Maximum wave height increase, of about 2.0 m, occurred in the borrow area vicinity only during storms. During a storm event, waves are large even without modifications caused by dredging.

Predicted changes in longshore sediment transport rates resulting from offshore sand mining are expected to have minimal impact along the shoreline. Although changes during storm conditions illustrated greater variation within the borrow area, the relative impacts along the shorelines were similar to non-storm conditions. This is mainly due to dissipating wave energy at the nearshore shallow bathymetry.

This analysis was conducted based upon the assumption of fully excavating the entire borrow area. This extreme borrow area removal is an unlikely scenario because the excavation of the borrow areas is scheduled to take place periodically during the nourishment project life of 50 years. Furthermore, the simulated volume of material excavated from the borrow area is more than twice the estimated volume needed for the beach nourishment project. Therefore, the investigated scenario represents a worst case condition. USACE (2009) stated that the total time for the borrow area to fully recover was estimated at 1.75 years. This recovery rate is expected to farther mitigate the impact of the borrow area mining on Edisto Beach shorelines.

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EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX F

BIOLOGICAL ASSESSMENT OF THREATENED AND ENDANGERED SPECIES

US Army Corps
Of Engineers®
Charleston District

BIOLOGICAL ASSESSMENT

COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

EDISTO BEACH, COLLETON COUNTY
SOUTH CAROLINA

August 2013

1.0 INTRODUCTION

Edisto Beach is a barrier island located at the mouth of the Edisto River in Colleton and Charleston Counties, South Carolina, approximately 45 miles southwest of Charleston, South Carolina and approximately 20 miles east-northeast of Beaufort, South Carolina (see Figure 1). The incorporated Town of Edisto Beach is located on the island, as is Edisto Beach State Park. The specific study area (See Figure 2) includes Edisto Beach, two Coastal Barrier Resources Act (CBRA) zones (the Edisto Complex (Unit M09) to the northeast and Otter Island (Unit M10) to the southwest), and the coastal Atlantic Ocean waters where offshore borrow investigations will be conducted and potential borrow areas will be identified and located.

The Town of Edisto Beach and Edisto Beach State Park are part of Edisto Island. They are separated from the main body of Edisto Island by Big Bay Creek, Scott Creek, and the associated salt marsh to the northwest and Jeremy Inlet to the northeast. The Town of Edisto Beach and Edisto Beach State Park are also bounded by the South Edisto River and St. Helena Sound to the southwest and the Atlantic Ocean to the southeast. The maximum width at the southern end of this portion of Edisto Island is approximately 1.5 miles, while the northern end is much narrower. The Town of Edisto Beach occupies the central and southern portions of the island and is generally separated from Edisto Beach State Park by State Highway 174, which provides the only access to the island. Its beachfront extends approximately 4.5 miles between Highway 174 and the South Edisto River/St. Helena Sound. The town has been developed as a permanent and seasonal residential area with limited commercial development. Edisto Beach State Park occupies approximately 1,255 acres of the island and is structured around a dense live oak and maritime forest. It offers ocean and marsh side camping sites, as well as cabins, picnic areas, and nature and hiking trails. The park is one of the most heavily visited of the South Carolina state parks, with approximately 327,000 recorded visitors in 2002. Its beachfront extends approximately 1.5 miles between Jeremy Inlet and Highway 174.

An environmental assessment (EA) has been prepared to evaluate the overall environmental impacts of the proposed project. This document evaluates the impact of the proposed project on threatened and endangered species and will be incorporated in the EA.

The Town of Edisto Beach has indicated that the most significant problem facing the study area in the near future and over the next 50 years is the threat to buildings and infrastructure from coastal storms, particularly along the northern shoreline. The threat to structures is exacerbated by high levels of long-term beachfront erosion. The loss of the beachfront threatens not only the local economy and tourism in the small coastal community, but has National Economic Development impacts as well when resources that could be used elsewhere are devoted to storm recovery and rebuilding efforts that could have been prevented. Additionally, there is a lack of local resources, both natural and financial for addressing coastal storm damage problems. Sources of beach quality sand are becoming increasingly difficult to obtain and local funding for renourishment projects is diminishing.

The overall goal of the study is to reduce the adverse economic effects of coastal storms at Edisto Beach, South Carolina. Specific goals are to:

(1) Provide coastal storm damage reduction (as measured by increases in NED net benefits) to approximately 4.5 miles of the Edisto Beach shoreline.

(2) Reduce the risks of damages to SC Hwy 174, which is the only emergency evacuation route for the community.

(3) Preserve sea turtle nesting habitat and protect shorebird nesting habitat, foraging areas, and roosting areas.

2.0 PROPOSED PROJECT

The proposed project was determined after a detailed alternatives analysis documented within the Feasibility Study/Environmental Assessment. The project consists of the following elements: 1) A 15-foot high (elevation), 15-foot wide dune beginning at the northern end of the project (i.e., the southern end of the State Park) and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would then taper to a 50-foot width for the remaining length of the berm. The width of each end of the berm would taper to tie into the existing beach profile; 2) The dune would then transition into a 14-foot high (elevation), 15-foot wide dune that extends around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm; and 3) Approximately 1,130 feet of total groin lengthening across 23 of the existing groins (Figure 2, Table 1). Results of a coastal engineering analysis determined that this minimal amount of lengthening will not have any downdrift impacts as the design is simply to stabilize the proposed berm width. Because the distance between the landward toe of the dune and the seaward edge of the berm for the beach design exceeds the existing condition distance between these same points along certain reaches within the project, the effective length of the groins in these areas will be reduced. Consequently, the length of some groins will need to be increased in order to create beach width necessary to maintain the design cross-section. The proposed groin lengthening is not provided as a means for trapping more sand and increasing beach width or significantly changing the rate of sand bypassing the groins. The renourishment interval for the proposed project has been estimated to occur every 8 years and is triggered by a mobilization threshold of 220,400 cubic yards of sand.

Construction will be by means of either a hydraulic cutterhead dredge or a hopper dredge that will transport the sand through a pipeline. The pipeline will run adjacent to the groins and parallel with the beach. Beach compatible material (sand) from an offshore source will be pumped along the 21,820 linear feet of the project and will be discharged as a slurry. During construction, temporary training dikes of sand will be used to contain the discharge and control the fill placement. Fill sections will be graded by land-based equipment, such as bulldozers, articulated front-end loaders, and other equipment as necessary to achieve the desired beach profile. Equipment will be selected based on whatever generates only minimal

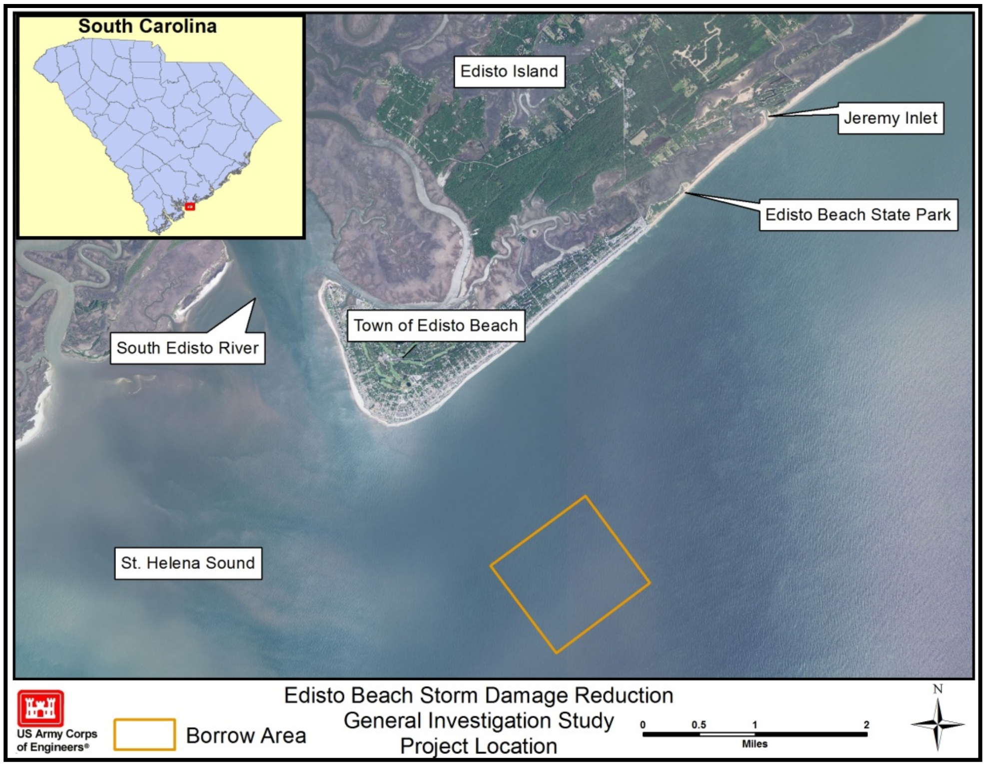

Figure 1. Location of Edisto Beach and proposed borrow site

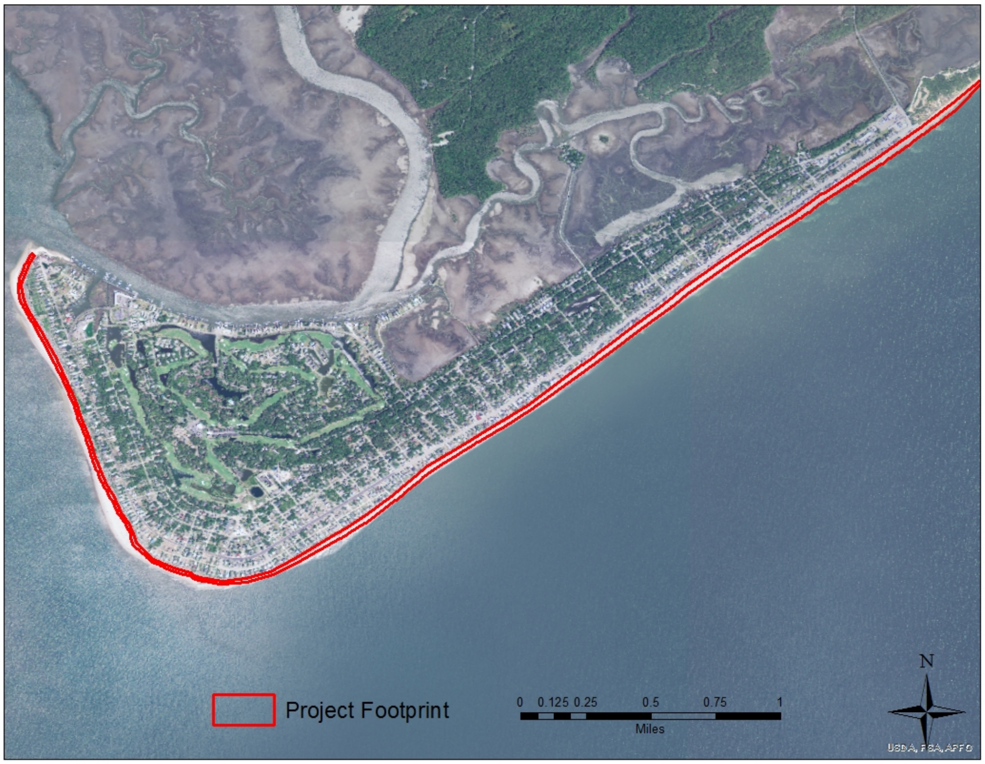

Figure 2. Project footprint from landward toe of dune to seaward berm crest

Figure 3. Project footprint along inlet reaches

Figure 4. Project footprint along Atlantic Ocean facing reaches

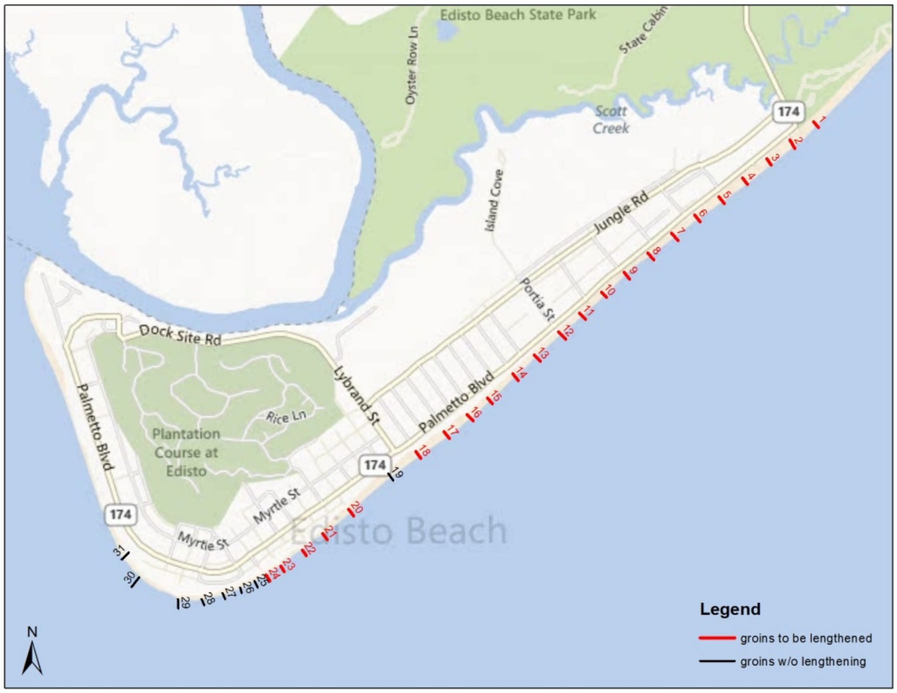

Figure 5. Spatial location of proposed groin lengthenings

Table 1. Proposed groin lengthening dimensions by groin number

Groin Extension Lengths			
Groin #	**Extension length (ft)**	**Groin #**	**Extension length (ft)**
1	80	13	40
2	80	14	30
3	90	15	20
4	90	16	20
5	100	17	20
6	100	18	20
7	80	20	20
8	60	21	30
9	50	22	30
10	50	23	20
11	40	24	20
12	40		
Total Groin Lengthening: 1,130 feet			

and acceptable temporary environmental impacts, as well as whatever proves to be the most advantageous economically. The sand will then be graded, raked, and tilled as necessary in coordination with recommendations and requirements from regulatory agencies. It is anticipated that construction will begin in late-2018 and will require approximately 4 to 5 months for completion. A construction window of November 1 through April 30 will minimize impacts to sea turtles, fish, shellfish, and infauna, and will be utilized whenever possible (see USFWS Construction Windows, Appendix A). The schedule could change due to congressional funding, contractual issues, inclement weather, equipment failure, or other unforeseen difficulties.

The borrow area for the proposed project occurs on an ebb-tidal shoal located approximately 1.5 miles to 2.5 miles southeast of the southern point of Edisto Beach and is approximately 649 acres in size (Figure 1). The site was determined from a larger search area and was narrowed down to include sands that most appropriately match the native beach sands on Edisto Beach. The borrow area contains approximately 7.2 million cubic yards of beach compatible sands. Native beach sands were determined based on beach samples collected at 34 stations along Edisto Beach and reflects conditions after the 2006 renourishment project (completed by Coastal Science and Engineering). Each station included four grab samples – one each from the toe of the dune, berm, beach face, and low tide swash zone. Results of this analysis determined that the beach sands have a mean phi size of 1.31, 0.1 % silt/clay mix, and 26.9% visual shell hash. These results compare favorably with the borrow area sands (see Table 2 and Figure 5).

Additionally, a cultural and hardbottom resources survey was completed at the borrow area in March 2013. The survey utilized three techniques: 1) Side scan sonar, 2) Sub-bottom profiling, and 3) Magnetometer. Results of this survey determined that there are no hardbottom resources within the proposed borrow area. The borrow area location has been shared with multiple resource agencies over the course of the study and no additional issues have been raised to date.

Edisto Beach has very coarse sand and previous attempts at using fencing along a constructed berm to create an eolian transport driven dune have been unsuccessful. Therefore, the proposed project involves the creation of a 14 to 15 foot high dune at 15 feet width and a 3:1 slope. This dune feature may bury existing dune vegetation in some areas, especially along the inlet section of the beach. The proposed project consists of planting dune vegetation along the constructed dune including foreslope and backslope. The use of native vegetation will provide an environmental enhancement to the beach front while helping to stabilize the constructed dune. Plantings will be done in a matrix fashion and consist of native vegetation including but not limited to sea oats, Bitter panicum, and American beachgrass (Bogue variety). The total area of necessary dune planting is 29.68 acres.

Table 2. Edisto Beach grain size comparison between borrow site and native beach sands

	MEAN (phi)	STD DEV (phi)	% PASSING #5	%PASSING #10	% PASSING #200	% PASSING #230	% VISUAL SHELL
Edisto Native Beach	1.31	1.33	97.8	93.5	0.1	0.0	26.9
Borrow - Scenario A	1.73	1.31	94.7	90.0	0.4	0.2	18.8

NOTE: The data comparison above is not a Federal requirement, but is provided to gain a perspective as to the quality of material in the borrow area which is proposed for placement as nourishment material on the beach.

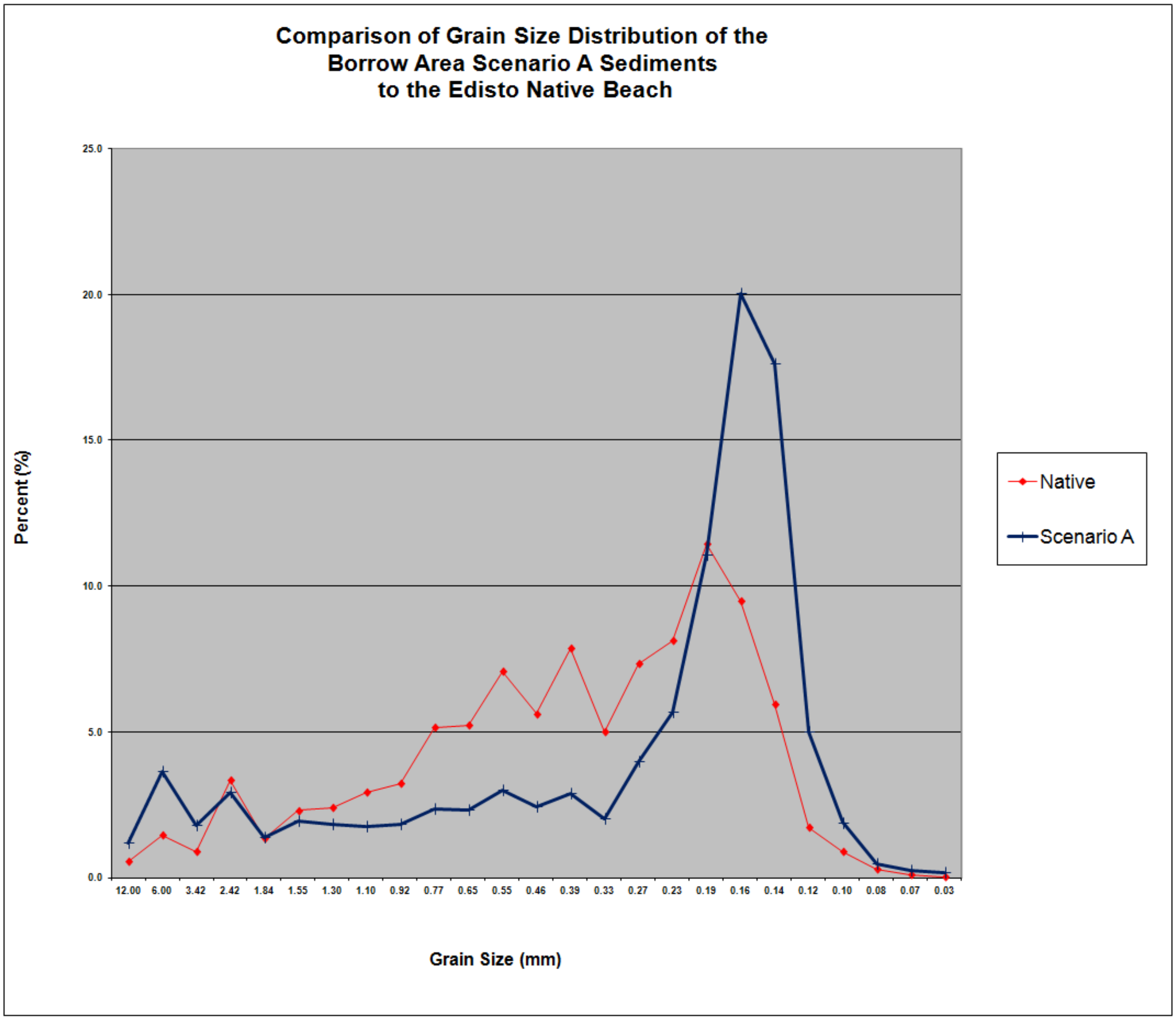

Figure 5. Histogram of native beach sands vs. proposed borrow site

3.0 PRIOR CONSULTATIONS

No previous Section 7 formal or informal consultations are known to have occurred for this proposed Project.

4.0 LIST OF SPECIES

4.1 US FISH AND WILDLIFE SERVICE

Table 3 contains a list of species that have been listed by the U.S. Fish and Wildlife Service as occurring or possibly occurring in Colleton County.

Table 3. USFWS Threatened and Endangered Species in Colleton County, South Carolina

COLLETON COUNTY T&E Species			
Common Name	**Scientific Name**	**Status**	**Occurrence**
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	Known
Wood stork	*Mycteria americana*	E	Known
Red-cockaded woodpecker	*Picoides borealis*	E	Known
Piping plover	*Charadrius melodus*	T, CH	Known
Kemp's ridley sea turtle	*Lepidochelys kempii**	E	Known
Leatherback sea turtle	*Dermochelys coriacea**	E	Known
Loggerhead sea turtle	*Caretta caretta*	T, CH*	Known
Green sea turtle	*Chelonia mydas**	T	Known
Shortnose sturgeon	*Acipenser brevirostrum**	E	Known
Atlantic sturgeon	*Acipenser oxyrinchus**	E	Known
Pondberry	*Lindera melissifolia*	E	Possible
Canby's dropwort	*Oxypolis canbyi*	E	Known
Southern dusky salamander	*Desmognathus auriculatus*	SC	Possible
Angiosperm (no common name)	*Elytraria caroliniensis*	SC	Known
Godfrey's privet	*Forestiera godfreyi*	SC	Known
Pondspice	*Litsea aestivalis*	SC	Known
Boykin's lobelia	*Lobelia boykinii*	SC	Known
Carolina bird-in-a-nest	*Macbridea caroliniana*	SC	Known
Crested fringed orchid	*Pteroglossaspis ecristata*	SC	Known
Bachman's sparrow	*Aimophila aestivalis*	SC	Possible
Kirtland's warbler	*Dendroica kirtlandii*	E	
Henslow's sparrow	*Ammodramus henslowii*	SC	Possible
Red knot	*Calidris canutus*	C	Possible
Black-throated green warbler	*Dendroica virens*	SC	Possible
Swallow-tailed kite	*Elanoides forficatus forficatus*	SC	Known
American kestrel	*Falco sparverius*	SC	Possible
American oystercatcher	*Haematopus palliatus*	SC	Known
Loggerhead shrike	*Lanius ludovicianus*	SC	Possible
Black rail	*Laterallus jamaicensis*	SC	Possible
Painted bunting	*Passerina ciris ciris*	SC	Possible
Gull-billed tern	*Sterna nilotica*	SC	Known
Bluebarred pygmy sunfish	*Elassoma okatie*	SC	Known
Southern hognose snake	*Heterodon simus*	SC	Possible
Island glass lizard	*Ophisaurus compressus*	SC	Known
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	SC	Known

E - Federally endangered *T - Federally threatened*
BGEPA - Bald and Golden Eagle Protection Act *CH - Critical Habitat Designated* *CH* - proposed*
SC - State Species of Concern. These species are rare or limited in distribution but are not currently legally

4.2 NOAA FISHERIES (NATIONAL MARINE FISHERIES SERVICE)

Table 4 contains a list of threatened and endangered species in South Carolina under the jurisdiction of NOAA Fisheries.

Table 4: NMFS Threatened and Endangered Species in South Carolina

Common Name	Scientific Name	Status	Date Listed
Marine Mammals			
Blue whale	*Balaenoptera musculus*	E	12/2/1970
Finback whale	*Balaenoptera physalus*	E	12/2/1970
Humpback whale	*Megaptera movaeangliae*	E	12/2/1970
North Atlantic right whale	*Eubalaena glacialis*	E	12/2/1970
Sei whale	*Balaenoptera borealis*	E	12/2/1970
Sperm whale	*Physeter macrocephalus*	E	12/2/1970
Turtles			
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	12/2/1970
Leatherback sea turtle	*Dermochelys coriacea*	E	6/2/1970
Loggerhead sea turtle	*Caretta caretta*	T, CH*	7/28/1978
Green sea turtle	*Chelonia mydas*	T	7/28/1978
Hawksbill sea turtle	*Eretmochelys imbricata*	E	6/2/1970
Fish			
Atlantic sturgeon	*Acipenser Oxyrinchus*	E	2/6/2012
Shortnose sturgeon	*Acipenser brevirostrum*	E	3/11/1967
E - Federally endangered	*T - Federally threatened*	*CH - Critical Habitat proposed*	

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

** Candidate species are not protected under the Endangered Species Act, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

5.0 GENERAL EFFECTS ON LISTED SPECIES/CRITCAL HABITAT

Dredging and placement of beach quality sand have the potential to affect animals and plants in a variety of ways. The potential for adverse impacts may result from actions of the dredging equipment (i.e. suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels; physical barriers imposed by the presence of dredging equipment (i.e. pipelines); and placement of dredged material on the beach within the proposed construction template (i.e. covering, suffocation). Although beach placement of material, and associated construction operations (i.e. operation of heavy equipment, pipeline route, etc.), may adversely affect some species and their habitat, the resultant constructed beach profile also promotes restoration of important habitat that has been degraded as a result of erosion along Edisto Beach. Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

Any potential impacts on federally listed threatened and endangered species would be limited to those species that occur in habitats provided by the project area. Therefore, the proposed work will not affect any listed species which could be found within adjoining habitats surrounding the study area but do not have interrelated linkage to the habitats directly within the study area. Dredging methods and placement of beach quality sand associated with the proposed action are similar to current maintenance dredging methods and existing beach nourishment projects. These methods have been addressed in a number of previous environmental documents, including biological assessments and biological opinions rendered regarding endangered and threatened species. Detailed discussions of the dredging methods and associated activities for this project are provided in section 7.01 the Integrated Feasibility Study/Environmental Assessment. The accounts, which follow, will summarize this information as it applies to the proposed action.

6.0 SPECIES ASSESSMENTS

6.1 BLUE WHALE, FINBACK WHALE, HUMPBACK WHALE, NORTH ATLANTIC RIGHT WHALE (NARW), SEI WHALE, AND SPERM

a. Status. Endangered

The blue whale may be the largest mammal ever to inhabit the earth. It may have reached lengths of up to 100 feet - roughly the length of a basketball court. Blue whales have weighed up to 160 tons. They feed on small shrimp-like crustaceans. The whales consume up to eight tons of these animals a day during their feeding period. A blue whale produced the loudest sound ever recorded from an animal, and some scientists have speculated that they may be able to remain in touch with each other over hundreds of miles. The number of blue whales in the southern hemisphere was severely depleted by whaling. Due to commercial whaling the size of the population is less than ten percent of what it was originally.

The finback whale is the second largest whale, reaching lengths of up to 88 feet and weighs up to 76 tons. The finback whale because of its crescent-shaped dorsal fin, and obvious characteristic, is easily seen at sea. Depending on where they live, finback whales eat both fish and small pelagic crustaceans, and squids. It sometimes leaps clear of the water surface, yet it is also a deeper diver than some of the other baleen whales. The finback's range is in the Atlantic from the Arctic Circle to the Greater Antilles, including the Gulf of Mexico. In the Pacific Ocean the Finback ranges from the Bering Sea to Cape San Lucas, Baja California.

The humpback whale reaches a maximum length of about 50 feet long and a maximum weight of about 37.5 tons. They are mostly black, but the belly is sometimes white. Flippers and undersides of the flukes are nearly all white. They are migratory. They eat krill and schooling fish. In the Atlantic they migrate from Northern Iceland and Western Greenland south to the West Indies, including the Northern and Eastern Gulf of Mexico. In the Pacific Ocean they migrate from the Bering Sea to Southern Mexico. The humpback is one of the most popular whales for whale watching on both the east and west coasts. Scientists estimate that there are 10,000 humpbacks worldwide, only about 8% of its estimated initial population.

The sei whale is one of the largest whales. It can reach a length of 60 feet and a weight of 32 tons. They feed primarily on krill and other small crustaceans, but also feed at times on small fish. The sei whale is the fastest of the baleen whales and can reach speeds of more than

20 miles per hour. In the Atlantic Ocean the Sei whale ranges from the Arctic Circle to the Gulf of Mexico. The Sei whale is endangered due to past commercial whaling.

Unlike the other great whales on the endangered species list, the sperm whale is a toothed whale. It is the largest of the toothed whales reaching a length of 60 feet in males and 40 feet in females. Sperm whales are noted for their dives that can last up to an hour and a half and go as deep as 2 miles under the surface. It is the most abundant of all the endangered whales, with an estimated population of two million. Sperm whales feed mainly on squid, including the giant squid. They range in the Atlantic Ocean from the Arctic Circle to the Gulf of Mexico. In the Pacific Ocean the sperm whale ranges from the Bering Sea to Southern Mexico. The sperm whale was almost hunted to extinction for its oil (spermaceti). This oil was used in the manufacture of ointments, cosmetics, and candles. The sperm whales usually inhabit the offshore waters.

The right whale is the most endangered species of whale off of the U.S. coasts. The right whale got its name because it was the "right" whale to hunt. It was slow moving and floated after being killed. Current estimates indicate that presently no more than a few hundred exist. Right whales can reach a length of 60 feet and a weight of 100 tons. Although the species has been internationally protected since 1937, it has failed to show any signs of recovery. The National Marine Fisheries Service (NMFS) now acknowledge three distinct right whale lineages as separate phylogenetic species: North Atlantic (*Eubalaena glacialis*), North Pacific (*Eubalaena japonica*), and southern (*Eubalaena australis*) right whales. Of concern along the eastern seaboard of the United States is the North Atlantic right whale, and more specifically, the western population.

Right whales have been observed along the eastern coast of North America from the Florida Keys north to the Gulf of St. Lawrence in Canada. They are found in relatively large numbers around Massachusetts and near Georges Bank in the spring, and then they migrate to two areas in Canadian waters by mid-summer. Most cows that give birth in any given year travel in the winter to the coastal waters of Georgia and Florida to calve and raise their young for the first three months. The Bay of Fundy, between Maine and Nova Scotia, appears to serve as the primary summer and fall nursery hosting mothers and their first-year calves. The calf will stay with its mother through the first year and it is believed that weaning occurs sometime in the fall. Calves become sexually mature in about 8 years. Females are believed to calve about every three to four years. Sightings of right whales and their occurrence in the inshore waters of the State, although very rare, are generally assumed to represent individuals seen during this migration. The current size of the western North Atlantic population is approximately 300 animals (NMFS, 2006).

Right whales are large baleen whales that feed primarily on copepods and euphausids (NMFS, 2006). They swim very close to the shoreline, often noted only a few hundred meters offshore. Because of their habit of traveling near the coast, there is concern over impacts resulting from collisions with boats and ships, as well as entanglement in fishing gear (NMFS, 2006). Some right whales have been observed to bear propeller scars on their backs resulting from collisions with boats (NMFS, 1984). Available evidence strongly suggests that the western population of North Atlantic right whale cannot sustain the number of deaths resultant from vessel and fishing gear interactions. However, there is no designation of critical habitat for right whales in SC.

b. Project Impacts

(1) Habitat. No critical habitat has been designated for humpback whales or NARWs within the project area.

(2) Food Supply. NARWs feed primarily on copepods (Calanus sp.) and euphausids (krill) (NMFS 1991). Humpback whales are generally piscivorus but also feed on krill. The proposed dredging will not diminish productivity of the nearshore ocean; therefore, the food supply of these species should be unaffected.

(3) Relationship to Critical Periods in Life Cycle. Detailed life history information for humpback whales and NARWs and potential effects from dredging activities area provided within the following Section 7 consultation document:

> *National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland*

(4) Effect Determination. Of these six species of whales being considered, only the humpback whale and NARW would normally be expected to occur within the project area; therefore the other species of whales are not likely to be adversely affected. Therefore the proposed project is not likely to adversely affect the blue whale, finback whale, sei whale, and sperm whale. The majority of right whale sightings occur from December through February. Conditions outlined in previous consultations in order to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project. If the proposed work is expected to occur during this time period, the dredge will be required to have endangered species observers standing watch on the bridge of the dredge to look for whales during construction. The presence of a hydraulic cutterhead pipeline or hopper dredge in this area should pose no direct impacts to the right whale or humpback whale, however, when relocating, the dredge and any supporting vessels are required to alter course and stop if necessary to avoid approaching whales. If whales are spotted during the day within 10 miles of the dredging operation, then the dredge is required to reduce transit speed at night, should it need to relocate during that time period. Corps contract specifications expressly require avoidance of right whales. The project will not impact existing near-shore habitat conditions and food supplies already available to the right whale or humpback whale. All in water dredging activities are addressed and covered by reference in the 29 October 1997 “National Marine Fisheries Service, Regional Biological Opinion on Hopper Dredging along the South Atlantic Coast”, which has jurisdiction on humpback and NARW effects. The beach placement portion of the project will have **no effect** on the humpback or NARW.

6.2 WEST INDIAN MANATEE

West Indian manatees are massive fusiform-shaped animals with skin that is uniformly dark grey, wrinkled, sparsely haired, and rubber-like. Manatees possess paddle-like forelimbs, no hind limbs, and a spatulate, horizontally flattened tail. Females have two axillary mammae, one at the base of each forelimb. Adults are about 10 feet in length and weigh 800-1200 pounds (USFWS, 2010). Newborns average 4 to 4½ feet in length and about 66 pounds (Odell 1981).

The West Indian manatee (*Trichechus manatus*) was listed as endangered on March 11, 1967, under a law that preceded the Endangered Species Act of 1973, as amended (16 USC 1531 et seq.). Additional Federal protection is provided for this species under the Marine Mammal Protection Act of 1972, as amended (16 USC 1461 et seq.). The manatee population in the United States is confined during the winter months to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia (USFWS, 1996). However, during the summer months, they may migrate as far north as coastal Virginia on the East Coast and as far west as Louisiana on the Gulf of Mexico (USFWS, 1991).

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. SC DNR indicates that manatees have been observed in SC since 1850. From 1850-2004 there have been 1117 records of manatees were documented in SC. These data suggest that manatees are rare visitors in SC (http://www.dnr.sc.gov/manatee/dist.html). There is no designation of critical habitat for the West Indian manatee in SC.

c. Project Impacts.

(1) Habitat. Typical coastal habitats utilized by manatees which are found within South Carolina include coastal tidal rivers, salt marshes, and vegetated bottoms where they feed on the aquatic vegetation and, in some cases, smooth cordgrass (*Spartina alterniflora*) (USFWS 2007). Project related impacts to estuarine and nearshore ocean habitat of the area associated with the placement of sediment on the beach should be minor and direct impacts to specific habitat requirements will be avoided.

(2) Food Supply. Specific food sources utilized by the manatee in South Carolina are unknown; however, the manatee diet in Florida consists primarily of vascular plants and is likely the same in South Carolina, including aquatic vegetation and salt marsh grasses. The proposed action will involve negligible change to the physical habitat of the beach and nearshore environment with no known impacts to aquatic vascular plants and overall estuarine and nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should be unaffected.

(3) Relationship to Critical Periods in Life Cycle. Since the manatee is considered to be an infrequent summer resident of the South Carolina coast, the proposed action should have little effect on the manatee since its habitat and food supply will not be significantly impacted. The Corps will implement precautionary measures for avoiding impacts to manatees from

associated transiting vessels during construction activities, as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee" established by the USFWS.

(4) Effect Determination. Since the habitat and food supply of the manatee will not be significantly impacted, overall occurrence of manatees in the project vicinity is infrequent, all dredging will occur in the offshore environment, and precautionary measures for avoiding impacts to manatees, as established by USFWS, will be implemented for transiting vessels associated with the project, the proposed action is **not likely to adversely affect the west Indian manatee**.

6.3 KEMP'S RIDLEY, LEATHERBACK, LOGGERHEAD, GREEN, AND HAWKSBILL SEA TURTLES

a. Status. There are five species of sea turtles on the Atlantic Coast, Kemp's ridley sea turtle (*Lepidochelys kempii*), Leatherback sea turtle (*Dermochelys coriacea*), Loggerhead sea turtle (*Caretta caretta*), Green sea turtle (*Chelonia mydas)*, and the Hawksbill sea turtle (*Eretmochelys imbricata*). These five species of sea turtles are protected by the Convention on International Trade in Endangered Species (CITES). They are also listed as endangered or vulnerable in the Red Data Book by the International Union for the Conservation of Nature (IUCN). The hawksbill, Kemp's ridley and leatherback were listed as endangered by the U. S. Endangered Species Act in 1973. The green turtle and the loggerhead were added to the list as threatened in 1978.

b. Critical Habitat. Critical habitat is not currently designated in the continental U.S. for the five species of sea turtles identified to occur within the proposed project vicinity. However, USFWS and NMFS have proposed listing critical habitat for nesting beaches and various ocean waters of the Northwest Atlantic Ocean Distinct Population Segment of the loggerhead sea turtle (50 CFR Part 17 in Federal Register Vol. 78, No. 57 and 50 CFR Part 226 in Federal Register Vol. 78, No. 138). Critical habitat has been proposed by USFWS for Edisto Beach and all surrounding beaches, including Otter Island, Pine Island, Edisto Beach State Park, Edingsville Beach, Interlude Beach, and Botany Bay Island and Botany Bay Plantation (Figures 6 and 7). Critical habitat has been proposed by NMFS for the nearshore waters (i.e., from mean high water seaward for 1.6 km) off of Edisto Beach and all the surrounding beaches (Figure 8).

The description of the USFWS proposed Critical Habitat at Edisto Beach is as follows:

> *"This unit consists of 6.8 km (4.2 miles) of island shoreline along the Atlantic Ocean and South Edisto River. This unit includes a section of Edisto Island, which is separated from the mainland by the Atlantic Intracoastal Waterway, Big Bay Creek, a network of coastal islands, and salt marsh. The unit extends from 32.50307 N, 80.29625 W (State Park boundary separating Edisto Beach State Park and the Town of Edisto Beach) to South Edisto Inlet. The unit includes lands from the MHW line to the toe of the secondary dune or developed structures. The unit occurs within the town limits of Edisto Beach. Land in this unit is in private and other ownership (see Table 1). This unit was occupied at the time of listing and is currently occupied. This unit supports expansion of nesting from an*

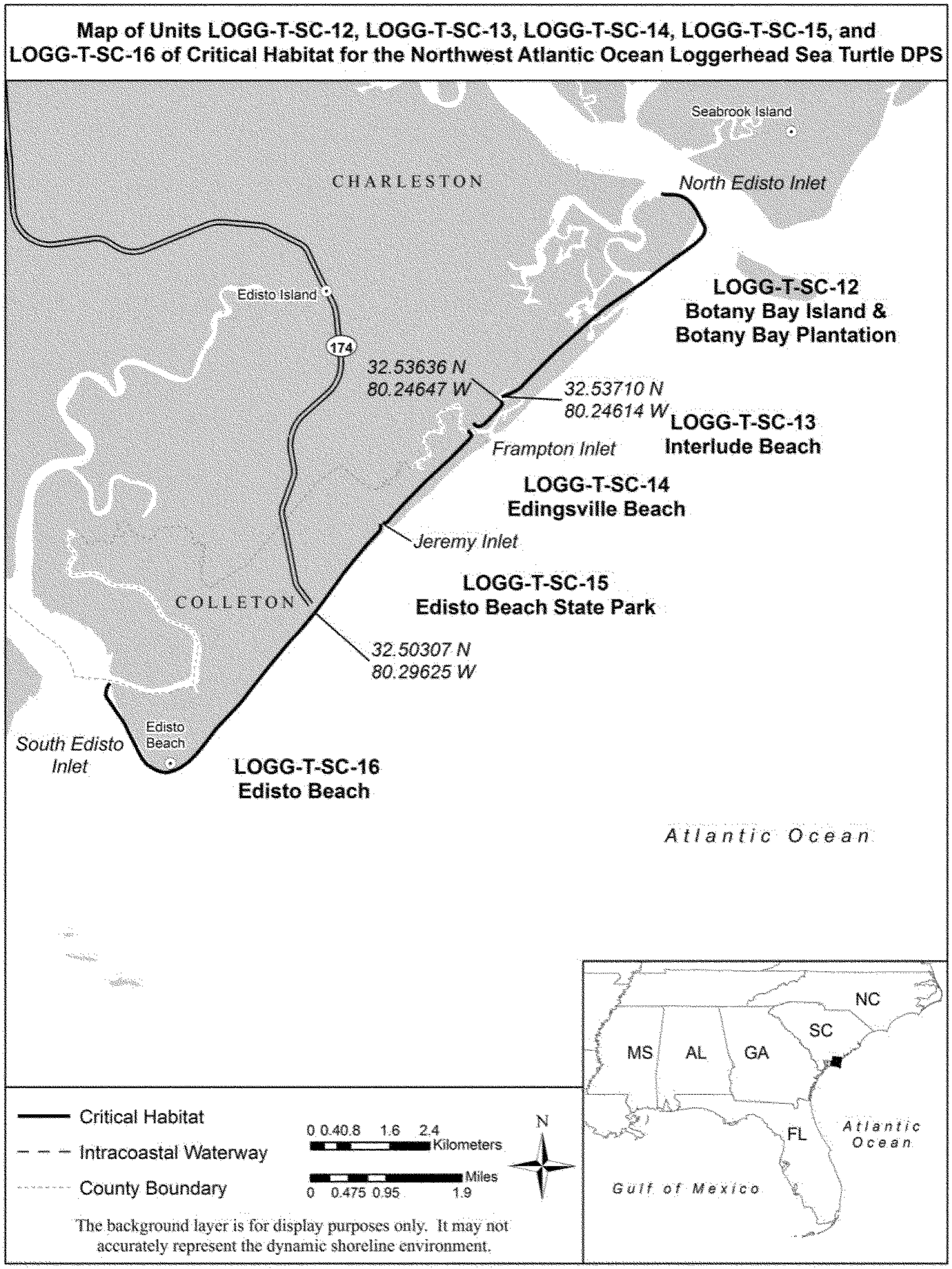

Figure 6. USFWS Proposed Critical Habitat for Loggerhead nesting turtles

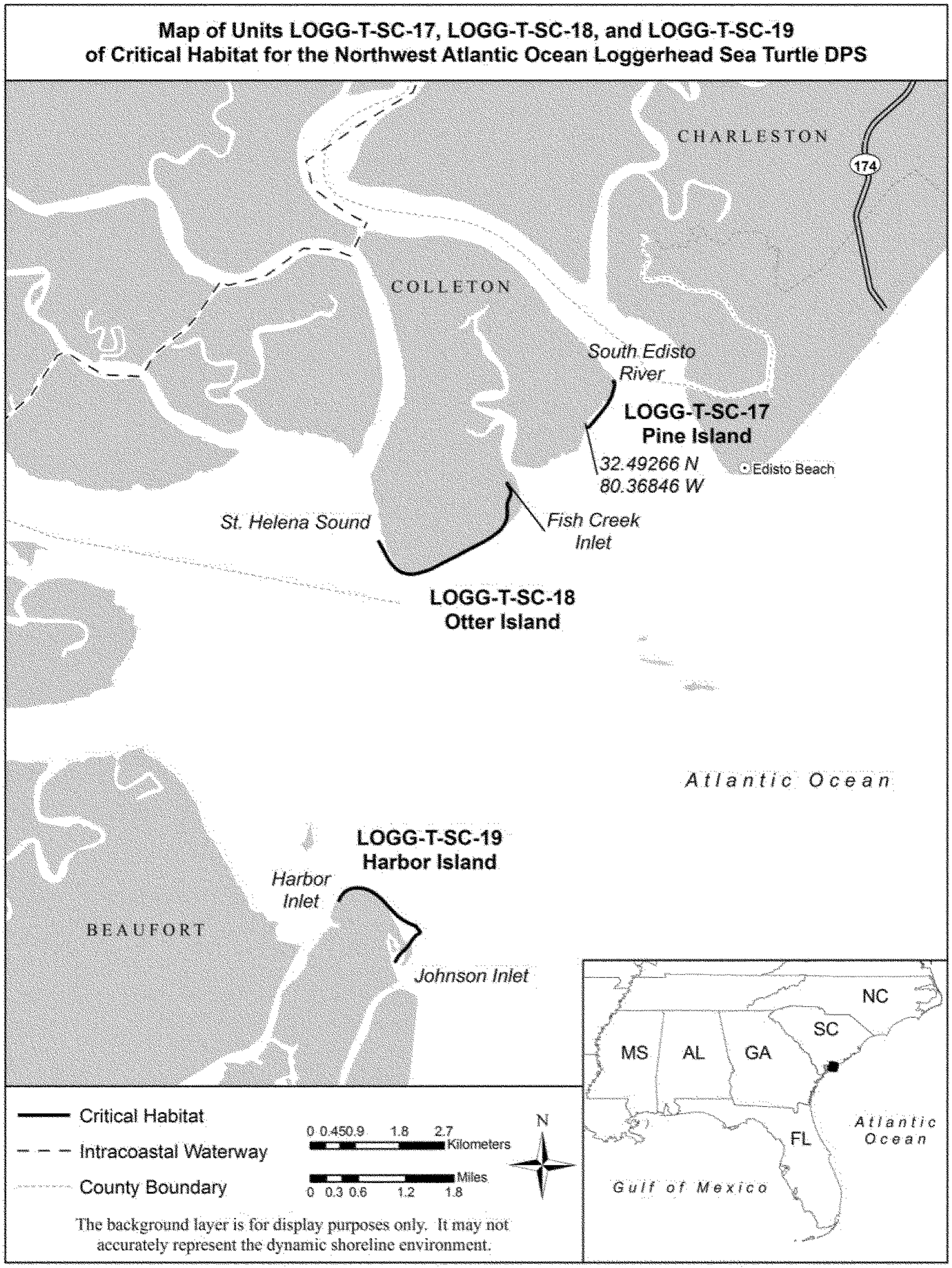

Figure 7. USFWS Proposed Critical Habitat for Loggerhead nesting turtles south of proposed project

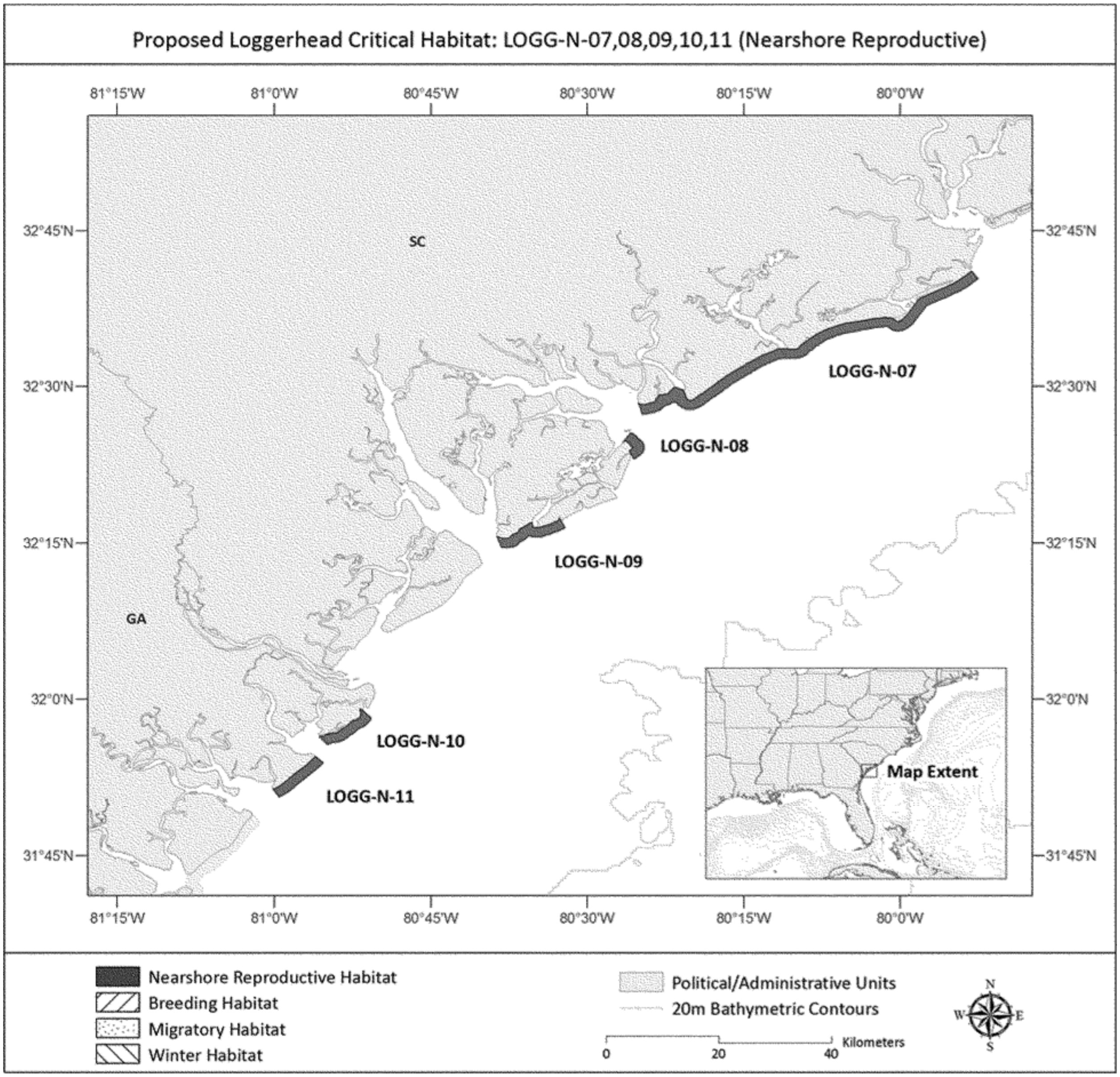

Figure 8. NMFS Proposed Critical Habitat for Loggerhead Sea turtles in the vicinity of the proposed project

adjacent unit (LOGG–T–SC–16) that has highdensity nesting by loggerhead sea turtles in South Carolina. This unit contains all of the PBFs and PCEs. The PBFs in this unit may require special managementconsiderations or protections to ameliorate the threats of recreational use, predation, beach sand placement activities, in-water and shoreline alterations, beach erosion, climate change, artificial lighting, humancaused disasters, and response to disasters. The Town of

Edisto Beach has a Local Comprehensive Beach Management Plan that includes the implementation of sea turtle nesting surveys, nest marking, and beach management to protect nesting and hatchling loggerhead sea turtles from anthropogenic disturbances (Town of Edisto Beach 2011, p. 25). These measures apply to the private lands within this critical habitat unit although the degree of implementation is uncertain."

The description of the NMFS proposed Critical Habitat in the vicinity of Edisto Beach is as follows:

"LOGG-N-7—Folly, Kiawah, Seabrook, Botany Bay Islands, Botany Bay Plantation, Interlude Beach, and Edingsville Beach, Charleston County, South Carolina; Edisto Beach State Park, Edisto Beach, and Pine and Otter Islands, Colleton County, South Carolina. This unit contains nearshore reproductive habitat only. The unit consists of nearshore area from Lighthouse Inlet to Saint Helena Sound (crossing Folly River, Stono, Captain Sam's, North Edisto, Frampton, Jeremy, South Edisto and Fish Creek Inlets) from the MHW line seaward 1.6 km."

c. Background. Sea turtles vary in size from an average of 75 pounds for the olive ridley (does not occur in the project area) to the giant leatherback, which may exceed 800 pounds. Modified for living in the open ocean, they have paddle-like front limbs for swimming. The thick neck and head cannot be drawn back into the body. Sea turtles also have special respiratory mechanisms and organs to excrete excess salt taken in with seawater when they feed.

Detailed life history information associated with the in-water life cycle requirements for sea turtles and a subsequent analysis of impacts from the proposed dredging activities is provided within the following NMFS Section 7 consultation document:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

d. Occurrence in Immediate Project Vicinity. Of the five listed species of sea turtles, only the loggerhead is considered to be a regular nester in SC. However, in September 1996, a green sea turtle nested on Garden City Beach and another also nested on Garden City Beach in September 2002. Leatherback nests were recorded on Huntington Beach State Park in 2000, at Botany Bay in June 2003, on Folly Beach in July 2003, and on Edisto Beach in 2009. Figure 9 shows the history of sea turtle nesting at both Edisto Beach and Edisto Beach State Park over the past 30 years. There is currently no critical habitat designation for sea turtles in SC, however, USFWS and NMFS have issued proposed rulings to designate critical habitat for the northern Distinct Population Segment of loggerhead sea turtles and Edisto Beach and the nearshore waters are proposed critical habitat. Data from DNR indicates that the mean number of nests for the period 2006-2011 was 60.33 for the Town of Edisto Beach and 69.83

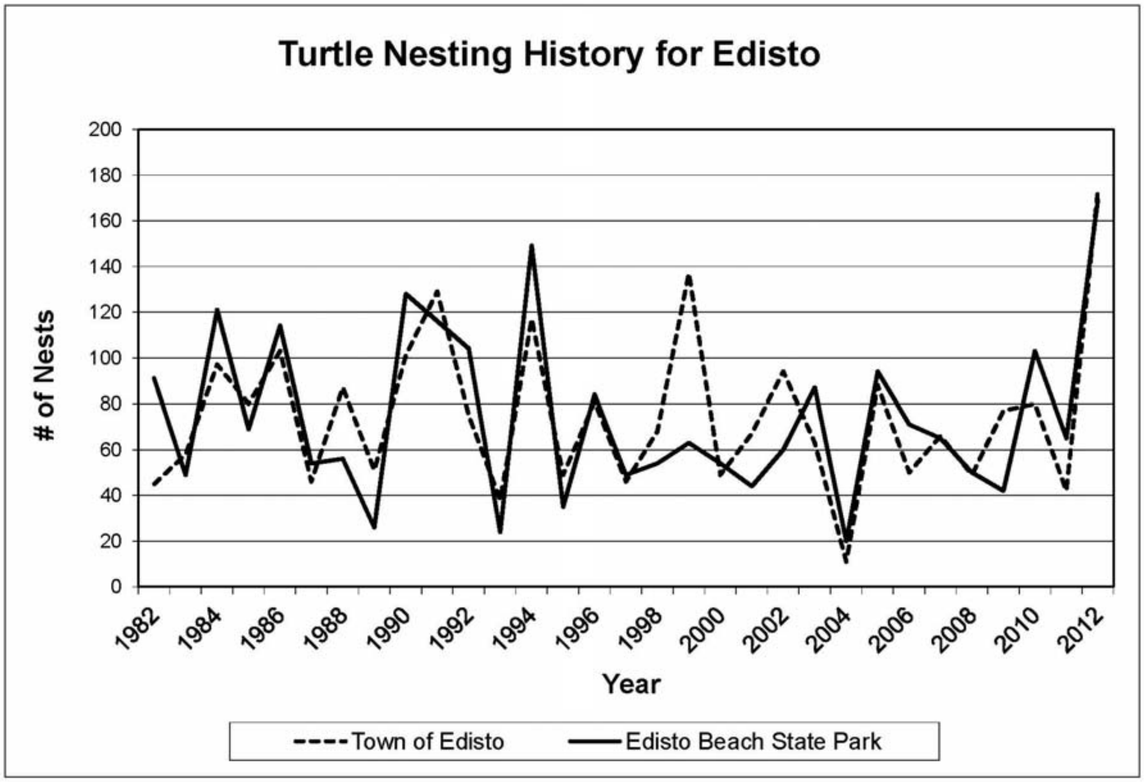

Figure 9. Loggerhead nesting on Edisto Beach from 1982 - 2012

for Edisto Beach State Park. The nesting densities were 7.8 nests/km and 32.4 nests/km, respectively (Dubose Griffin, personal communication). For purposes of this assessment, the loggerhead is considered to be the only species likely to nest in the project area.

Teleconference with former S.C. Department of Natural Resources personnel, Ms. Sally Murphy, indicates that the waters off-shore of Edisto are very active with sea turtles, particularly loggerheads and leatherbacks. Ms. Murphy indicated that they are frequently seen in higher numbers in this area during airplane surveys then in any other area of the state. Ms. Murphy also indicated that the lack of suitable habitat in the project area resulted in false crawls, false nesting attempts and the need to relocate nests frequently to more suitable habitat. Finally, Ms. Murphy expressed concerns that any sand placement on the beach areas should be restricted to the cooler months of the year so as not to impact sea turtle nesting.

e. Current Threats to Continued Use of the Area. In addition to affecting the coastal human population, coastal sediment loss also poses a threat to nesting sea turtles. A large percentage of sea turtles in the United States nest on nourished beaches (Nelson and Dickerson 1988a), therefore, nourishment has become an important technique for nesting beach restoration (Crain *et al.* 1995). Edisto Beach and Edisto Beach State Park are important nesting beaches for the Northern Recovery Unit of the loggerhead population; thus restoration of nesting habitat on this eroding beach is critical. Most of the project area has experienced severe erosion over the last decades. In response to short and long term erosion processes, the beach community continues to implement short term efforts to mitigate the lost beach. Past mitigative efforts included the construction of 34 groins, beach scraping, dune building, beach nourishment, revetments, etc.

The primary threats facing these species worldwide are the same ones facing them in the project area. Of these threats, the most serious seem to be loss of breeding females through accidental drowning by shrimpers (Crouse, *et al.* 1987) and human encroachment on traditional nesting beaches. Research has shown that the turtle populations have greatly declined in the last 20 years due to a loss of nesting habitat along the beachfront and by incidental drowning in shrimp trawl nets. It appears that the combination of poorly placed nests coupled with unrestrained human use of the beach by auto and foot traffic has impacted this species greatly. Other threats to these sea turtles include excessive natural predation in some areas and potential interactions with hopper dredges during the excavation of dredged material. With the exception of hopper dredges, none of the dredge plants (i.e., pipeline dredges) proposed for potential use in the construction of this project are known to take sea turtles.

f. Project Impacts. The areas of affected environment for this proposed project are the borrow area (an approximately 1.5 nm2 site located between 1 and 2.5 miles offshore) (see Figure 1) and the placement of approximately 800,000 cubic yards of sand along 21,820 feet of beach from the northern most groin southward (see Figure 2). This sand placement will result in an increase in the size of the dry beach, conversion of existing intertidal beach to dry beach and shifting the intertidal zone seaward from its existing location, and conversion of some subtidal beach to intertidal beach and shifting the subtidal zone seaward from its existing location.

In order to avoid periods of peak sea turtle abundance during warm water months and minimize impacts to sea turtles in the offshore environment, all beach placement of sediment will occur outside of the South Carolina sea turtle nesting season of 1 May through 31 October, where practible. If a hopper dredge will be used, the construction will occur within the dredging window for hopper dredging from 1 December through 31 March. By adhering to this dredging window to the maximum extent practicable, impacts to sea turtles will be minimized.

In the unanticipated event that construction activities extend into the nesting season (i.e. weather, equipment breakdown, etc.), all available data associated with the nesting activities within the project area will be utilized to consider risks of working within the nesting season. Variables to consider will include the number of days construction will extend into the nesting season, existing conditions of the pre-project nesting habitat such as: erosion rates, existing protective measures (i.e. sandbags, beach bulldozing, etc.), development, recreational use, the historic nesting density within the project area, etc. In coordination with the USFWS and SCDNR, an evaluation of these variables will be used to potentially incorporate project modifications (i.e. modified pipeline routes, staging areas, etc.) during the nesting season that may avoid or minimize potential impacts.

Upon evaluation of site-specific conditions, if nourishment beach activities extend into a portion of the nesting season, monitoring for sea turtle nesting activity will be considered throughout the construction area including the disposal area and beachfront pipeline routes so that nests laid in a potential construction zone can be bypassed and/or relocated outside of the construction zone prior to project commencement. The location and operation of heavy equipment on the beach within the project area will be limited to daylight hours to the maximum extent practicable in order to minimize impacts to nesting sea turtles.

(1) Beach Placement. Post-nourishment monitoring efforts have documented potential impacts on nesting loggerhead sea turtles for many years (Fletemeyer 1984; Raymond 1984; Nelson and Dickerson 1989; Ryder 1993; Bagley *et al*. 1994; Crain *et al*. 1995; Milton *et al*. 1997; Steinitz *et al.* 1998; Trindell *et al*. 1998; Davis *et al*. 1999; Ecological Associates, Inc. 1999; Herren 1999; Rumbold *et al*. 2001; Brock 2005; and Brock *et al.* 2009). Results from these studies indicate that, in most cases, nesting success decreases during the year following nourishment as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction. A comprehensive post-nourishment study conducted by Ernest and Martin (1999) documented an increase in abandoned nest attempts on nourished beaches compared to control or pre-nourished beaches as well as a change in nest placement with subsequent increase in wash-out of nests during the beach equilibration process.

As suggested by the historical literature, there are inherent changes in beach characteristics as a result of mechanically placing sediment on a beach from alternate sources. The change in beach characteristics often results in short-term decreases in nest success and/or alterations in nesting processes. However, when done properly, beach construction projects may mitigate the loss of nesting beach when the alternative is severely degraded or non-existent habitat (Brock et al. 2009).

i. Pipe Placement. In the event unanticipated circumstances arise and construction operations extend into the sea turtle nesting season pipeline routes and pipe staging areas may act as an impediment to nesting females approaching available nesting habitat or to hatchlings orienting to the water's edge. If the pipeline route or staging areas extend along the beach face, including the frontal dune, beach berm, mean high water line, etc., some portion of the available nesting habitat will be blocked. Nesting females may either encounter the pipe and false crawl, or nest in front of the pipeline in a potentially vulnerable area to heavy equipment operation, erosion, and washover. If nests are laid prior to placement of pipe and are landward of the pipeline, hatchlings may be blocked or mis-oriented during their approach to the water.

Though pipeline alignments and staging areas may pose impacts to nesting females and hatchlings during the nesting season, several measures can be implemented to minimize these impacts. If construction activities extend into the nesting season, monitoring should be done in advance to document all nests within the beach placement template. Construction operations and pipeline placement could be modified to bypass existing nests. If bypassing is not a practical alternative for a given project, the relocation of nests outside of construction areas could be implemented. Throughout the period of sea turtle nesting and hatching, construction pipe that is placed on the beach parallel to the shoreline should be placed as far landward as possible so that a significant portion of available nesting habitat can be utilized and nest placement is not subject to inundation or wash out. Furthermore, temporary storage of pipes and equipment can be located off the beach to the maximum extent practicable. If placement on the beach is necessary, it will be done in a manner so as to impact the least amount of nesting habitat by placing pipes perpendicular to shore and as far landward as possible without compromising the integrity of the existing or constructed dune system.

ii. Slope and escarpments. Beach nourishment projects are designed and constructed to equilibrate to a more natural profile over time relative to the wave climate of a given area. Changes in beach slope as well as the development of steep escarpments may develop along the mean high water line as the constructed beach adjusts from a construction profile to a natural beach profile (Nelson *et al.* 1987). Though escarpment formation is a natural response to shoreline erosion, the escarpment formation as a result of the equilibration process during a short period following a nourishment event may have a steeper and higher vertical face than natural escarpment formation and may slough off more rapidly landward.

Though the equilibration process and subsequent escarpment formation are features of most beach projects, management techniques can be implemented to reduce the impact of escarpment formations. For completed sections of beach during beach construction operations, and for subsequent months following as the construction profile approaches a more natural profile, visual surveys for escarpments and slope adjustments could be performed. Escarpments that are identified prior to or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) can be leveled to the natural beach for a given area. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions will be directed by the SCDNR and USFWS and coordinated with the Town of Edisto Beach. Additionally, allowing sufficient time for the equilibration process to adjust the constructed profile to the pre-project profile of the native beach prior to the nesting season could facilitate improved nesting success (Brock *et al.* 2009).

iii. Incubation Environment. Physical changes in sediment properties that result from the placement of sediment, from alternate sources, on the beach pose concerns for nesting sea turtles and subsequent nest success. Nesting can be affected by insufficient oxygen diffusion and variability in moisture contenct levels within the egg clutch. Additionally, nest temperature can affect the sex ratio of developing turtles. Eggs incubated at constant temperatures of 28°C or below develop into males. Those kept at 32°C or above develop into females. Therefore, the pivotal temperature, those giving approximately equal numbers of males and females, is approximately 30°C (Yntema and Mrosovsky 1982). Matching borrow site sands with the native beach sands is extremely important to maintain consistency. As addressed previously, the borrow site sand and native beach sands are compatible.

iv. Lighting. Extensive research has demonstrated that the principal component of the sea finding behavior of emergent hatchlings is a visual response to light. Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights has been documented in the disorientation (loss of bearings) and misorientation (incorrect orientation) of hatchling turtles. The results of disorientation or misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully find the water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even draw hatchlings back out of the surf (NMFS, USFWS, 1991). Artificial lighting on beaches tends to deter sea turtles from emerging from the sea to nest; thus, evidence of lighting impacts on nesting females is not likely to be revealed by nest to false crawl ratios considering that no emergence may occur (Mattison *et al*. 1993; Witherington 1992; Raymond 1984). The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. The impact of light on nesting females and hatchlings can be minimized by reducing the number and wattage of light sources or by modifying the direction of light sources through shielding, redirection, elevation modifications, etc. (Figure 10). If shielding of light sources is not effective, it is important that any light reaching the beach has spectral properties that are minimally disruptive to sea turtles like long wavelength light. The spectral properties of low-pressure sodium vapor lighting are the least disruptive to sea turtles among other commercially available light sources.

During beach placement construction operations associated with the proposed project, lighting is required during nighttime activities at both the hopper dredge pumpout site and the location on the beach where sediment is being placed. In compliance with the US Army Corps of Engineers Safety and Health Requirements Manual (2008), a minimum luminance of 30 lm/ft2 is

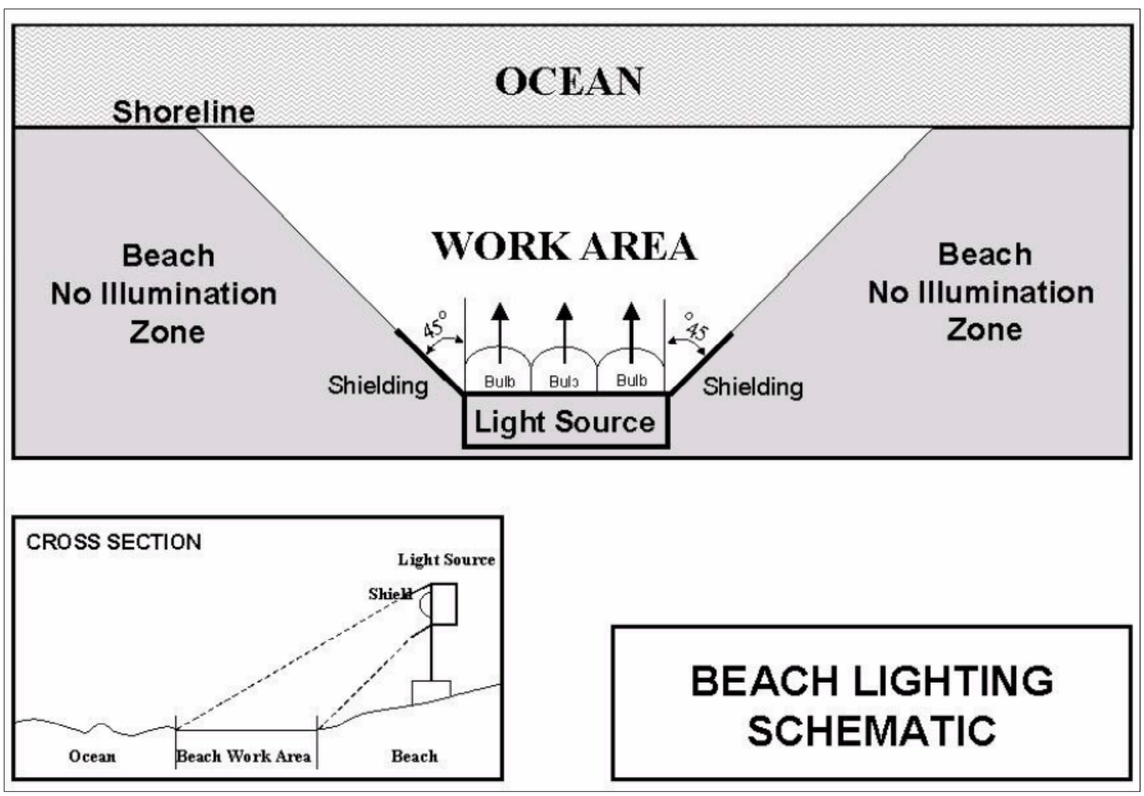

Figure 10. Beach lighting schematic

required for dredge operations and a minimum of 3 lm/ft2 is required for construction activities on the beach. For dredging vessels, appropriate lighting is necessary to provide a safe working environment during nighttime activities on deck (i.e. general maintenance work deck, endangered species observers, etc.). During beach construction operations, lighting is generally associated with the active construction zone around outflow pipe and the use of heavy equipment in the construction zone (i.e. bulldozers) in order to maintain safe construction operations at night.

USFWS has expressed concerns that on newly nourished beaches where the elevation of the beach berm is raised for coastal storm damage reduction purposes, it is possible that lighting impacts to nesting females and emerging hatchlings from adjacent lighting sources (streets, parking lots, hotels, etc) may become more problematic as shading from dunes, vegetation, etc. is not longer evident (Brock 2005; Brock et al. 2009; Ehrhart and Roberts 2001). In a study on Brevard county beaches, Brock (2005) found that loggerhead hatchling disorientations increased significantly post-nourishment. This was attributed to the increase in light sources not previously visible to be seen by hatchlings as a result of the increase in profile elevation combined with an easterly expansion of the beach. However, a dune feature will be constructed as a component of this project and is, therefore, expected to reduce lighting impacts to nesting and hatchling sea turtles that are associated with raising the beach elevation. Additionally, as stated in section 1.0 above, the berm will not be raised above the existing elevation, and instead the width will be expanded.

If beach construction activities extend into the sea turtle nesting and hatching season, all lighting associated with project construction will be minimized to the maximum extent practicable while maintaining compliance with all Corps, U.S. Coast Guard, and OSHA safety requirements. Direct lighting of the beach and near shore waters will be limited the immediate construction area(s). Lighting aboard dredges and associated vessels, barges, etc. operating near the sea turtle nesting beach shall be limited to the minimal lighting necessary to comply with the Corps, U.S. Coast Guard, and OSHA requirements. Lighting on offshore or onshore equipment will be minimized through reduced wattage, shielding, lowering, and/or use of low pressure sodium lights, in order to reduce illumination of adjacent beach and nearshore waters will be used to the extent practicable.

(2) Dredging Impacts. The effects of dredging are evidenced through the degradation of habitat and incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment. Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. Other types of dredges (clamshell and pipeline) have not been implicated in incidental take (NMFS, USFWS, 1991). Incidental takes of sea turtles by hopper dredges comes under the jurisdiction of NOAA Fisheries and is covered by a separate Biological Opinion (NMFS, 1997).

(3) Summary Effect. Currently, there is very little suitable sea turtle nesting habitat in the area of the project (e.g., dry beach/dune habitat). Upon completion of the project, the total area of suitable nesting habitat will be approximately 2,280 acres.

Loggerhead sea turtle nesting activities have been recorded within the project area on Edisto Island. The placement of sand and construction activities associated with the placement of that sand on this reach of beach could adversely affect any existing sea turtle nests and sea turtles attempting to nest. The extent of nesting on Edisto Island beach is somewhat irregular when compared with many other beaches along the coast; however, it does average approximately 14 nests per mile (despite the high erosion rate and resultant damage). Placement of the dredged material is anticipated to occur during the months of November through April; however, it is possible that the start of construction work will be delayed until nesting season or that completion of the project will be delayed and construction will extend into the nesting season. If any construction work occurs during sea turtle nesting season, then the following precautions will be taken to minimize the effects to sea turtles:

- If any construction of the project occurs during the period between May 1 and September 15, the dredging contractor will provide nighttime monitoring along the beach where construction is taking place to ensure the safety of female turtles attempting to nest. A buffer zone around the female will be imposed in the event of an attempt to nest.
- If any construction of the project occurs during the period between May 1 and September 15, daily nesting surveys will be conducted starting either May 1 or 65 days prior to the start of construction, whichever is later. These surveys will be performed between sunrise and 9:00 A.M. and will continue until the end of the project, or September 15, whichever is earlier. Any nests found in the area that will be impacted by construction activities will be moved to a safe location. The nesting surveys and nest relocations will only be performed by people with a valid South Carolina DNR license.
- If any construction of the project occurs during the period September 15 to April 30, no nesting surveys will be performed.
- For construction activities occurring during the period May 1 through October 31, staging areas for equipment and supplies will be located off of the beach to the maximum extent possible.
- For construction activities occurring during the period May 1 through October 31, all on-beach lighting associated with the project will be limited to the minimum amount necessary around active construction areas to satisfy Occupational Safety and Health Administration (OSHA) requirements.

Immediately after completion of the project, the Corps of Engineers will perform tilling in order to reduce compaction associated with newly placed sand. Visual surveys for escarpments along the Project area will be made immediately after completion of the project and prior to May 1 for 3 subsequent years, if needed. Results of the surveys will be submitted to the USFWS prior to any action being taken. Since the Project should not occur during the sea turtle nesting season, escarpment leveling will not be performed until immediately prior to the nesting season. The USFWS will be contacted immediately if subsequent reformation of escarpments exceeding 18 inches in height for a distance of 100 feet occurs during nesting and hatching season. This coordination will determine what appropriate action must be taken. An annual summary of escarpment surveys and action taken will be submitted to the USFWS.

Adherence to the above precautions should minimize the effects to nesting loggerhead sea turtles and emerging loggerhead sea turtle hatchlings. The monitoring and relocation program will minimize potential adverse affects to nesting sea turtles. Completion of the project will recreate lost habitat and protect existing turtle nesting habitat as well as the structures on the island. However, because of the possibility of missing a sea turtle nest during the nest monitoring program or inadvertently breaking eggs during relocation, it has been determined that the proposed project **<u>is likely to adversely affect the loggerhead sea turtle for beach placement activities</u>**. This determination has been made per USFWS ESA Consultation Handbook and states that, "in the event the overall effect of the proposed action is beneficial to the listed species, but also is likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species." Since leatherback nesting has been documented in the past but is not common, the proposed project **<u>may affect but is not likely to adversely affect the leatherback sea turtle for beach placement activities</u>**. **<u>There will be no effect on all other sea turtle species for beach placement activities.</u>** Since all in water dredging activities are addressed and covered by reference in the 1997 NMFS SARBO, no additional sea turtle consultation with NMFS is required.

6.4 SHORTNOSE STURGEON

Detailed life history information associated with the life cycle requirements for shortnose Sturgeon and a subsequent analysis of impacts from the proposed dredging activities are provided within the following Section 7 consultation document:

> *National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland*

a. <u>Status.</u> Endangered

b. <u>Occurrence in Immediate Project Vicinity</u>. The Shortnose Sturgeon occurs in Atlantic seaboard rivers from southern New Brunswick, Canada to northeastern Florida, USA. They typically inhabit estuarine and riverine habitats and are not often found offshore. SCDNR reports that in SC they inhabit Winyah Bay Rivers, those that drain into Lake Marion, The Santee, Cooper and Savannah rivers, and the ACE Basin. Within the ACE Basin, shortnose sturgeons are found at the freshwater-saltwater interface, where the adult and sub-adult shortnose sturgeons are known to inhabit that area during spring through fall. Whereby spawning may take place well upriver, the existence of a spawning stock in the ACE Basin is yet to be determined (SCDNR, 2009). Additionally, through a multi-state telemetry study, only 2 shortnose sturgeon have been documented passing through the borrow site area and only during the month of March. Four shortnose sturgeon have more than likely passed through the area during the north/south migrations along the coast. Since the study only picks up fish with transmitters on them, there are likely to be others in the vicinity (Bill Post, personal communication 5/2/2013).

Studies have shown that the shortnose sturgeon exists in many of the large coastal river systems in South Carolina. Little is known about the shortnose sturgeon population level, life history or ecology. Their status is probably due to exploitation, damming of rivers and deterioration of water quality. Because there is no coastal river associated with this project, there is a lack of suitable freshwater spawning areas for the sturgeon in the immediate project area.

c. Current Threats to Continued Use of the Area. Pollution, blockage of traditional spawning grounds, and over fishing are generally considered to be the principal causes of the decline of this species.

d. Project Impacts.

(1) Habitat. The shortnose sturgeon 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 over wintering; (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 ppt salinity or greater) as adults during the winter. Habitat conditions suitable for juvenile and adult shortnose sturgeon could occur within the estuaries behind the project area; however, spawning habitat should lie well outside of the project area and should not be affected by this project. The presence of juvenile shortnose sturgeon is not likely due to high salinity. Adults are found in shallow to deep water (6 to 30 feet) and, if present, would be expected to occupy the deeper waters during the day and the shallower areas adjacent to the deeper waters during the night (Dadswell *et al*. 1984).

(2) Food Supply. The shortnose sturgeon is a bottom feeder, consuming various invertebrates and stems and leaves of macrophytes. Adult foraging activities normally occur at night in shallow water areas adjacent to the deep-water areas occupied during the day. Juveniles are not known to leave deep-water areas and are expected to feed there. The foraging ecology of the shortnose sturgeon is not known for any portion of its range, and little information exists on the animal's food habits (SCDNR, 2009). Dredging for this project will occur at a borrow site located offshore; therefore, shallow water feeding areas will not be affected by the project.

(3) Effect Determination. Since shortnose sturgeons rarely inhabit coastal ocean waters, and tend to stay closer to the freshwater/saltwater divide, it is unlikely that the shortnose sturgeon occurs in the project area along the beachfront of Edisto Beach. However, should it occur, its habitat would be only minimally altered by the proposed project. Any shortnose sturgeon in the area should be able to avoid being taken by a slow moving pipeline dredge or hopper dredge. Although hopper dredges have been known to impact shortnose sturgeons, dredging for this project will occur in offshore environments, outside of its habitat

range. Therefore, impacts from dredges are not anticipated to occur, but are covered by reference in the 1997 NMFS SARBO. For beach placement activities it has been determined that the proposed project will have **no effect on shortnose sturgeon.**

6.5 ATLANTIC STURGEON

a. Status. Endangered.

Within the Federal Register dated February 6, 2012 (Volume 77, Number 24), NMFS issued a final determination to list the Carolina and South Atlantic distinct population segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) as endangered under the Endangered Species Act (ESA) of 1973, as amended. This final rule was made effective April 6, 2012. NMFS had not designated any “critical habitat” for this species at the time this document was prepared. Since the Atlantic sturgeon is found within the project area, the purpose of this section is to address project impacts on this potentially listed species.

b. Occurrence in Immediate Project Vicinity. Although specifics vary latitudinally, the general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, estuarine dependent, anadromous species. The species’ historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida (Murawski and Pacheco 1977; Smith and Clungston 1997).

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clungston 1997; Caron *et al*. 2002). In some southern rivers, a fall spawning migration may also occur (Rogers and Weber 1995; Weber and Jennings 1996; Moser *et al.* 1998). Comprehensive information on current or historic abundance of Atlantic sturgeon is lacking for most river systems; however, use of waters within the ACE Basin for spawning and nursery habitat is well documented (SCDNR). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 cm/s and deep depths of 11-27 meters (Borodin 1925; Leland 1968; Crance 1987; Moser *et al*. 1998; Bain *et al*. 2000). Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (e.g., cobble) (Gilbert 1989; Smith and Clungston 1997). Additionally, through a multi-state telemetry study, 13 Atlantic sturgeon have been documented passing through the borrow site area during February – May and October – November. Thirty two Atlantic sturgeon have more than likely passed through the same area during north/south migrations along the coast (Bill Post, personal communication 5/2/2013).

Juveniles spend several years in the freshwater or tidal portions of rivers prior to migrating to sea (Gilbert 1989). Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters (Murawski and Pacheco 1977; Smith 1985), where populations may undertake long range migrations (Dovel and Berggren 1983; Bain 1997; Van den Avyle 1984). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Subadult Atlantic sturgeon wander among coastal and estuarine habitats, undergoing rapid growth (Dovel and Berggren 1983; Stevenson 1997). These migratory subadults, as well as adult sturgeon, are normally captured in shallow (10-50m) near shore areas dominated by gravel and sand substrate (Stein *et al*. 2004). Coastal features or shorelines where migratory Atlantic sturgeon commonly aggregate include the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, Delaware, Delaware Bay, Chesapeake Bay, and North Carolina, which presumably provide better foraging opportunities (Dovel and Berggren 1983; Johnson *et al*. 1997; Rochard *et al*. 1997; Kynard *et al*. 2000; Eyler *et al*. 2004; Stein *et al*. 2004; Dadswell 2006).

c. Current Threats to Continued Use of the Area. According to the Atlantic sturgeon status review (Atlantic Sturgeon Status Review Team, 2007), projects that may adversely affect sturgeon include dredging, pollutant or thermal discharges, bridge construction/removal, dam construction, removal and relicensing, and power plant construction and operation. Potential direct and indirect impacts associated with dredging that may adversely impact sturgeon include entrainment and/or capture of adults, juveniles, larvae, and eggs by dredging and closed net sea turtle relocation trawling activities, short-term impacts to foraging and refuge habitat, water quality, and sediment quality, and disruption of migratory pathways.

d. Project Impacts.

(1) Habitat and Food Supply. Dredging activities can impact benthic assemblages either directly or indirectly and may vary in nature, intensity, and duration depending on the project, site location, and time interval between maintenance operations. However, the relatively small size of the proposed borrow area and the short duration of disturbance will limit any disruption of food supply to the Atlantic sturgeon.

(2) Relationship to Critical Periods in Life Cycle. Analyses of the surficial and sub-bottom sediments have been conducted within the proposed borrow areas to assure compatibility with the native sediment. Several vibracore samples were taken to document the physical characteristics of the sediment relative to depth and sub-bottom geophysical surveys were conducted to correlate the physical samples with the underlying geology layers of the borrow area. These data are used to evaluate quality and quantity of sediment relative to depth so that post-dredging surface sediments are not different from pre-dredging conditions. Assuming similarity in post dredging composition of sediment, no long term impacts to sturgeon from alterations physical habitat (i.e. changes in benthic substrate) are expected.

(3) Effect Determination. Atlantic sturgeons have been taken by hopper dredges in the past and to lesser extent mechanical dredges. Therefore, the proposed dredging activity will have **no effect if performed by a cutterhead dredge and is likely to adversely affect the Atlantic sturgeon if performed by a hopper dredge.** Since USACE has initiated consultation with NMFS on a new regional Biological Opinion, no additional Atlantic sturgeon consultation with NMFS is required.

Endangered species observers (ESOs) on board hopper dredges as well as trawlers will be responsible for monitoring for incidental take of Atlantic sturgeon. For hopper dredging operations, dragheads as well as all inflow and overflow screening will be inspected for sturgeon species following the same ESO protocol for sea turtles. Furthermore, all ESOs on board trawlers will be capable of identifying Atlantic sturgeon as well as following safe handling protocol as outlined in Moser *et al.* 2000.

6.6 PIPING PLOVER

Piping plovers are small shorebirds approximately six inches long with sand-colored plumage on their backs and crown and white under parts. Breeding birds have a single black breast band, a black bar across the forehead, bright orange legs and bill, and a black tip on the bill. During the winter, the birds lose the black bands, the legs fade to pale yellow, and the bill becomes mostly black. The piping plover breeds on the northern Great Plains, in the Great Lakes, and along the Atlantic coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf of Mexico coasts from North Carolina to Mexico, and in the Bahamas West Indies.

Piping plovers nest along the sandy beaches of the Atlantic Coast from Newfoundland to North Carolina, the gravelly shorelines of the Great Lakes, and on river sandbars and alkali wetlands throughout the Great Plains region. They prefer to nest in sparsely vegetated areas that are slightly raised in elevation (like a beach berm). Piping plover breeding territories generally include a feeding area, such as a dune pond or slough, or near the lakeshore or ocean edge. The piping plover winters along the coast, preferring areas with expansive sand or mudflats (feeding) in close proximity to a sandy beach (roosting). The primary threats to the piping plover are habitat modification and destruction, and human disturbance to nesting adults and flightless chicks. A lack of undisturbed habitat has been cited as a reason for the decline of other Piping plovers are considered threatened species under the Endangered Species Act of 1973, as amended, when on their wintering grounds. Additionally, the U.S. Fish and Wildlife Service has designated critical habitat under the Endangered Species Act for the piping plover (*Charadrius melodus*) on breeding grounds in the Great lakes and Northern Great Plains Regions, and in the wintering grounds along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. Georgia and South Carolina were reported to have the highest density of wintering populations (Nicholls and Baldassarre, 1990). Sites with the highest concentrations of piping plovers have expansive sandflats, or sandy mudflats, and sandy beaches (Nicholls and Baldassarre, 1990).

a. <u>Status.</u> Threatened

b. <u>Occurrence in Immediate Project Vicinity</u>. There are 4 areas of designated critical wintering habitat for the piping plover near the project area of Edisto Island (Figure 11). From north to south these areas are: (1) Seabrook Island (approx 8 miles NE of Jeremy Inlet), (2) Deveaux Bank (approx 6 miles NE of Jeremy Inlet), (3) Otter Island (approx 3 miles E of the south Edisto River Inlet), and (4) Harbor Island (approx 6 miles SE of South Edisto River Inlet). None of these four areas of critical habitat are directly in the project area. Edisto Beach is not known to have any overwintering piping plovers (Melissa Bimby, USFWS, personal communication).

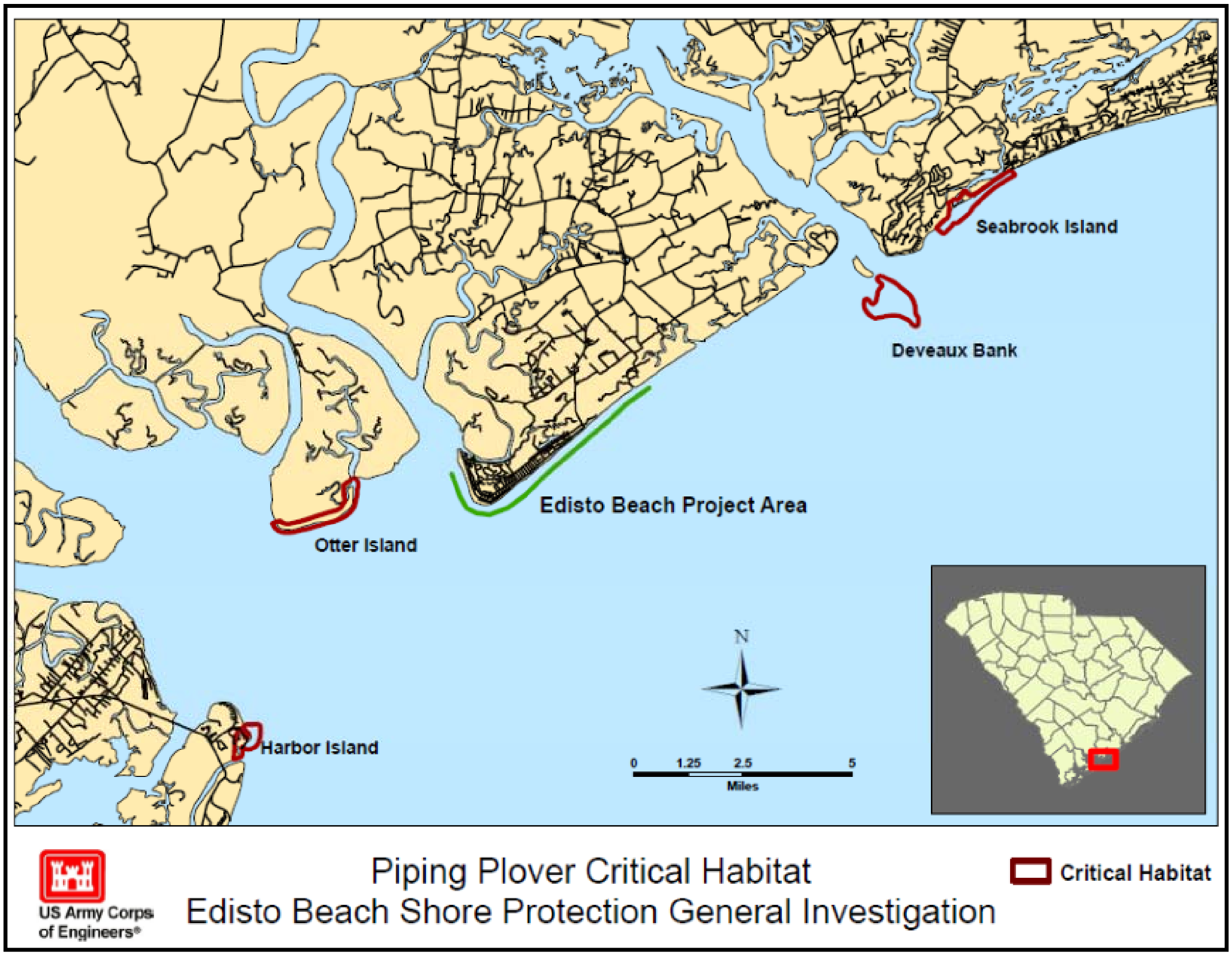

Figure 11. Piping Plover Critical Habit

c. Current Threats to Continued Use of the Area. Loss and degradation of habitat due to development and shoreline stabilization have been major contributors to the decline of piping plovers. Depending on timing and location, anthropogenic coastal stabilization activities may degrade plover habitat by altering natural processes of dune and beach erosion and accretion (Melvin et al. 1991). The current commercial, residential, and recreational development has decreased the amount of coastal habitat available for piping plovers to nest, roost, and feed. Washover habitat created after large hurricane events is a significant feature of natural barrier islands and serves as important habitat for piping plovers. However, these features are usually developed and/or rebuilt with residential homes shortly after they are created resulting in a continued decrease in nesting habitat availability. Dune construction and subsequent vegetative stabilization is often utilized to protect property and can serve as an impediment to natural overwash features; thus, limiting available nesting habitat. Cross-island transport of sediment and subsequent washover fan formation is considered a primary constituent element used in defining piping plover critical habitat. These low lying sand flats contain sparse vegetation and offer optimum habitat for piping plovers. Beach construction projects can also reduce sparse vegetation and coarse substrate, which may affect Piping Plover nest site selection (Cohen *et al.* 2008). Long and short-term coastal erosion and the abundance of predators, including wild and domestic animals as well as feral cats, have further diminished the potential for successful nesting of this species.

d. Project Impacts.

(1) Habitat. Piping plover breeding territories on the Atlantic Coast typically include a feeding area along expansive sand or mudflats in close proximity to a sandy beach that is slightly elevated and sparsely vegetated for roosting and nesting. As erosion and development persist, piping plover breeding, nesting, roosting, and foraging habitat loss continues. Habitat loss from development and shoreline erosion and heavy public use has led to the degradation of piping plover habitat in the project area. The enhancement of beach habitat through the addition of beach fill may potentially restore lost roosting and nesting habitat; however, short-term impacts to foraging and roosting habitat may occur during project construction.

Initial construction and each periodic nourishment cycle will be performed using either a hydraulic cutterhead dredge or a hopper dredge and will adhere to a 1 November to 31 April dredging window to the maximum extent practicable. Since piping plovers head to their breeding grounds in late March and nesting occurs in late April, project initial construction and nourishment events will avoid impacts to breeding and nesting piping plovers to the maximum extent practicable. Additionally, the project construction limits and activities, including pipeline routes, heavy equipment, staging, etc., and associated direct impacts to habitat will avoid the designated piping plover critical wintering habitat. Lastly, the extension of 14 groins a total of 590 feet should have no downdrift impacts because they are only being extended enough to maintain the constructed berm.

(2) Effect Determination. All construction activities will avoid USFWS designated critical habitat areas. Direct loss of nests from the disposal of the dredged material should not occur, as the species is not known to nest in the project area. Potential piping plover foraging habitat on the beach during the winter months may be altered as beach food resources may be affected by placement of material along the project area, however they are not known to occur on Edisto Beach. Such disruptions will be temporary and of minor significance. Since only a small portion of the foraging habitat is directly affected at any point in time during pump out and adjacent habitat is still available, overall direct loss of foraging habitat will be minimal and short-term.

Any shorebird habitat area originally existing along the length of the island has suffered severe erosion. Dredged material will likely help restore the habitat lost to erosion in this area while the protective berm is being constructed. The placement of dredged material into the intertidal zone will provide additional foraging habitat for the wintering piping plover. For these reasons, it has been determined that the proposed project will have **no effect on the piping plover.** Additionally, since the project is far enough removed from areas of Piping Plover Critical Habitat, it will have **no affect on critical habitat**.

7.0 SUMMARY OF PROTECTIVE MEASURES

The following is a summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. These commitments address agreements with resource agencies, mitigation measures, and construction practices.

7.1 WEST INDIAN MANATEE

Should a change in the schedule necessitate work during the manatee migration period, personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing manatees. The Contractor may be held responsible for any manatee harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The standard manatee conditions apply annually from 1 June to 30 September. The Contractor will be instructed to take necessary precautions to avoid any contact with manatees. If manatees are sighted within 100 yards of the dredging area, all appropriate precautions will be implemented to insure protection of the manatee. The Contractor will stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment.

7.2 NORTH ATLANTIC RIGHT WHALE

Since the construction is anticipated to be scheduled during the right whale migration period, personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing right whales. The Contractor may be held responsible for any whale harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The time when most right whale sightings occur is December, January, and February. The Contractor will be instructed to take necessary precautions to avoid any contact with whales. If whales are sighted within 1000 feet of the borrow area, all appropriate precautions shall be implemented to insure protection of the whale. In addition, the Contractor will stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than this distance.

7.3 SEA TURTLES

Should the schedule necessitate work during the sea turtle nesting time period, in order to minimize impacts to nesting sea turtles a beach monitoring and nest relocation program for sea turtles will be implemented. This program will include nighttime monitoring along the beach where construction is taking place to ensure the safety of female turtles attempting to nest; daily patrols of sand placement areas at sunrise; relocation of any nests laid in areas to be impacted by sand placement; and monitoring of hatching success of the relocated nests. Sea turtle nests will be relocated to an area suitable to both the USFWS and the SCDNR. The Corps or the Town of Edisto Beach will perform any necessary maintenance of beach profile (tilling and shaping or knocking down escarpments) during construction and prior to the three subsequent nesting seasons.

During construction of this project, staging areas for construction equipment will be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use shall be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all dredge pipes that are placed on the beach will be located as far landward as possible without compromising the integrity of the existing or reconstructed dune system. Temporary storage of pipes will be off the beach to the maximum extent possible. Temporary storage of pipes on the beach will be in such a manner so as to impact the least amount of nesting habitat and will likewise not compromise the integrity of the dune systems (placement of pipes perpendicular to the shoreline will be recommended as the method of storage).

During construction of this project, all on-beach lighting associated with the project will be limited to the immediate area of active construction only. Such lighting will be shielded, low-pressure sodium vapor lights to minimize illumination of the nesting beach and nearshore waters. Red filters will be placed over vehicle headlights (i.e., bulldozers, front end loaders). Lighting on offshore equipment will be similarly minimized through reduction, shielding, lowering, and appropriate placement of lights to avoid excessive illumination of the water, while meeting all U.S. Coast Guard and OSHA requirements. Shielded, low pressure sodium vapor lights will be highly recommended for lights on any offshore equipment that cannot be eliminated.

7.4 STURGEONS

Endangered species observers (ESOs) on board hopper dredges as well as trawlers will be responsible for monitoring for incidental take of shortnose and Atlantic sturgeon species. For hopper dredging operations, dragheads as well as all inflow and overflow screening will be inspected for sturgeon species following the same ESO protocol for sea turtles. Furthermore, all ESOs on board trawlers will be capable of identifying shortnose and Atlantic sturgeon as well as following safe handling protocol as outlined in Moser *et. al.* 2000.

8.0 SUMMARY EFFECT DETERMINATION

This Biological Assessment of Threatened and Endangered Species has examined the potential impacts of the proposed project on the habitat and listed species of plants and animals that are, or have been, present in the project area. Both primary and secondary impacts to habitat have been considered. Critical habitat has not been designated for whales, manatees, sea turtles, or sturgeon in South Carolina; therefore, none would be affected. The USFWS designated critical habitat for the wintering piping plover is adjacent and to the north of the island, but not on the island. Based on the analysis presented in this Biological Assessment, the following determinations have been made (Table 5).

Table 5. Threatened and endangered species effect determination

<table>
<tr><th colspan="2" rowspan="2">Listed Species within Project Area</th><th colspan="2">Effect Determination</th></tr>
<tr><th>Beach Placement Activities (USFWS)</th><th>In-water Dredging Activities: Cutterhead/Hopper Dredge (NMFS)</th></tr>
<tr><td rowspan="5">Sea Turtles</td><td>Leatherback</td><td>MANLAA</td><td rowspan="13">Covered by 1997 SARBO</td></tr>
<tr><td>Loggerhead</td><td>MALAA</td></tr>
<tr><td>Green</td><td>MANLAA</td></tr>
<tr><td>Kemp’s Ridley</td><td>NE</td></tr>
<tr><td>Hawksbill</td><td>NE</td></tr>
<tr><td rowspan="6">Large Whales</td><td>Blue</td><td>NE</td></tr>
<tr><td>Finback</td><td>NE</td></tr>
<tr><td>Sei</td><td>NE</td></tr>
<tr><td>Sperm</td><td>NE</td></tr>
<tr><td>Humpback</td><td>NE</td></tr>
<tr><td>North Atlantic Right Whale</td><td>NE</td></tr>
<tr><td colspan="2">West Indian Manatee</td><td>NE</td></tr>
<tr><td colspan="2">Piping Plover and Critical Wintering Habitat</td><td>NE/NE</td></tr>
<tr><td colspan="2">Shortnose Sturgeon</td><td>NE</td></tr>
<tr><td colspan="2">Atlantic Sturgeon</td><td>NE</td><td>NE / MALAA (Covered by Reinitiation of Consultation under 1997 SARBO)</td></tr>
</table>

9.0 LITERATURE CITED

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Appendix A: USFWS Construction Windows

INFORMATION ON OCCURANCES OF FEDERALLY THREATENED AND ENDANGERED ANIMAL SPECIES IN SOUTH CAROLINA

SCIENTIFIC NAME	COMMON NAME	STATUS	TIME PERIOD	COMMENTS
Acipenser brevirostrum	Shortnose sturgeon	Endangered	February 15 – April 30	spawning migration
Ambystoma cingulatum	Flatwoods salamander	Threatened	January – April	larvae present in breeding ponds
Caretta caretta	Loggerhead sea turtle	Threatened	May 1 – October 31	nesting and hatching
Charadrius melodus	Piping plover	Threatened	July 15 – May 1	migration and winter
Dermochelys coriacea	Leatherback sea turtle	Endangered	April 15 – September 30	nesting and hatching
Drymarchon corais couperi	Eastern Indigo snake	Threatened	November – March	breeding season
Haliaeetus leucocephalus	Bald eagle	Threatened	October 1 – May 15	nesting season
Lasmigona decorada	Carolina heelsplitter	Endangered	March – September	optimal survey window
Mycteria americana	Wood stork	Endangered	February 15 – September 1	nesting season
Myotis sodalis	Indiana bat	Endangered	August – late March	winter migration and
Picoides borealis	Red-cockaded woodpecker	Endangered	April 15 – July 31	nesting season
Trichechus manatus	West Indian manatee	Endangered	May 15 – October 15	in coastal waters

For additional information about these species, please visit the U.S. Fish and Wildlife Service web page at http://endangered.fws.gov.

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX G
ESSENTIAL FISH HABITAT ASSESSMENT

US Army Corps
Of Engineers®
Charleston District

ESSENTIAL FISH HABITAT ASSESSMENT

COASTAL STORM DAMAGE REDUCTION

GENERAL INVESTIGATION STUDY

EDISTO BEACH, COLLETON COUNTY

SOUTH CAROLINA

August 2013

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this document is to present the findings of the Essential Fish Habitat (EFH) assessment conducted for the proposed Edisto Beach Shore Protection Project as required by the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended through 1996 (Magnuson-Stevens Act). The objectives of this EFH assessment are to describe how the actions proposed by the project may affect EFH designated by the National Marine Fisheries Service (NMFS) and the South Atlantic Fisheries Management Council.

The EFH assessment will include a description of the proposed action, an analysis of the direct, indirect, and cumulative effects on EFH for the managed fish species and their major food sources, and our views regarding the effects of the proposed action.

2.0 PROJECT DESCRIPTION

The proposed project (see Figures 1 thru 4) was determined after a detailed alternatives analysis documented within the Feasibility Study/Environmental Assessment. The project consists of the following elements: 1) A 15-foot high (elevation), 15-foot wide dune beginning at the northern end of the project (i.e., the southern end of the State Park) and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would then taper to a 50-foot width for the remaining length of the berm. The width of each end of the berm would taper to match the existing beach profile; 2) The dune would then transition into a 14-foot high (elevation), 15-foot wide dune that extends around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm; and 3) Approximately 1,130 ft of total groin lengthening across 23 of the existing groins (Figure 5 and Table 1). Results of a coastal engineering analysis determined that this minimal amount of lengthening will not have any downdrift impacts as the design is simply to stabilize the proposed berm width. Because the distance between the landward toe of the dune and the seaward edge of the berm for the beach design exceeds the existing condition distance between these same points along certain reaches within the project, the effective length of the groins in these areas will be reduced. Consequently, the length of some groins will need to be increased in order to create beach width necessary to maintain the design cross-section. The proposed groin lengthening is not provided as a means for trapping more sand and increasing beach width or significantly changing the rate of sand bypassing the groins. The renourishment interval for the proposed project has been estimated to occur every 8 years and is triggered by a mobilization threshold of 220,400 cubic yards of sand.

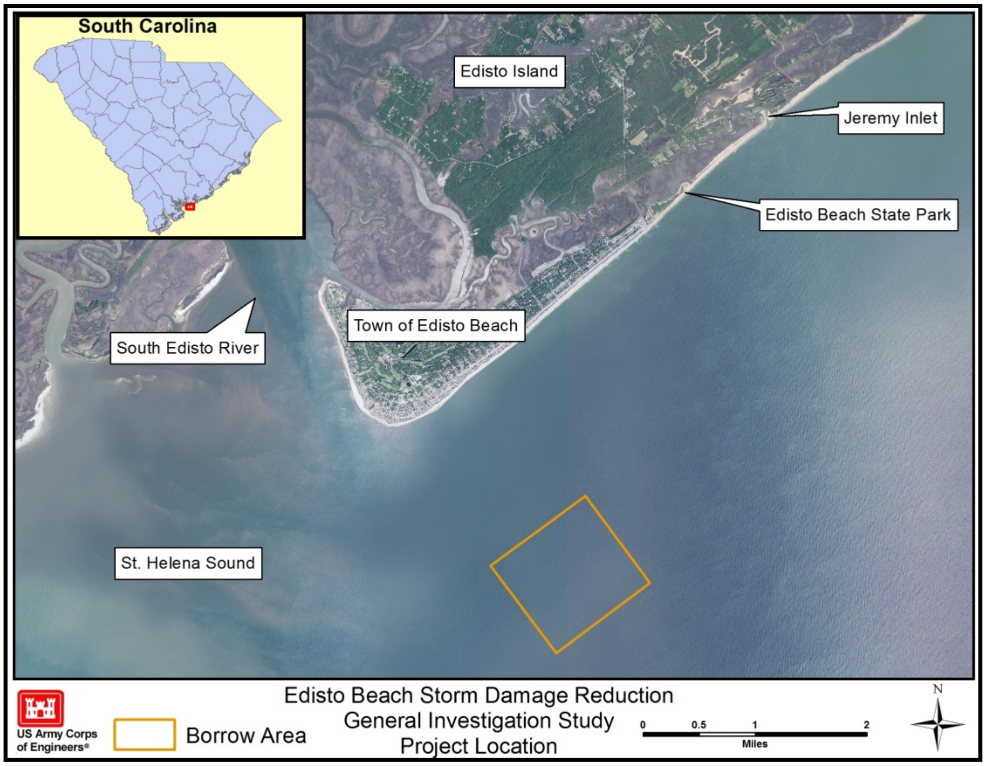

Figure 1. Location of Edisto Beach and proposed borrow site

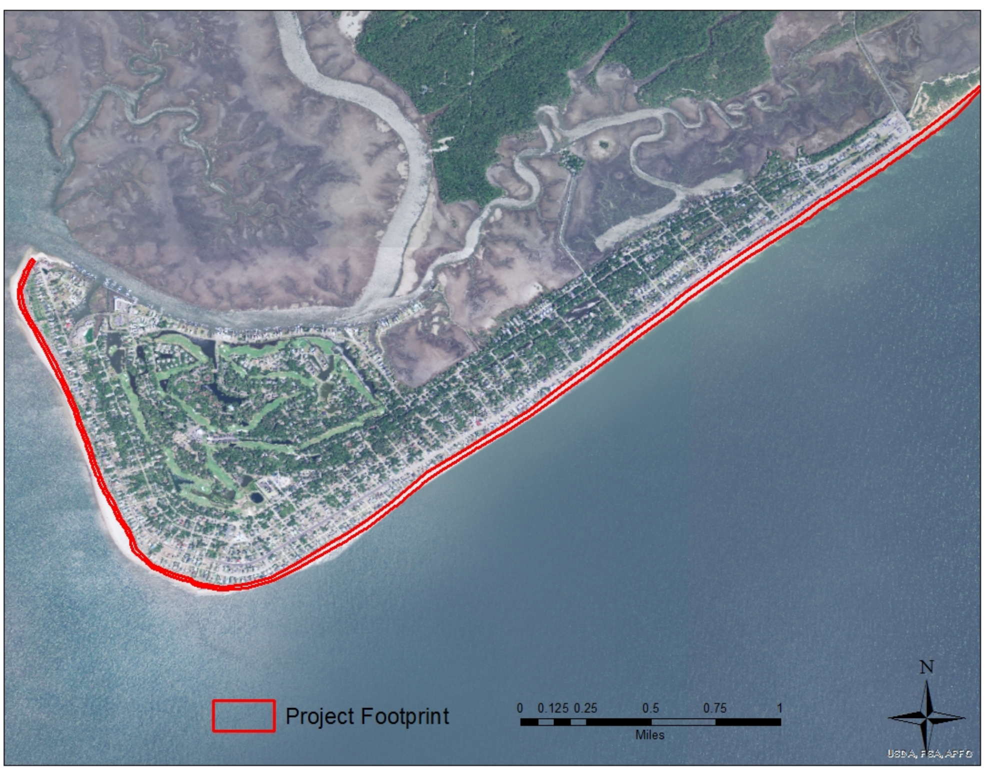

Figure 2. Project footprint from landward toe of dune to seaward berm crest

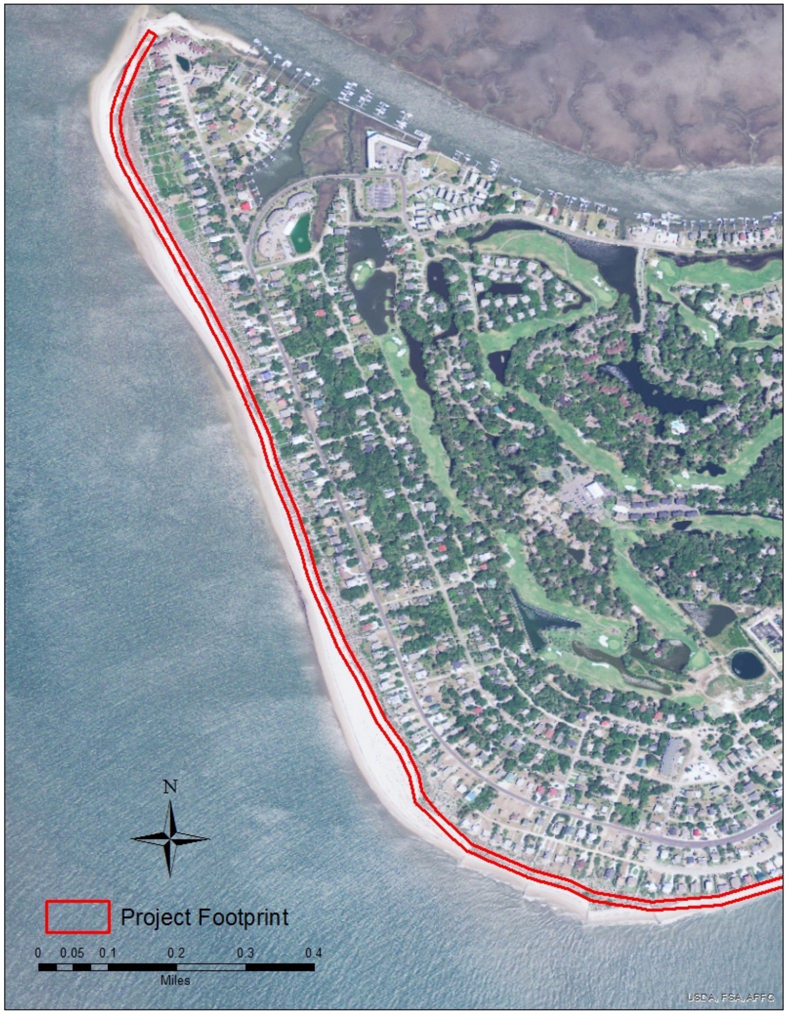

Figure 3. Project footprint along inlet reaches

Figure 4. Project footprint along Atlantic Ocean facing reaches

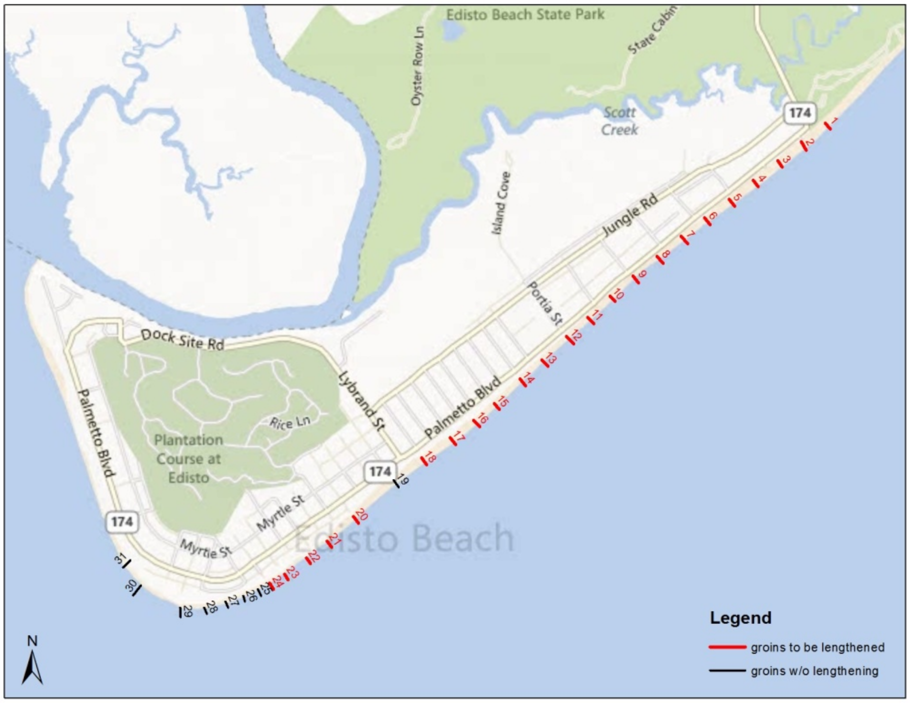

Figure 5. Spatial location of proposed groin lengthenings

Table 1. Proposed groin lengthening dimensions by groin number

Groin Extension Lengths			
Groin #	**Extension length (ft)**	**Groin #**	**Extension length (ft)**
1	80	13	40
2	80	14	30
3	90	15	20
4	90	16	20
5	100	17	20
6	100	18	20
7	80	20	20
8	60	21	30
9	50	22	30
10	50	23	20
11	40	24	20
12	40		
Total Groin Lengthening: 1,130 feet			

Construction will be by means of either a hydraulic cutterhead dredge or a hopper dredge that will transport the sand through a pipeline. The pipeline will run adjacent to the groins and parallel with the beach. Beach compatible material (sand) from an offshore source will be pumped along the 21,820 linear feet of the project and will be discharged as a slurry. During construction, temporary training dikes of sand will be used to contain the discharge and control the fill placement. Fill sections will be graded by land-based equipment, such as bulldozers, articulated front-end loaders, and other equipment as necessary to achieve the desired beach profile. Equipment will be selected based on whatever generates only minimal and acceptable temporary environmental impacts, as well as whatever proves to be the most advantageous economically. The sand will then be graded, raked, and tilled as necessary in coordination with recommendations and requirements from regulatory agencies. It is anticipated that construction will begin in late-2018 and will require approximately 4 to 5 months for completion. A construction window of November 1 through April 30 will minimize impacts to sea turtles, fish, shellfish, and infauna, and will be utilized whenever possible (see USFWS Construction Windows, Appendix A). The schedule could change due to congressional funding, contractual issues, inclement weather, equipment failure, or other unforeseen difficulties.

The borrow area for the proposed project occurs on an ebb-tidal shoal located approximately 1.5 miles to 2.5 miles southeast of the southern point of Edisto Beach and is approximately 649 acres in size (Figure 1). The site was determined from a larger search area and was narrowed down to include sands that most appropriately match the native beach sands on Edisto Beach. The borrow area contains approximately 7.2 million cubic yards of beach compatible sands. Native beach sands were determined based on beach samples collected at 34 stations along Edisto Beach and reflects conditions after the 2006 renourishment project (completed by Coastal Science and Engineering). Each station included four grab samples – one each from the toe of the dune, berm, beach face, and low tide swash zone. Results of this analysis determined that the beach sands have a mean phi size of 1.31, 0.1 % silt/clay mix, and 26.9% visual shell hash. These results compare favorably with the borrow area sands (Table 2).

Additionally, a cultural and hardbottom resources survey was completed at the borrow area in March 2013. The survey utilized three techniques: 1. Side scan sonar, 2. Sub-bottom profiling, and 3. Magnetometer. Results of this survey determined that there are no hardbottom resources within the proposed borrow area. The borrow area location has been shared with multiple resource agencies over the course of the study and no additional issues have been raised to date.

Table 2. Edisto Beach grain size comparison between borrow site and native beach sands

	MEAN (phi)	STD DEV (phi)	% PASSING #5	%PASSING #10	% PASSING #200	% PASSING #230	% VISUAL SHELL
Edisto Native Beach	**1.31**	**1.33**	**97.8**	**93.5**	**0.1**	**0.0**	**26.9**
Borrow - Scenario A	**1.73**	**1.31**	**94.7**	**90.0**	**0.4**	**0.2**	**18.8**

NOTE: The data comparison above is not a Federal requirement, but is provided to gain a perspective as to the quality of material in the borrow area which is proposed for placement as nourishment material on the beach.

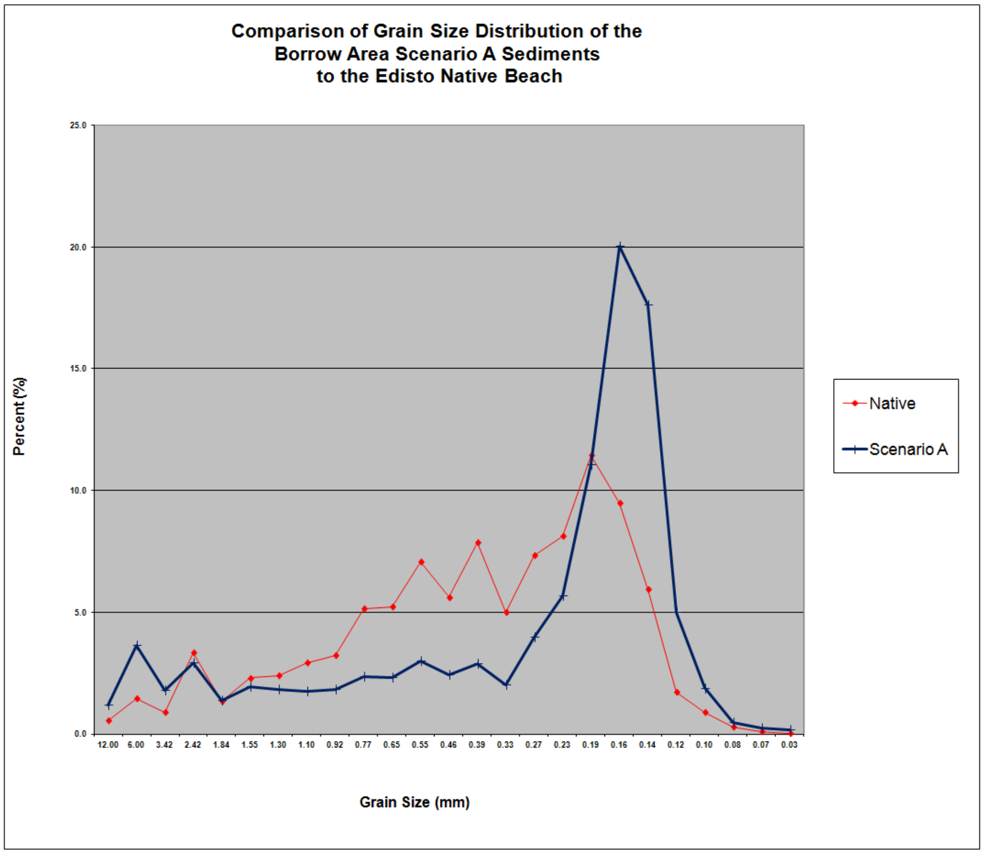

Figure 5. Histogram of native beach sands vs. proposed borrow site

Edisto Beach has very coarse sand and previous attempts at using fencing along a constructed berm to create an eolian transport driven dune have been unsuccessful. Therefore, the proposed project involves the creation of a 14 to 15 foot high dune at 15 feet width and a 3:1 slope. This dune feature may bury existing dune vegetation in some areas, especially along the inlet section of the beach. The proposed project consists of planting dune vegetation along the constructed dune including foreslope and backslope. The use of native vegetation will provide an environmental enhancement to the beach front while helping to stabilize the constructed dune. Plantings will be done in a matrix fashion and consist of native vegetation including but not limited to sea oats, Bitter panicum, and American beachgrass (Bogue variety). The total area of necessary dune planting is 29.68 acres.

3.0 ESSENTIAL FISH HABITAT

The 1996 amendments to the Magnuson-Stevens Act set forth a mandate for NOAA Fisheries, regional Fishery Management Councils, and other Federal agencies to identify and protect EFH of economically important marine and estuarine fisheries. To achieve this goal, suitable fishery habitats need to be maintained. In South Carolina waters, there are three federal entities that manage fish: the NMFS, the South Atlantic Fishery Management Council, and the Mid-Atlantic Fishery Management Council.

Edisto Beach supports significant fish and wildlife resources including many marine and estuarine species. The estuary supports large populations of penaeid shrimp and blue crabs which are economically important species. Demersal fish species include Atlantic croaker, bay anchovy, Atlantic menhaden, spotted hake, weakfish, spot, blackcheek tonguefish, white catfish, and silver perch. Other fish of commercial or recreational value are commonly found around Edisto Beach, including flounder, red drum, spotted seatrout, bluefish, spot, and black drum.

All of the tidally influenced reaches and adjacent wetlands are considered EFH, as well as coastal waters. Some of these areas include estuarine emergent wetlands, oyster reefs/shell banks, intertidal flats, aquatic beds, estuarine water column, and marine water column (Table 3).

Table 3. Essential Fish Habitat list and occurrence

Essential Fish Habitat List and Study Area Occurrence

Habitat Type	Habitat Name	Project Area
Estuarine	Estuarine Emergent Wetland (tidal marsh)	Yes
Estuarine	Estuarine Scrub/shurb mangroves	No
Estuarine	Sea grass	No
Estuarine	Oyster reefs and shell banks	Yes
Estuarine	Intertidal flats	Yes
Estuarine	Palustrine emergent and forested wetland	No
Estuarine	Aquatic beds	No
Estuarine	Estuarine Water Column	Yes
Estuarine	Unconsolidated Bottom	Yes
Marine	Live/Hard bottoms	No
Marine	Coral and coral reefs	No
Marine	Artificial/manmade reefs	No
Marine	Sargassum	No
Marine	Marine water column	Yes

3.1 Estuarine Emergent Wetland (tidal marsh)

Tidal marshes are one of the dominant features of the coastal plain in South Carolina. Tidal marshes serve many important functions. The basis of the importance of these marsh communities involves the basic high productivity of the marsh itself and its function of trapping nutrients. The dense plant growth in the marsh also provides excellent cover for many species of birds, aquatic and semi-aquatic mammals, reptiles and amphibians, and typically provides spawning grounds, nurseries, shelter, and food for many species of finfish, shellfish, birds, and other types of wildlife. Besides water quality and habitat benefits, marshes also serve to buffer storm waves and slow shoreline erosion.

3.2 Oyster Reefs and Shell Banks

Oyster reefs and shell banks are defined by SAFMC as being the, "natural structures founds between and beneath tide lines, that are composed of oyster shell, live oysters and other organisms". This habitat is usually found adjacent to emergent marsh vegetation and provides the other three-dimensional structural relief in soft-bottom, benthic habitat (Wenner et al., 1996). Optimal salinity for *Crassostrea virginica* ranges from 12ppt to 25ppt, and in South Carolina are 95% intertidal (Lunz 1952). Oyster reefs are extremely important to the aquatic ecosystem in South Carolina as they remove particulate matter, release inorganic and organic nutrients, stabilize sediments, provide habitat cover, etc.

3.3 Intertidal Flats

Intertidal flats serve various functions for many species' life stages. The estuarine flats serve as a foraging ground, refuge, and nursery area for many mobile species as well as the microalgal community, which can function as a nutrient (nitrogen and phosphorus) stabilizer between the substrate and water column. An intertidal flat's benthic community can include, but is not limited to, worms, bivalves, and gastropods. This tidally influenced, constantly changing EFH provides feeding grounds for predators, refuge and feeding grounds for juvenile and forage fish species, and nursery grounds for estuarine dependant benthic species (SAFMC 1998).

Animals that move from a pelagic larval to a benthic juvenile existence make use of these EFH flats for life stage development. These flats can provide a comparatively low energy area with tidal phases which allow species the use of shallow water habitat as well as relatively deeper water within small spatial areas. Species such as summer flounder (*Paralichthys dentatus*), red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), striped mullet (*Mugil cephalus*), gray snapper (*Lutjanus griseus*), blue crab (*Callinectes sapidus*), and shrimp use these EFHs as nurseries. These flats also serve as refuge areas for species avoiding predators, which use the tide cycles for access to estuarine feeding grounds(SAFMC 1998).

3.4 Estuarine Water Column

This habitat comprises multiple salinity regimes, the one most important to this study being euhaline waters (>30ppt) and to a lesser extent polyhaline waters (18-30ppt). The water column has both horizontal and vertical components that result in changing salinity, phytoplankton, oxygen content, nutrients, etc. This habitat provides a rich opportunity for biota to live within whichever parameters they are adapted to. Many marine-spawning species use the water column as larvae as they are transported through inlets.

3.5 Unconsolidated Bottom

This habitat type consists of soft sediments that are inhabitated by a diverse assemblage of macroinvertebrates that serve as prey to demersal fish species. They can be characterized by the lack of large stable surfaces for plant and animal attachment. These areas include all wetland and deepwater habitats with at least 25% cover of particles smaller than stones and a vegetative cover less than 30% (USGS, http://www.npwrc.usgs.gov/resource/wetlands/classwet/unconsol.htm).

3.6 Marine Water Column

The water column serves as EFH for all managed species and their prey, at various life stages, by providing habitat for spawning, breeding, feeding and growth. Species (and life stages) for which the column of seawater has been designated as EFH are discussed in the following section, Managed Fish Species.

4.0 HABITAT AREAS OF PARTICULAR CONCERN

4.1 Penaeid Shrimp

Areas which meet the criteria for HAPC for penaeid shrimp include all coastal inlets, all state-designated nursery habitats of particular importance to shrimp, and state-identified overwintering areas. In South Carolina, since there are no seagrass beds, nursery habitat of shrimp is the high marsh areas with shell hash and mud bottoms. Since there is seasonal movement out of the marsh and into deep water and creek channels during the winter months, the HAPC encompasses the entire estuarine system (Figure 6).

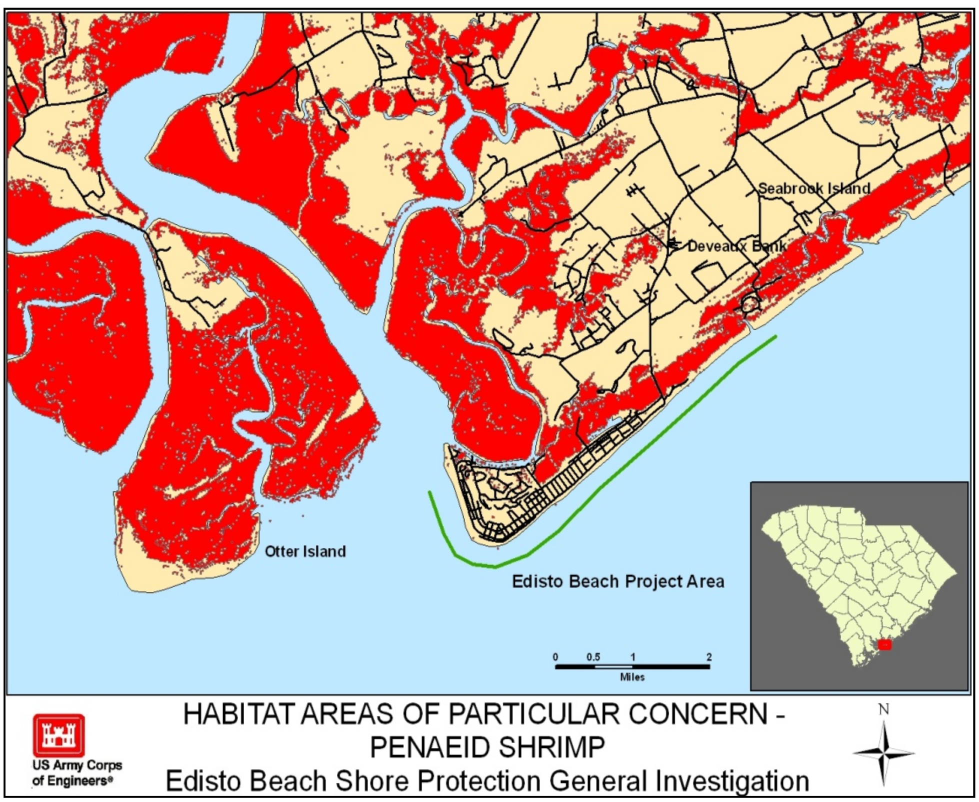

Figure 6. Penaeid Shrimp HAPC

4.2 Snapper-Grouper Complex

HAPC exists for the Snapper-Grouper complex in and around the Edisto Beach project area. These HAPC consist of coastal inlets, oyster/shell habitat, and Special Management Areas (Figure x). The closest Special Management Area is approximately 8 miles from the Edisto beachfront and will not be impacted by the project. Others areas of HAPC include medium to high profile hard bottom, localities of known or likely periodic spawning aggregations, and nearshore hard bottom areas. None of these are in the vicinity of the proposed project (Figure 7).

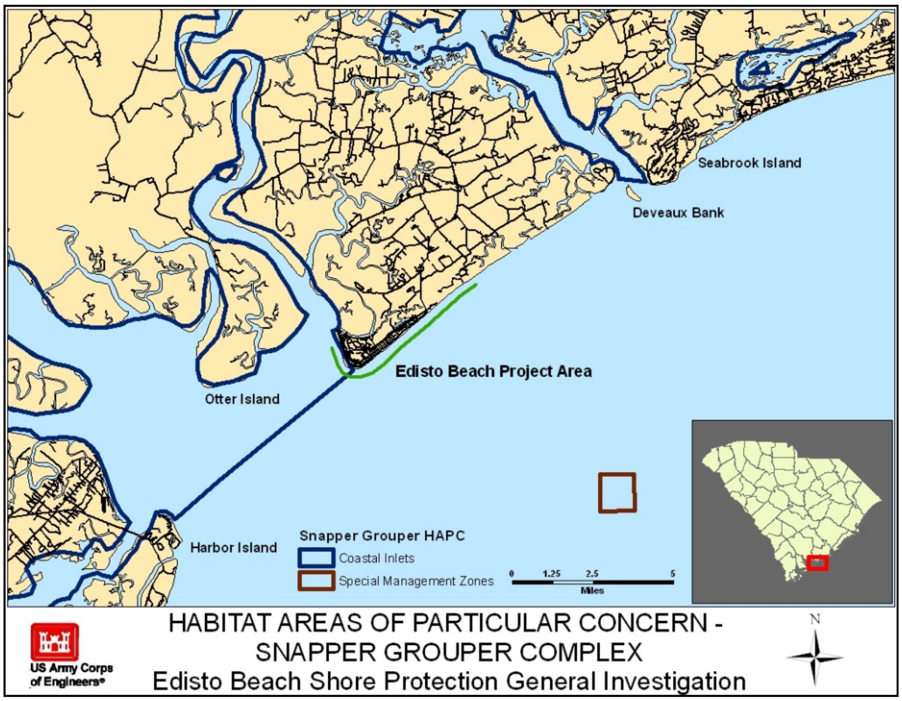

Figure 7. Snapper-Grouper complex HAPC

5.0 MANAGED FISH SPECIES

Table 4 lists the managed species that may occur in the project area.

5.1 Penaeid Shrimp

In the southeastern United States, the shrimp industry is based on the white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*Farfantepenaeus duorarum*), and the deeper water rock shrimp (*Sicyonia brevirostri*). The royal red shrimp (*Pleoticus robustus*) also occurs in deeper water and sustains a limited harvest. For the above species, coastal inlets have been classified as HAPC. Within the project area, this includes the estuarine and marine water columns within the South Edisto River inlet. These areas are the

Table 4. Fishery Management Plans and managed species for the project area

Fishery Management Plans (FMPS) and Managed Species for the South Atlantic that may Occur in the Project Area	
Common Name	**Species**
Shrimp	
brown shrimp	*Farfantepenaeus aztecus*
pink shrimp	*Farfantepenaeus aduorarum*
rock shrimp	*Sicyonia brevirostris*
royal red shrimp	*Pleoticus robustus*
white shrimp	*Litopenaeus setiferus*
Snapper Grouper Complex	
Jack crevalle	*Caranx hippos*
gag grouper	*Mycteroperca microlepis*
black sea bass	*Centropristis striata*
mutton snapper	*Lutjanus analis*
red snapper	*Lutjanus campechanus*
lane snapper	*Lutjanus synagris*
gray snapper	*Lutjanus griseus*
yellowtail snapper	*Ocyurus chrysurus*
spadefish	*Chaetodipterus faber*
white grunt	*Haemulon plumieri*
sheepshead	*Archosargus probatocephalus*
hogfish	*Lachnolaimus maximus*
Coastal Migratory Pelagics	
king mackerel	*Scomberomorus cavalla*
Spanish Mackerel	*Scomberomorus maculatus*
cobia	*Rachycentron canadum*
Mid-Atlantic FMP species which occur in South Atlantic	
bluefish	*Pomatomus saltatrix*
summer flounder	*Paralichthys dentatus*
Federally Implemented FMP	
lemon shark	*Negaprion brevirostris*
bull shark	*Carcharhinus leucas*
blacknose shark	*Carcharhinus acronotus*
finetooth shark	*Aprionodon isodon*
dusky shark	*Carcharhinus obscurus*
bonnethead shark	*Sphyrna tiburo*
Atlantic sharpnose shark	*Rhizoprionodron terraenovae*

connecting waterbodies between inshore estuarine nursery areas, offshore marine habitats used for spawning and growth to maturity. Essential Fish Habitat for rock shrimp and royal red shrimp occurs in deeper offshore waters. None of these offshore areas occur within the study area.

5.1.1 White Shrimp

White shrimp are offshore and estuarine dwellers. They can be either pelagic or demersal depending on their life stage. They prefer muddy or peaty bottoms rich in organic matter and decaying vegetation when occupying inshore waters. When offshore, they are most abundant on soft muddy bottom sediments. Postlarval white shrimp are benthic dwellers when reaching their nursery areas in estuaries. The juveniles move from estuarine areas to coastal waters as they mature, and adults generally inhabit waters of 27 m or less. White shrimp have centers of abundance in South Carolina, Georgia, and northeast FL.

Spawning area: Most spawning in South Carolina occurs within about 4 miles of the coast, between April and October.

Nursery area: South Edisto River Inlet, Big Bay Creek and Scott Creek

5.1.2 Brown Shrimp

Brown shrimp prefer soft muddy bottom sediments when offshore, and as adults may be found in areas of mud, sand, and shell. They are more active at night and bury into the sediment during the day.

Spawning area: Most spawning in South Carolina occurs in relatively deep water. The season is uncertain, although mature females and males have been found off South Carolina during October and November.

Nursery area: South Edisto River Inlet, Big Bay Creek and Scott Creek

5.1.3 Pink Shrimp

Pink shrimp most commonly found on hard sand and calcareous shell bottom. Similar to brown shrimp, the pink shrimp is more active at night, and generally buries into the sediment during the day.

Spawning area: Most spawning in South Carolina occurs between 3.7 and 15.8 m starting in May.

Nursery area: South Edisto River Inlet, Big Bay Creek and Scott Creek

5.2 Snapper Grouper

The snapper grouper complex utilizes both pelagic and benthic habitats throughout their life cycles. Larvae are free swimming within the water column. During this stage they commonly feed on zooplankton. Juveniles and adults are frequently bottom dwellers that associate with hard structures with moderate to high relief. The principal fishing areas are located in live bottom and shelf-edge habitats in deeper waters. Several patterns are present: (1) for many groupers, spawning occurs over one or two winter months, (2) spawning occurs at low levels year-round with peaks during the warmer months, and (3). The species tend to form sizable spawning aggregations, but this might not be the case with all species.

Ten families of fish containing 73 species are managed by the South Atlantic Fishery Management Council (SAFMC). There is variation in specific life history patterns and habitat use among the snapper grouper species complex. Snapper grouper species utilize both benthic and pelagic habitats during their life cycle. They live in the water column and feed on zooplankton during their planktonic larval stage, while juveniles and adults are demersal and usually associate with hard structures with high relief. EFH for these species in SC includes estuarineemergent wetlands, estuarine scrub/shrub wetlands, unconsolidated bottom, live/hard bottom, and oyster beds. Coastal inlets, including those waters of the South Edisto River inlet are considered Habitat Areas of Particular Concern (HAPC), along with oyster beds. These areas are critical for spawning activity as well as feeding and daily movements.

5.3 Coastal Migratory Pelagics

King and Spanish mackerel and cobia are coastal migratory pelagic species managed by the SAFMC. EFH for these species include the South Edisto River inlet. Many coastal pelagic prey species are estuarine-dependant in that they spend all or a portion of their lives in estuaries. Accordingly, the coastal pelagic species, by virtue of their food source, are to some degree also dependent upon estuaries and, therefore, can be expected to be detrimentally affected if the productive capabilities of estuaries are greatly degraded.

5.4 Highly Migratory Pelagics

This category consists of Atlantic Bluefin Tuna, Atlantic Bigeye Tuna, Atlantic Yellowfin Tuna, Atlantic Albacore Tuna, Atlantic Skipjack Tuna, Swordfish, Blue Marlin, White Marlin, Sailfish, Longbill Spearfish, and Atlantic sharks. These species tend to occupy deep water and will not occur within the project area.

5.5 Spiny Lobster

The Spiny lobster occurs throughout the Caribbean Sea, and along the shelf waters of the southeastern United States north to North Carolina. They are primarily hard substrate dwellers and are not expected to be located in the project area.

5.6 Mid-Atlantic Species Which Occur in the South Atlantic

Bluefish and summer flounder are two species listed in the Mid-Atlantic Fisheries Management Plan that occur in the South Atlantic. Bluefish juveniles and adults are listed as using estuaries from North Carolina to Florida and are common around the project area.

6.0 ASSESSMENT OF IMPACTS AND MITIGATIVE MEASURES

In this section, potential impacts to managed species and EFH are examined. Impacts will occur as a result of two different actions: 1. the dredging of beach quality sand from an offshore borrow area, and 2. the placement of that sand onto the beachfront.

The borrow area for the proposed project is located between 1.5 and 2.5 miles offshore, and therefore the dredging of these sediments will have no impact on estuarine emergent wetlands, oyster reefs, nor intertidal flats. The borrow area consists of roughly 649 acres of soft sandy bottom habitat, which will be impacted by dredging operations. The post-dredge infilling rate and quality and type of the material are contributing factors to the recovery of the area dredged. A change in the hydrologic regime as a consequence of altered bathymetry may result in the deposition or scour of fine sediments, which may result in a layer of sediment that differs from the existing substrate. Benthic organisms within the defined borrow area dredged for construction and periodic nourishment would be lost. However, recolonization by opportunistic species would be expected to begin soon after the dredging activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Rapid recovery would be expected from recolonization from the migration of benthic organisms from adjacent areas and by larval transport. SCDNR has recommended the use of ebb-tidal shoal complexes on the downdrift end of beaches in order to assist in the faster recovery of the borrow area, and one of the factors in the selection of the proposed borrow area was the potential for faster recovery and possible re-use of the site. In addition, if a hopper dredge is used at the borrow area, impacts will likely be minimized (Bergquist et al., 2009).

Dredging in the selected borrow area would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended sediment and turbidity generated during dredging. Factors that are known to influence sediment spread and water column turbidity are grain size, water currents and depths. During construction, there would be elevated turbidity and suspended solids in the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate construction/maintenance area (turbidity increases of 25 nephelometric turbidity units [NTUs]) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would hug the shore and be transported with waves either up-drift or down-drift depending on wind conditions. Because of the low percentage of silt and clay in the borrow areas (less than 10 percent), and the high shell content, turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events. Any increases in turbidity in the borrow area during project construction and maintenance would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the surf zone when dredging ends. As a result of sediment suspension there is the potential for some change in local dissolved oxygen levels. However, if such a change were to occur it is anticipated it would be short term in nature and not appreciable.

Oceanic nekton are active swimmers, and are distributed in the relatively shallow oceanic zone. Any entrainment of adult fish, and other motile animals in the vicinity of the borrow area during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas. Fish species are expected to leave the area temporarily during the dredging operations and return when dredging ceases (Pullen and Naqvi 1983). Impacts to the nekton community of the nearshore ocean will be temporary and minor.

Beach nourishment may have negative effects on intertidal macrofauna through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile. While beach nourishment may produce negative effects on intertidal macrofauna, they would be localized in the vicinity of the nourishment operation. Construction and subsequent nourishments will occur during the winter months when possible. Because of this, beach nourishment would therefore be completed before the onshore recruitment of most surf zone fishes and invertebrate species. To assure compatibility of nourishment material with native sediment characteristics and minimize impacts to benthic invertebrates from the placement of incompatible sediment, all sediment identified for use for this project has gone through compatibility analysis to assure compatibility with the native sediment. In summary, only temporary effects on intertidal macrofauna in the immediate vicinity of the beach nourishment project would be expected as a result of discharges of nourishment material on the beach.

6.1 Species Impacts

The potential for adverse impact to fish with EFH designated in the project area is likely to differ from species to species, depending upon life history, habitat use (demersal vs. pelagic), and distribution and abundance. However, it is anticipated that short-term impacts to older life-stages of fish (both pelagic and demersal) will be limited to temporary displacement during initial dredging, and subsequently, during renourishment projects. There may be some entrainment of eggs and early larval stages of fish species during the dredging process. However, it is anticipated that this displacement will not be significant because pelagic larve and eggs will continue to be carried through the project area with prevailing tides, currents, and wave action and the effect would only be on demersal eggs/larvae.

7.0 CONSERVATION MEASURES

Although the dredging and disposal of sand resources at the Town of Edisto Beach is not likely to result in any adverse impacts to managed species, the following conservation measures are proposed to minimize or reduce the potential for adversely impacting managed species and other living marine resources:

- Use of a borrow area on an ebb-tidal shoal complex at the downdrift inlet of the barrier island
- Maintaining a 1’ vertical sand buffer in the borrow area should facilitate faster benthic recovery
- Potential use of a hopper dredge for borrow areas has been recommended in the past by SCDNR and will be implemented where possible
- Construction during the winter months should decrease short term impacts to managed fisheries

8.0 CONCLUSIONS

The proposed project will involve impacts to marine and estuarine water column and unconsolidated bottom (Table 5). The overall magnitude of these impacts is expected to be short term and minor under the dredging operations to be employed. Recolonization of both the borrow area and beach face are expected to occur within 1 to 2 years, or faster. The use of best management practices should limit the extent and duration of turbidity impacts, which will temporarily alter fish dynamics in the vicinity of the construction activities. Overall, the impacts to EFH and HAPC related to the proposed beach project at Edisto Beach will be temporary and will not result in significant effects on managed species.

Table 5. Potential EFH Impacts for Edisto Beach Storm Damage Reduction Project

Habitat Type	Habitat Name	Project Area	Potential Impacts	
			Dredging at borrow site	Beach Placement
Estuarine	Estuarine Emergent Wetland (tidal marsh)	Yes	No	No
Estuarine	Estuarine Scrub/shurb mangroves	No	No	No
Estuarine	Sea grass	No	No	No
Estuarine	Oyster reefs and shell banks	Yes	No	Yes
Estuarine	Intertidal flats	Yes	No	No
Estuarine	Palustrine emergent and forested wetland	No	No	No
Estuarine	Aquatic beds	No	No	No
Estuarine	Estuarine Water Column	Yes	No	Yes
Estuarine	Unconsolidated Bottom	Yes	Yes	Yes
Marine	Live/Hard bottoms	No	No	No
Marine	Coral and coral reefs	No	No	No
Marine	Artificial/manmade reefs	No	No	No
Marine	Sargassum	No	No	No
Marine	Marine water column	Yes	Yes	Yes

9.0 REFERENCES

Bergquist, Derk C., Stacie E. Crowe and Martin Levisen. 2009. Change and recovery of physical and biological characteristics of the borrow area impacted by the 2007 Folly Beach emergency renourishment project. Final Report submitted to USACE, Charleston District. SC Department of Natural Resources, Marine Resources Division. Technical Report Number 104.

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South Atlantic Fishery Management Council. 1998. Final habitat plan for the South Atlantic region: Essential Fish Habitat requirements for fishery management plans of the South Atlantic Fishery Management Council. 457 pp plus appendices.

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EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX H
SECTION 404(b)(1) EVALUATION

404(b)(1) Evaluation

Edisto Beach Hurricane and Storm Damage Reduction General Investigation Report

Edisto Beach, Colleton County South Carolina

August 2013

I. PROJECT DESCRIPTION

a. Location and General Description.

The proposed project (see Figures 1 thru 4) was determined after a detailed alternatives analysis documented within the Feasibility Study/Environmental Assessment. The project consists of the following elements: 1) A 15-foot high (elevation), 15-foot wide dune beginning at the northern end of the project (i.e., the southern end of the State Park) and extending southward along the beach for 16,530 feet. This dune would be fronted by a 7-foot high (elevation) berm. The first 7,740 feet of berm length would have a width of 75 feet. The width would then taper to a 50-foot width for the remaining length of the berm. The width of each end of the berm would taper to match the existing beach profile; 2) The dune would then transition into a 14-foot high (elevation), 15-foot wide dune that extends around the end of the island for 5,290 feet. No berm would be constructed in front of this dune because the existing beach profile provides an adequate berm; and 3) Approximately 1,130 ft of total groin lengthening across 23 of the existing groins (see Figure 5 and Table 1). Results of a coastal engineering analysis determined that this minimal amount of lengthening will not have any downdrift impacts as the design is simply to stabilize the proposed berm width. Because the distance between the landward toe of the dune and the seaward edge of the berm for the beach design exceeds the existing condition distance between these same points along certain reaches within the project, the effective length of the groins in these areas will be reduced. Consequently, the length of some groins will need to be increased in order to create beach width necessary to maintain the design cross-section. The proposed groin lengthening is not provided as a means for trapping more sand and increasing beach width or significantly changing the rate of sand bypassing the groins. The renourishment interval for the proposed project has been estimated to occur every 8 years and is triggered by a mobilization threshold of 220,400 cubic yards of sand.

Construction will be by means of either a hydraulic cutterhead dredge or a hopper dredge that will transport the sand through a pipeline. The pipeline will run adjacent to the groins and parallel with the beach. Beach compatible material (sand) from an offshore source will be pumped along the 21,820 linear feet of the project and will be discharged as a

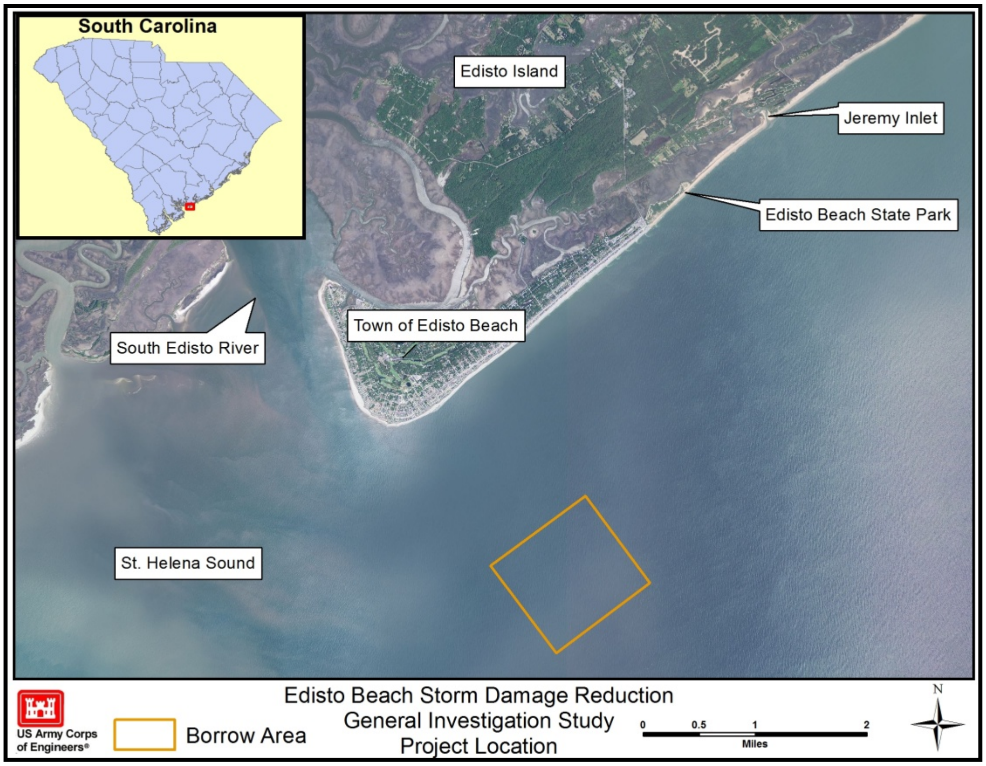

Figure 1. Location of Edisto Beach and proposed borrow site

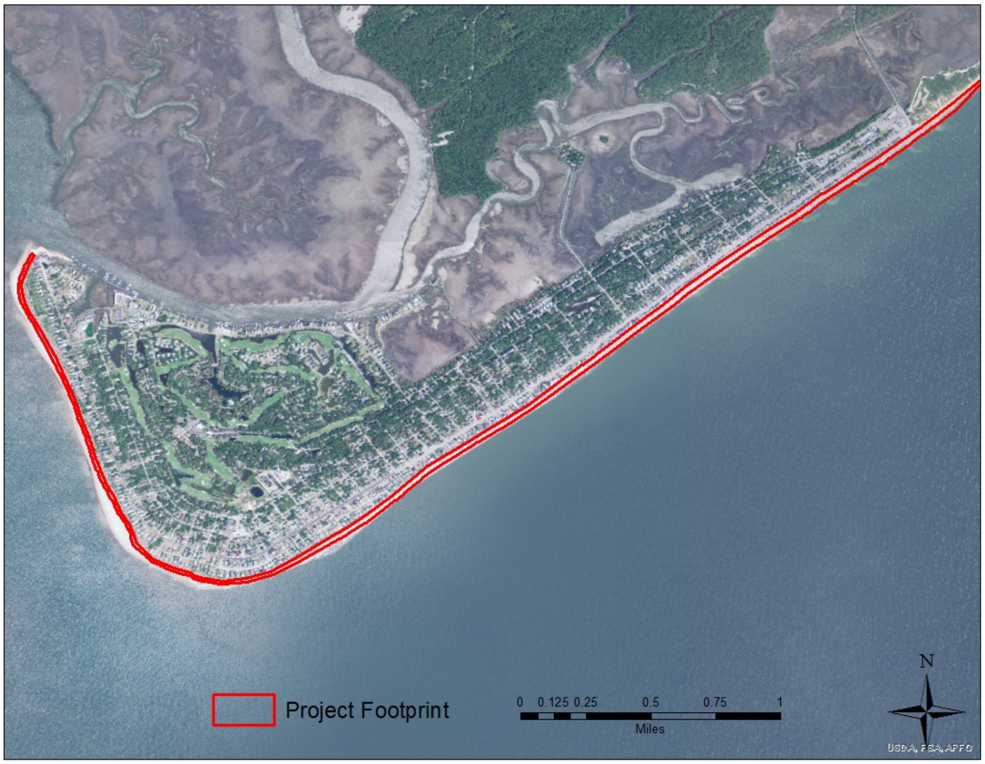

Figure 2. Project footprint from landward toe of dune to seaward berm crest

Figure 3. Project footprint along inlet reaches

Figure 4. Project footprint along Atlantic Ocean facing reaches

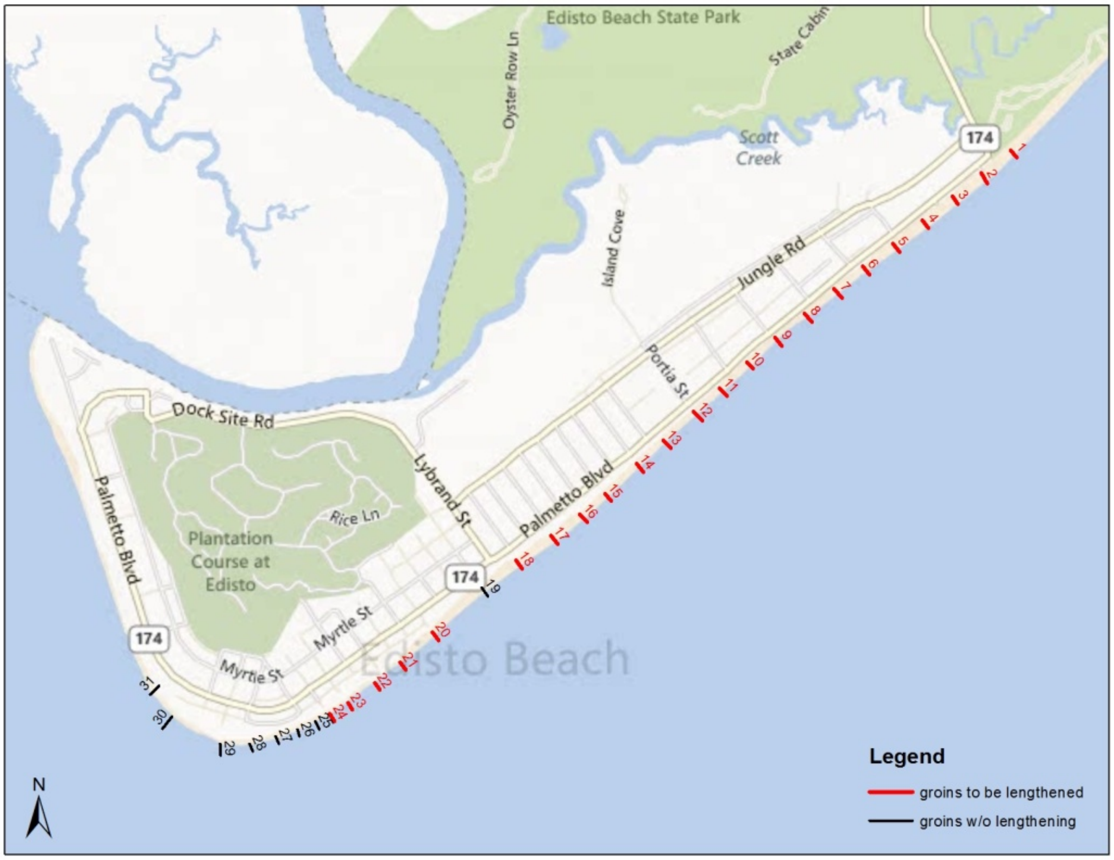

Figure 5. Spatial location of proposed groin lengthenings

Table 1. Proposed groin lengthening dimensions by groin number

Groin Extension Lengths			
Groin #	**Extension length (ft)**	**Groin #**	**Extension length (ft)**
1	80	13	40
2	80	14	30
3	90	15	20
4	90	16	20
5	100	17	20
6	100	18	20
7	80	20	20
8	60	21	30
9	50	22	30
10	50	23	20
11	40	24	20
12	40		
Total Groin Lengthening: 1,130 feet			

slurry. During construction, temporary training dikes of sand will be used to contain the discharge and control the fill placement. Fill sections will be graded by land-based equipment, such as bulldozers, the fill placement. Fill sections will be graded by land-based equipment, such as bulldozers, articulated front-end loaders, and other equipment as necessary to achieve the desired beach profile. Equipment will be selected based on whatever generates only minimal and acceptable temporary environmental impacts, as well as whatever proves to be the most advantageous economically. The sand will then be graded, raked, and tilled as necessary in coordination with recommendations and requirements from regulatory agencies. It is anticipated that construction will begin in late-2018 and will require approximately 4 to 5 months for completion. A construction window of November 1 through April 30 will minimize impacts to sea turtles, fish, shellfish, and infauna, and will be utilized whenever possible (see USFWS Construction Windows, Appendix A). The schedule could change due to congressional funding, contractual issues, inclement weather, equipment failure, or other unforeseen difficulties.

The borrow area for the proposed project occurs on an ebb-tidal shoal located approximately 1.5 miles to 2.5 miles southeast of the southern point of Edisto Beach and is approximately 649 acres in size (Figure 1). The site was determined from a larger search area and was narrowed down to include sands that most appropriately match the native beach sands on Edisto Beach. The borrow area contains approximately 7.2 million cubic yards of beach compatible sands. Native beach sands were determined based on beach samples collected at 34 stations along Edisto Beach and reflects conditions after the 2006 renourishment project (completed by Coastal Science and Engineering). Each station included four grab samples – one each from the toe of the dune, berm, beach face, and low tide swash zone. Results of this analysis determined that the beach sands have a mean phi size of 1.31, 0.1 % silt/clay mix, and 26.9% visual shell hash. These results compare favorably with the borrow area sands (Table 2).

Additionally, a cultural and hardbottom resources survey was completed at the borrow area in March 2013. The survey utilized three techniques: 1) Side scan sonar, 2) Sub-bottom profiling, and 3) Magnetometer. Results of this survey determined that there are no hardbottom resources within the proposed borrow area. The borrow area location has been shared with multiple resource agencies over the course of the study and no additional issues have been raised to date.

Table 2. Edisto Beach grain size comparison between borrow site and native beach sands

	MEAN (phi)	STD DEV (phi)	% PASSING #5	%PASSING #10	% PASSING #200	% PASSING #230	% VISUAL SHELL
Edisto Native Beach	1.31	1.33	97.8	93.5	0.1	0.0	26.9
Borrow - Scenario A	1.73	1.31	94.7	90.0	0.4	0.2	18.8

NOTE: The data comparison above is not a Federal requirement, but is provided to gain a perspective as to the quality of material in the borrow area which is proposed for placement as nourishment material on the beach.

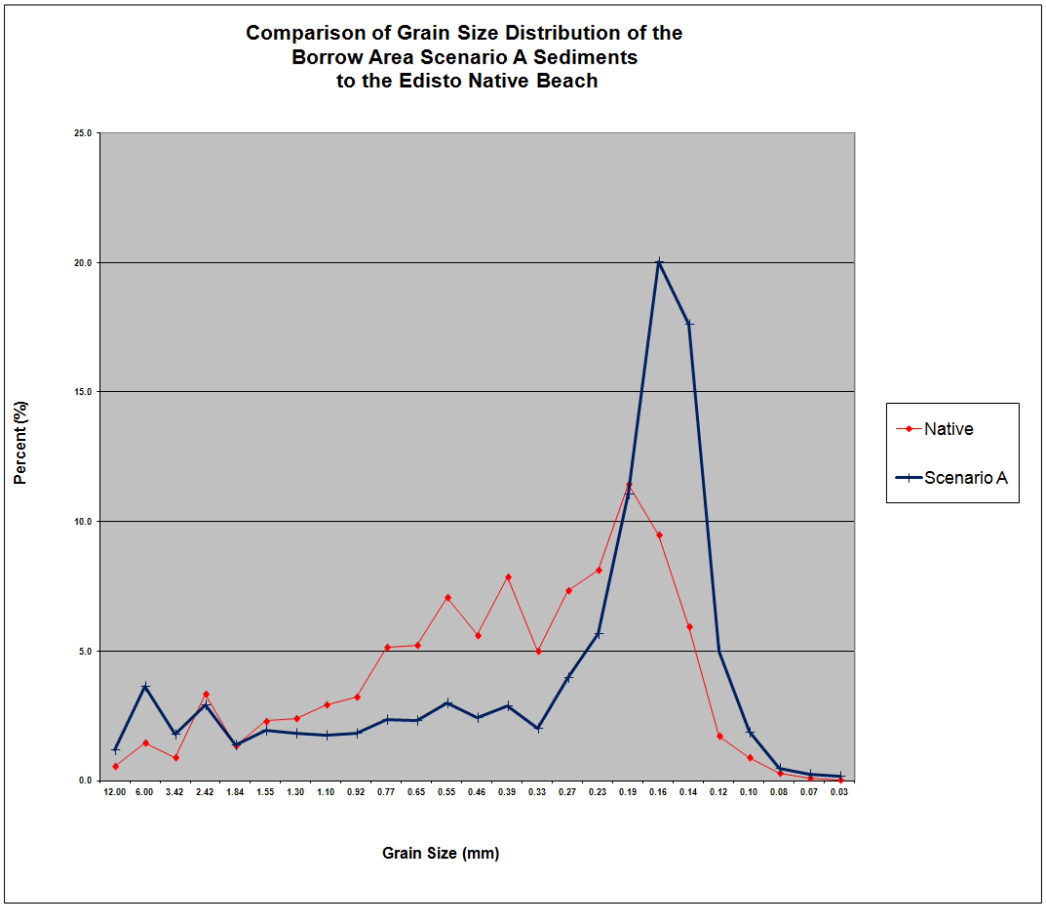

Figure 5. Histogram of native beach sands vs. proposed borrow site

Edisto Beach has very coarse sand and previous attempts at using fencing along a constructed berm to create an eolian transport driven dune have been unsuccessful. Therefore, the proposed project involves the creation of a 14 to 15 foot high dune at 15 feet width and a 3:1 slope. This dune feature may bury existing dune vegetation in some areas, especially along the inlet section of the beach. The proposed project consists of planting dune vegetation along the constructed dune including foreslope and backslope. The use of native vegetation will provide an environmental enhancement to the beach front while helping to stabilize the constructed dune. Plantings will be done in a matrix fashion and consist of native vegetation including but not limited to sea oats, Bitter panicum, and American beachgrass (Bogue variety). The total area of necessary dune planting is 29.68 acres.

b. <u>Authority and Purpose.</u> The Edisto Beach Coastal Storm Damage Reduction GI Feasibility Study is being conducted in response to a resolution adopted on April 22, 1988 by the Committee on Environment and Public Works of the United States Senate:

"*Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army in accordance with the provisions of Section 110 of the River and Harbor Act of 1962, is hereby authorized to study, in* *cooperation with the State of South Carolina, its political subdivisions and agencies and instrumentalities thereof, the entire Coast of South Carolina in the interests of beach erosion control, hurricane protection and related purposes. Included in this study will be the development of a comprehensive body of knowledge, information, and data on coastal area changes and processes for such entire coast.*"

c. <u>General Description and Quantities of the Dredged or Fill Material.</u>

The borrow area for the proposed project occurs on an ebb-tidal shoal located approximately 1.5 miles to 2.5 miles southeast of the southern point of Edisto Beach (Figure 1). The borrow area contains approximately 7.2 million cubic yards of beach compatible sands. Native beach sands were determined based on beach samples collected at 34 stations along Edisto Beach. Each station included four grab samples – one each from the toe of the dune, berm, beach face, and low tide swash zone. Results of this analysis determined that the beach sands have a mean phi size of 1.31, 0.1 % silt/clay mix, and 26.9% visual shell hash. These results compare favorably with the borrow area sands (Table 2).

d. <u>Description of the Proposed Discharge Site(s).</u> The beach compatible material will be placed on the ocean shoreline along Edisto Beach for a length of 21,820 feet, extending from Big Bay Creek at the southern inlet end and moving north to the first groin north of the pavilion, as shown in Figures 2 through 4.

e. <u>Description of Disposal Method.</u> The material will be excavated by either a hydraulic cutter head dredge or a hopper dredge, either of which will transport the sand through a pipeline, as described in Paragraph I.a. above.

II. <u>FACTUAL DETERMINATIONS</u>

a. <u>Physical Substrate Determinations.</u>

(1) Substrate Evaluation and Slope. The elevations of the developed portion of Edisto Beach range from 5 to 14 feet NGVD. The borrow area covers 1.49 nm2 and is located between 1.5 and 2.5 miles southeast of the southern point of Edisto Island on an ebb-tidal shoal complex.

(2) Sediment Type. See section I.c. above.

(3) Dredged/Fill Material Movement. The material will be pumped as a slurry and shaped using land based equipment and training dikes. Some material, particularly any fine-grained sediments will be lost in the surf, but the majority of the material will remain on the island.

(4) Physical Effects on Benthos. Benthic organisms in the vicinity of the construction, either dredging or placement, will be impacted by the construction. However, the construction is temporary, and it is expected that organisms will recolonize the disturbed areas following construction activities.

(5) Actions Taken to Minimize Impacts. The amount of material removed from the borrow sites will only be that quantity necessary to accomplish the project, thereby minimizing impacts to the greatest extent possible. Additionally, the project will maintain a one foot vertical buffer in the borrow area which will allow for similar substrate material to remain following the dredging. This practice will allow for a faster recolonization of similar macroinvertebrates to the existing condition. If possible, the project will use a hopper dredge to minimize the impact to the borrow area. Timing and funding constraints may limit this measure.

b. <u>Water Circulation, Fluctuation and Salinity Determinations.</u>

(1) Water.

(a) Salinity. This activity will occur in the open ocean and on an adjacent beach. Construction will have no impact on salinity.

(b) Water Chemistry. Temporary changes in water chemistry related to increased turbidity levels and potential decrease in DO at the construction site may occur. Impacts would be temporary and minimal in nature.

(c) Clarity and Color. The water may become temporarily cloudy at the construction site during construction activity due to increased turbidity levels associated with disturbance of sediments. As noted above, this is expected to return to normal levels shortly after construction ends because the nourishment sand is of similar physical characteristics to the native beach sands.

(d) Odor. Construction activities may result in a release of hydrogen sulfide (rotten egg) odor from the disturbance of sediments. This should be minimal, and will be a temporary impact which would not result in long-term effects.

(e) Taste. Not applicable.

(f) Dissolved Gas Levels. There may be minor impacts to dissolved oxygen levels as a result of increased turbidity levels and from sediment oxygen demand. These would be similar to any dredging project, and the impacts will be localized and temporary.

(g) Nutrients. No impacts to nutrient loading at the dredging site or on the beach are expected to occur.

(h) Eutrophication. Not applicable.

(2) Current Patterns and Circulation.

(a) Current Patterns and Flow. This project will not change present current patterns or flow in or around Edisto Bach. Regarding the groin construction, results of a coastal engineering analysis determined that this minimal amount of lengthening will not have any downdrift impacts as the design is simply to stabilize the proposed berm width. Because the distance between the landward toe of the dune and the seaward edge of the berm for the beach design exceeds the existing condition distance between these same points along certain reaches within the project, the effective length of the groins in these areas will be reduced. Consequently, the length of some groins will need to be increased in order to create beach width necessary to maintain the design cross-section. The proposed groin lengthening is not provided as a means for trapping more sand and increasing beach width or significantly changing the rate of sand bypassing the groins.

(b) Velocity. Not applicable.

(c) Stratification. Not applicable.

(d) Hydrologic Regime. This project will not change the present hydrologic regime.

(3) Normal Water Level Fluctuations. Water level will not change, but the increased beach elevations will provide protection to existing structures on the beach.

(4) Salinity Gradients. Salinity gradients will not change.

(5) Actions That Will Be Taken to Minimize Impacts. Groins are only proposed to be lengthened to a point to help hold the constructed berm profile in place. There are no additional actions needed since there are not measurable impacts to current patterns and circulation.

c. <u>Suspended Particulate/Turbidity Determinations.</u>

(1) Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site. Turbidity will increase during construction/disposal operations, but will return to normal levels when construction is complete.

(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column.

(a) Light Penetration. During construction, light penetration at the disposal site may diminish slightly due to a temporary increase in turbidity levels. Light penetration will return to normal levels following construction.

(b) Dissolved Oxygen. Dissolved oxygen (DO) levels may decrease during construction at the disposal site as a result of increased turbidity and in oxygen demanding substances. However, this decrease will be minimal due to the dynamic characteristics of the ocean and the ebb-tidal shoal complex that the borrow site is situated on, and DO levels should return to normal conditions immediately following construction.

(c) Toxic Metals and Organics. The borrow sites have been tested for grain size analysis and are predominantly sand and shell. No further testing is required since contaminants would not be associated with the sandy substrates.

(d) Pathogens. Not applicable.

(e) Aesthetics. During construction, there would be an increase in the ambient noise levels, which will return to normal levels following construction. In addition, construction activity on the beach obstructs the visual aesthetic of the ocean, but it is a temporary effect, which will also return to normal immediately following construction. Construction will occur on only one portion of beach at a time so the impacts will be short term and spread out over the project. Additionally, when possible, construction will occur during the winter months (between late fall and early spring) when recreational beach activity will be minimal.

(3) Effects on Biota.

(a) Primary Production & Photosynthesis. Although there will be some turbidity at the construction site, it is not expected that measurable impacts to primary production and photosynthesis will occur since the area of impact is small.

(b) Suspension/Filter Feeders. Temporary impacts would include increased turbidity, which may reduce oxygen levels and impact food intake to organisms at the construction site. However, water clarity and dissolved oxygen concentrations will improve following construction.

(c) Sight Feeders. A minimal, temporary disruption due to construction disturbances is possible. A rapid recovery is expected since most sight feeders are transient and can relocate until construction activities are complete.

(4) Actions taken to Minimize Impacts. As mentioned above in Section II.(a)(5), a vertical buffer will be included in the borrow area so that the material left after construction in the borrow area is similar to the existing surface material. This should allow for faster recovery by benthic macroinvertebrates.

d. <u>Contaminant Determinations.</u> The borrow sites have been tested for grain size analysis and are predominantly sand and shell. No further testing is required since contaminants would not be associated with the sandy substrates.

e. <u>Aquatic Ecosystem and Organism Determinations.</u>

(1) Effects on Plankton. Effects on plankton would be related to turbidity associated with the construction activity. Effects would be minor and temporary in duration.

(2) Effects on Benthos. Benthic activity at the construction site would be impacted as bottom sediments are disturbed or placed on the beach. These disturbances will be temporary and recolonization on the beach will occur following construction. Historically, SC beaches have seen rapid recovery (one to six months) of beach sediment characteristics. This will likely be true with the proposed project.

(3) Effects on Nekton. Not significant.

(4) Effects on Aquatic Food Web. Not significant.

(5) Effects on Special Aquatic Sites.

(a) Sanctuaries and Refuges. Not applicable.

(b) Wetlands. Not applicable.

(c) Mud Flats. Not applicable.

(d) Vegetated Shallows. Not applicable.

(e) Coral Reefs. Not applicable.

(f) Riffle and Pool Complexes. Not applicable.

(6) Threatened and Endangered Species. Although there are known threatened or endangered species within the project area, the potential impacts have been addressed in the Biological Assessment (BA) and integrated feasibility study/environmental assessment and coordinated with pertinent state and Federal agencies. Subsequently, unacceptable adverse impacts to threatened or endangered species are not anticipated or expected. Refer to BA for details.

(7) Other Wildlife. A wide variety of wildlife - birds, mammals, reptiles and amphibians - utilize the beach and ocean. Impacts to wildlife in the project area would be associated with the construction activities and the placement on top of existing dunes. Wildlife would be expected to leave the area during construction, but would return when construction is complete. Birds have been known to forage in the renourished areas due to the abundance of invertebrates at those sites. The planting of native beach vegetation along the constructed dune portion of the project would facilitate a relatively quick recovery of this valuable habitat.

(8) Actions to Minimize Impacts. Plans and specs for the project will specify requirements to ensure impacts to the environment are minimized or avoided. The landward construction line was moved seaward in the inlet reach to avoid impacts to rare and valuable maritime forest habitat.

f. <u>Proposed Disposal Site Determinations.</u>

(1) Mixing Zone Determination. Not applicable. The State of South Carolina Department of Health and Environmental Control (SCDHEC) does not recognize mixing zones.

(2) Determination of Compliance with Applicable Water Quality Standards. Section 401 Water Quality Certification for beach nourishment and groin projects has been currently granted without review due to the similarities between projects and the known level of minimal environmental impacts.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supply. Not applicable.

(b) Recreational and Commercial Fisheries. The presence of the dredge and the pipeline may cause commercial or recreational fisherman and commercial shrimpers to utilize different routes or fishing locations since the pipeline will extend perpendicular to the coast for a distance of up to 2.5 miles. However, this should result in minimal, temporary impacts to the fishery.

(c) Water Related Recreation. Water related recreational activities may be limited on the beach and in the waters adjacent to the beach due to the presence of the pipeline and equipment. These limitations will move along the beach as the construction activity advances.

(d) Aesthetics. The construction activity will have a negative impact on visual and audible aesthetics. However, the activity will move relatively rapidly down the beach, so no one area will endure the aesthetic impacts for long.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. Beach and water related recreational activities may be temporarily limited due to the presence of the pipeline and equipment. These limitations will pass through and move along the portion of the beach fronting the park area as the construction activity advances. Edisto Beach State Park is at the north end of the project. This area will benefit by the application of a taper from groin 1 into the park by a distance of 1000 feet. Since the longshore current is predominately north to south, the proposed project will not likely have much more of a positive impact on the State Park.

g. Determination of Secondary and Cumulative Effects on the Aquatic Ecosystem. Initial negative effects related to this project include those associated with turbidity, impacts to the benthic community, and aesthetics. These effects are considered temporary. Long-term, permanent effects will provide for the restoration of a dune system which will provide storm damage protection for structures on the island as well as nesting habitat for endangered sea turtles as well as shorebirds. The beneficial long term effects outweigh the negative temporary effects associated with the construction activity.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE.

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

b. Alternatives that were considered are included in the 2013 Integrated Feasibility Study/Environmental Assessment.

c. The proposed construction described in this evaluation would not cause or contribute to violations of any known applicable state water quality standards, which would result in permanent damage to the ecosystem.

d. The proposed project will not violate the Endangered Species Act of 1973.

e. The proposed project will not violate any specified protection measures for marine sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

f. The proposed project will not result in significant adverse affects on human health and welfare in regard to municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life states of aquatic life and other wildlife will not be adversely affected. Significant adverse affects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values will not occur.

g. Steps taken to minimize potential adverse impacts of the construction on aquatic ecosystems include limiting construction to the minimum alternative needed to provide the required protection. Also, the landward construction limit was shifted seaward to avoid impacts to maritime forest. Lastly, a one foot vertical buffer was provided in the borrow area which will allow for faster recolonization by benthic macroinvertebrates. Plans and specs will provide guidance and requirements to avoid/minimize impacts to threatened and endangered species and other aquatic and terrestrial life.

h. The State Historic Preservation Office has expressed concern about two potential prehistoric sites found in the proposed borrow site survey. These areas have been afforded a 1,500 foot buffer and will not be impacted by the proposed dredging. There are no other cultural/historic resource impacts. Therefore, the proposed project will not cause unacceptable adverse impacts to any known cultural resources.

i. On the basis of the guidelines, the proposed construction is specified as complying with the requirement of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

John T. Litz, PMP
Lieutenant Colonel, U.S. Army
Commander and District Engineer

____
DATE

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX I

CORRESPONDENCE

Contents:

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

August 15, 2008

Planning Branch
Environmental Section

Mr. Leo Henry, Chief
Tuscarora Nation
2006 Mount Hope Road
Lewiston, NY 14092

Dear Mr. Leo Henry,

The US Army Corps of Engineers is working with the Town of Edisto on a feasibility study to examine alternatives for the reduction of hurricane and storm damages. In addition, we are also evaluating the potential for environmental benefits associated with providing protection of the beach, maritime forest and unique marsh habitats that exist along the Edisto Beach State Park area.

All Corps feasibility studies go through six basic steps before completion. Those steps are listed below as well as a short description of what the Corps' Project Delivery Team (PDT) is currently working on regarding each step.

1. **Identify Problems & Opportunities**- Identified high erosion rates for all beachfront Edisto Island- southwest of Highway 174 to the end of the island (beachfront). Beach nourishment would assist in reducing storm damages to structures and would have recreational & long-term T&E (sea turtle & piping plover) and environmental benefits.
2. **Inventory and Forcast Conditions**- A potential borrow source has been identified; however further analysis will be conducted to identify any other potential sites. Structures are being inventoried to determine damage potential. In addition, models will be used to determine the impacts associated with storm events.
3. **Formulate alternative plans-** Some alternatives that have been identified include nearshore placement, groin construction/manipulation, offshore breakwater, and beach nourishment.
4. **Evaluate alternative plans-** Once a complete list of alternatives is compiled, an evaluation of each individual alternative will be completed. Evaluation will consist of measuring or estimating the economic, environmental, and social

effects of each plan, and determining the difference between the without- and with-project conditions. Feasible plans will be carried forward for comparison against one another.

5. **Compare alternative plans-** Alternative plans will be compared, focusing on the differences among the plans identified in the evaluation phase including public comment. Differences in environmental and economic benefits produced by the alternatives are assessed.
6. **Select a plan**- A recommended plan will be identified for permitting and construction.

Enclosed you will find maps of the project areas as well as the type of benefit we believe will be derived from beach nourishment. Also enclosed is a map of the initial vibracore areas which help identify the potential borrow site. Please note this is preliminary and the area will more than likely be expanded or another borrow location may be identified. We are in the initial phases of this study. Some alternatives plans that will be considered include:

- Structure Relocation
- Groin Lengthening
- New Groin Construction
- Sand-Fencing/ Grassing
- Offshore Breakwater

During and after Step 5, “Selecting a Plan”, we will be seeking the appropriate authorizations required to move forward with construction. However, we will be coordinating throughout the process in order to identify the plan that is economically justified and is environmentally sustainable.

Please provide any information you may have regarding alternatives for beach nourishment, potential economic or environmental benefits, information on existing site conditions, or any questions or concerns regarding this project. Please forward your responses to Elizabeth Jackson at 843-329-8099, by mail or e-mail her at elizabeth.g.jackson@usace.army.mil. It would be appreciated if you could provide your comments, concerns or information by September 19, 2008.

Thank you for your cooperation and participation in the Edisto Island Project.

Respectfully,

Joseph A. Jones
Chief, Planning Branch

encls.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

September 11, 2008

Mr. Joseph A. Jones
Chief, Planning Branch
U.S. Army Corps of Engineers
69A Hagood Avenue
Charleston, SC 29403-5107

Attn: Elizabeth Jackson

Re: Hurricane and Storm Damage Reduction Study, Town of Edisto, SC
FWS Log No. 42410-2008-FA-0341

Dear Mr. Jones:

The U.S. Fish and Wildlife Service (Service) is in receipt of the U.S. Army Corps of Engineers (COE) letter regarding the feasibility study for storm damage reduction near the Town of Edisto, SC. The COE is evaluating multiple alternatives including beach renourishment, structure relocation, groin construction or enhancement, dune stabilization and use of offshore breakwaters, to accomplish this task as well as potential benefits associated with the beach protection measures. You have solicited the Service to provide any concerns regarding this project, potential alternatives as well as information on site conditions and benefits that may result from the project. Upon consideration of the alternatives we find this potential project represents several potential benefits as well as potential adverse impacts.

Renourishment

Renourishment of eroded beaches has proven to be an effective yet short-term method to protect coastal development. The Service believes placement of sand along the beachfront may provide effective protection and cause minimal harm to indigenous flora and fauna if the activity is performed during periods of low biological activity. The Service recommends any future renourishment project for the Town of Edisto beach be performed during the November through April time frame to avoid sea turtle nesting season. Turtle nesting success may increase upon completion of the renourishment project provided the source sand material is of suitable volume, grain size and texture.

Sand sources for renourishment projects should be thoroughly analyzed prior to use. The Service does not believe dynamic inlets or active beach areas are an appropriate source for large scale projects. Offshore borrow areas, devoid of live bottom resources, will provide long-term source material with minimal impacts to benthic habitat.

It is understood that several potential borrow site locations for the Edisto project are under review by the COE. The offshore area immediately south of the project is a designated unit of the Coastal Barrier Resources System (Otter Island Unit M10). As such, the area is subject to the Coastal Barrier Improvement Act (P.L.101-591) and may be ineligible for use by this project.

Structure Relocation

The Service believes that the highest and best economic or environmental benefits would be attained though structure relocation. Moving beachfront homes landward and therefore further from the active beachfront zone significantly reduces the possibility of storm related damage to the structures and increases human safety. With the relocation of homes, artificial erosion control structures would not be necessary and the coastal area of Edisto Beach would eventually revert to a more natural beach/dune system. We believe this would ultimately result in an economic benefit through increased tourism.

Groin Construction or Enhancement

The Service would not object to maintaining or replacing existing groins with the existing configuration. However, enlargement of groins already in place or construction of new hardened structures has the potential to cause more of an impact to fish and wildlife resources. Shore perpendicular groin fields provide a limited protection benefit. Groin structures typically trap sand on the updrift side while contributing to an increased erosion rate on the immediate downdrift side. In addition to serving as an aesthetic distraction, groins represent a public safety hazard. The Service finds that the adverse impacts of groins far outweigh their benefits.

Dune Stabilization

Dune stabilization measures such as placement of dune vegetation or sand fencing would serve as an effective enhancement measure for renourishment activities. If properly installed, vegetation and fencing provides sand investment protection without impeding use of the beach/dune system by the endangered loggerhead seaturtle or the general public. Only dune vegetation native to Charleston County, SC should be planted.

Offshore Breakwaters

The Service is concerned that the use of offshore breakwaters will pose more risks than benefits to the beach/dune system. Placement of shore parallel structures may reduce onshore wave energy; however breakwaters may also prevent sea turtles from accessing the beachfront during the nesting season. In addition, breakwaters may create a navigational hazard for near shore vessels in addition to a public safety hazard for recreational swimmers.

Upon review of the Heritage Trust database, the Service finds few known occurrences of federally protected threatened and endangered (T&E) species within the study area. The two most notable T&E species known to occur along the Edisto Beach shoreline are the loggerhead seaturtle, *Caretta caretta*, and the piping plover, *Charadrius melodus*. However, other T&E species and species of concern may also occur in the project area. A list of species for Charleston and Colleton Counties is included for your consideration during this project's planning efforts.

The Service appreciates the opportunity to provide comments on this project in its early stages. As planning proceeds, you should discuss the need for a Fish and Wildlife Coordination Act Report with the Service. If you have any questions or require additional information, please contact Mark Caldwell of the Charleston Field office. He may be reached at (843) 727-4707 ext. 215.

Sincerely,

Ed EuDaly

Timothy N. Hall
Field Supervisor

TNH/MAC/km

South Carolina Distribution Records of Endangered, Threatened, Candidate and Species of Concern March 2008

E	Federally endangered
T	Federally threatened
P	Proposed in the Federal Register
CH	Critical Habitat
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	The U.S. Fish and Wildlife Service or the National Marine Fisheries Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
S/A	Federally protected due to similarity of appearance to a listed species
SC	Federal Species of concern. These species are rare or limited in distribution but are not currently legally protected under the Endangered Species Act.
*	Contact the National Marine Fisheries Service for more information on this species

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated continually and may be different from the following.

CHARLESTON COUNTY

Common Name	Scientific Name	Status	Occurrence
West Indian manatee	Trichechus manatus	E	Known
Bald eagle	Haliaeetus leucocephalus	BGEPA	Known
Bachman's warbler	Vermivora bachmanii	E	Known
Wood stork	Mycteria americana	E	Known
Red-cockaded woodpecker	Picoides borealis	E	Known
Piping plover	Charadrius melodus	T, CH	Known
Kemp's ridley sea turtle	Lepidochelys kempii*	E	Known
Leatherback sea turtle	Dermochelys coriacea*	E	Known
Loggerhead sea turtle	Caretta caretta	T	Known
Green sea turtle	Chelonia mydas*	T	Known
Flatwoods salamander	Ambystoma cingulatum	T	Known
Shortnose sturgeon	Acipenser brevirostrum*	E	Known
Sea-beach amaranth	Amaranthus pumilus	T	Known
Canby's dropwort	Oxypolis canbyi	E	Known
Pondberry	Lindera melissifolia	E	Possible
Chaff-seed	Schwalbea americana	E	Known
Southern Dusky Salamander	Desmognathus auriculatus	SC	Known
Gopher frog	Rana capito	SC	Known

Kirtland's Warbler	Dendroica kirtlandii	E	Known
Incised groovebur	Agrimonia incisa	SC	Known
Venus' fly-trap	Dionaea muscipula	SC	Known
Angiosperm (no common name)	Elytraria caroliniensis	SC	Known
Godfrey's privet	Forestiera godfreyi	SC	Known
Creeping St. John's wort	Hypericum adpressum	SC	Known
Pondspice	Litsea aestivalis	SC	Known
Boykin's lobelia	Lobelia boykinii	SC	Known
Sweet pinesap	Monotropsis odorata	SC	Known
Savannah or Piedmont cowbane	Oxypolis ternata	SC	Known
Pineland plantain	Plantago sparsiflora	SC	Known
False coco	Pteroglossaspis ecristata	SC	Known
Awned meadowbeauty	Rhexia aristosa	SC	Known
Bachman's sparrow	Aimophila aestivalis	SC	Known
Henslow's sparrow	Ammodramus henslowii	SC	Possible
Red knot	Calidris canutus	C	Known
Black-throated green warbler	Dendroica virens	SC	Known
Swallow-tailed kite	Elanoides forficatus forficatus	SC	Known
American kestrel	Falco sparverius	SC	Known
American oystercatcher	Haematopus palliatus	SC	Known
Loggerhead shrike	Lanius ludovicianus	SC	Possible
Black rail	Laterallus jamaicensis	SC	Known
Swainson's warbler	Limnothlypis swainsonii	SC	Known
Painted bunting	Passerina ciris ciris	SC	Known
Gull-billed tern	Sterna nilotica	SC	Known
Rafinesque's big-eared bat	Corynorhinus rafinesquii	SC	Known
Southeastern myotis	Myotis austroriparius	SC	Known
Bull's Island white-tail deer	Odocoileus virginianus taurinsulae	SC	Known
Southern hognose snake	Heterodon simus	SC	Known
Island glass lizard	Ophisaurus compressus	SC	Known

COLLETON COUNTY

Common Name	Scientific Name	Status	Occurrence
Bald eagle	Haliaeetus leucocephalus	BGEPA	Known
Wood stork	Mycteria americana	E	Known
Red-cockaded woodpecker	Picoides borealis	E	Known
Piping plover	Charadrius melodus	T, CH	Known
Kemp's ridley sea turtle	Lepidochelys kempii*	E	Known
Leatherback sea turtle	Dermochelys coriacea*	E	Known
Loggerhead sea turtle	Caretta caretta	T	Known
Green sea turtle	Chelonia mydas*	T	Known
Shortnose sturgeon	Acipenser brevirostrum*	E	Known
Pondberry	Lindera melissifolia	E	Possible
Canby's dropwort	Oxypolis canbyi	E	Known
Southern Dusky Salamander	Desmognathus auriculatus	SC	Possible
Angiosperm (no common name)	Elytraria caroliniensis	SC	Known
Godfrey's privet	Forestiera godfreyi	SC	Known
Pondspice	Litsea aestivalis	SC	Known
Boykin's lobelia	Lobelia boykinii	SC	Known
Carolina bird-in-a-nest	Macbridea caroliniana	SC	Known
Crested fringed orchid	Pteroglossaspis ecristata	SC	Known
Bachman's sparrow	Aimophila aestivalis	SC	Possible
Kirtland's Warbler	Dendroica kirtlandii	E	
Henslow's sparrow	Ammodramus henslowii	SC	Possible
Red knot	Calidris canutus	C	Possible
Black-throated green warbler	Dendroica virens	SC	Possible
Swallow-tailed kite	Elanoides forficatus forficatus	SC	Known
American kestrel	Falco sparverius	SC	Possible
American oystercatcher	Haematopus palliatus	SC	Known
Loggerhead shrike	Lanius ludovicianus	SC	Possible
Black rail	Laterallus jamaicensis	SC	Possible
Painted bunting	Passerina ciris ciris	SC	Possible
Gull-billed tern	Sterna nilotica	SC	Known
Bluebarred pygmy sunfish	Elassoma okatie	SC	Known
Southern hognose snake	Heterodon simus	SC	Possible
Island glass lizard	Ophisaurus compressus	SC	Known
Rafinesque's big-eared bat	Corynorhinus rafinesquii	SC	Known

South Carolina Department of
Natural Resources

John E. Frampton
Director
Robert H. Boyles, Jr.
Deputy Director for
Marine Resources

September 8, 2008

Ms. Elizabeth Jackson
U. S. Army Corps of Engineers
69-A Hagood Avenue
Charleston, SC 29403-5107

REF: Feasibility Study on Alternatives for the Reduction of Hurricane and Storm Damages on Edisto Island

Dear Ms. Jackson:

Personnel with the South Carolina Department of Natural Resources have reviewed the proposal to conduct a feasibility study on alternatives for the reduction of hurricane and storm damages on Edisto Island and offer the following comments.

We understand your agency is in the initial phases of preparing a feasibility study for storm damage reduction on Edisto Island. As a part of this study, several alternative plans will be considered, including structure relocation, groin lengthening, new groin construction, sand fencing, and offshore breakwater construction. In general, our department prefers and encourages the use of soft solutions for erosion control, such as beach nourishment and sand fencing. These activities if properly planned and implemented can provide environmental benefits with minimal impacts to the environment. Other alternatives being considered that involve the construction of hard structures are of more concern and could potentially result in significant environmental impacts. The following is a summary on our concerns and recommendations for the alternatives being considered.

<u>Structure Relocation</u> – This alternative should be given serious consideration in areas subject to severe erosional patterns and where structures are threatened. We encourage a retreat from the beach in these situations.

<u>Beach Nourishment</u> - Soft solutions such as this are preferred using appropriate materials and timed to avoid impacts to nesting sea turtles. Beach nourishment should occur from November through April, which is outside of the sea turtle nesting season. The use of a hopper dredge to obtain borrow materials should only be used from December through March when sea turtles are not present. Only those borrow sites that provide materials with similar grain size and color to the native beach should be considered. The mining of sands from active beach areas, both intertidal and subtidal, should be avoided and considered in emergency situations only.

<u>Groin Construction</u> - We discourage the use of hard erosion control devices on the beach, especially in areas utilized for nesting by sea turtles. New groin construction is especially troublesome. The potential exists for significant direct and indirect impacts to nesting females

and nesting success as a result of groin construction and the use of heavy machinery on the beach. Groin placement can indirectly impact nesting activities by degrading nesting habitat on the downdrift side. Groin construction could result in accelerated erosion of the beach in areas currently used as nesting habitat. We are generally not opposed to the maintenance of existing groin structures, provided the size and dimension of the groins are not substantially different from the originally permitted structure.

Sand Fencing/Grassing – If properly designed, located and maintained, sand fencing can provide benefits in dune stabilization. All fencing should be done in accordance with current OCRM regulations. The same applies to plantings. Only native dune vegetation should be used.

Offshore Breakwater – The use of offshore breakwaters for erosion control is not a well known practice in this state and we have a number of concerns regarding its use on the beachfront. The potential exists for interference with aquatic life movement, particularly sea turtles attempting to access the beachfront. Such structures are also likely to adversely affect recreational use of the beach as well as pose a navigational hazard. Again, we discourage the use of hard erosional control devices on or near the beachfront.

We appreciate the opportunity to provide comments early in the planning stages of this project. We ask that you take the above comments into consideration in the formulation of a plan to reduce storm damages on Edisto Island.

Sincerely,

Susan F. Davis

Susan F. Davis
Coastal Environmental Coordinator

Cc: SCDHEC/Beckham
OCRM/Rodgers
USEPA/Lord
USFWS/Hall
NMFS

D H E C
PROMOTE PROTECT PROSPER
C. Earl Hunter, Commissioner
Promoting and protecting the health of the public and the environment

OCT 20 2008

October 14, 2008

Ms. Elizabeth Jackson
Charleston District, Corps of Engineers
69A Hagood Ave.
Charleston, SC 29403

RE: Hurricane Damage Reduction Feasibility Study
Edisto Beach, SC

Dear Ms. Jackson:

Personnel with the SCDHEC Office of Ocean and Coastal Resource Management have reviewed the proposal to conduct a feasibility study on alternatives for the reduction of hurricane and storm damage on Edisto Island and have the following comments for the alternatives being considered. These comments are all based on South Carolina's overall policy for beachfront management, which is to encourage retreat in areas where structures have been built in close proximity to the beach.

Structure Relocation: This alternative is consistent with South Carolina's policy of retreat on beachfront property, wherein owners of structures that are located too close to the ocean are encouraged to relocate farther landward. We encourage pursuit of this alternative.

Beach Renourishment: It is South Carolina's policy to promote carefully planned renourishment as a means of beach preservation and restoration, where economically feasible. We encourage careful consideration of this alternative.

Groin Lengthening or new Groin Construction: It is generally understood that improperly designed or constructed groins can have an adverse impact on adjacent beaches. In this regard, groins may only be constructed after a thorough analysis demonstrates that the groin will not cause a detrimental effect on adjacent or downdrift areas. South Carolina only allows new groins to be constructed on beaches that have high erosion rates with erosion threatening existing development or public parks. In addition, new groins may be constructed and existing groins may be reconstructed only in furtherance of an on-going beach renourishment effort that includes initial beach renourishment concurrent with groin construction and periodic beach renourishment for the life of the groins. The responsible party must provide a financially binding commitment, such as a performance bond or letter of credit that is reasonably estimated to cover the cost of reconstructing or removing the groin and/or restoring the affected beach through renourishment if the groin causes an adverse impact on adjacent beaches.

Offshore Breakwaters: South Carolina has limited experience with offshore breakwaters in an open ocean environment. Since breakwaters can also interfere with the natural transport of sediment, they can only be constructed after a thorough analysis of the project demonstrates that there will be no negative effect on adjacent beaches.

Sand Fencing and Grassing: These passive dune stabilization measures are generally encouraged, provided they are not installed in a manner that will interfere with sea turtle nesting. However, it should be recognized that sand fencing and dune vegetation will not stop beach erosion, and should only be used on erosional beaches in conjunction with other beach restoration alternatives.

As you may be aware, SCDHEC-OCRM has sponsored a beach profile data collection program for the past 20 years that includes Edisto Beach. All beach profile data is available on the internet under the Online Profile Management option at http://gis.coastal.edu. We also have a fairly extensive collection of hardcopy shoreline assessment studies and post-renourishment monitoring reports for Edisto Beach that are available for your review at our office.

We would also appreciate receiving a time schedule for this study. Please contact me at 843-953-0237 if you have any questions.

Sincerely,

William C. Eiser
Project Manager

cc: Carolyn R. Boltin
Barbara Neale
Blair Williams

Jackson, Elizabeth G SAW@SAC

From:	DuBose Griffin [GriffinD@dnr.sc.gov]
Sent:	Wednesday, September 03, 2008 3:40 PM
To:	Jackson, Elizabeth G SAW@SAC
Cc:	Susan Davis; Melissa_Bimbi@fws.gov; Bob Perry
Subject:	Town of Edisto Nourishment Project
Attachments:	USACOE Edisto 8-15-2008.pdf; image001.jpg; image004.jpg

USACOE Edisto 8-15-2008.pdf (1... image001.jpg (5 KB) image004.jpg (5 KB)

Ms. Jackson,

Thank you for the attached letter concerning the implementation of a nourishment project/study on Edisto Beach (both the Town and state park). Please accept my comments on this project as requested by your letter. Best management practices as stated in the Beachfront Management Act and SCDHEC OCRM Critical Area Permit Regulations, and as recommended by the SCDNR are as follows:

1. Beach nourishment should occur from November through April, which is outside of the sea turtle nesting season.

2. A hopper dredge in South Carolina state waters should be used from December through March when sea turtles are not present.

Thank you and please let me know if you have any questions,

DuBose

Ms. DuBose Griffin, SC Sea Turtle Coordinator

South Carolina Marine Turtle Conservation Program

griffind@dnr.sc.gov <mailto:griffind@dnr.sc.gov>

http://www.dnr.sc.gov/seaturtle/ <http://www.dnr.sc.gov/seaturtle/>

Voice: (843) 953-9016

Cell: (843) 870-3667

Fax: (843) 953-9353

SC Department of Natural Resources

Wildlife and Freshwater Fisheries Division

Post Office Box 12559

217 Fort Johnson Road

Charleston, SC 29422 USA

Directions: www.dnr.sc.gov/boating/offices.html#charles
<http://www.dnr.sc.gov/boating/offices.html#charles>

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small Light Bumper sticker.jpg

Jackson, Elizabeth G SAW@SAC

From: Tritapoe, Fred - Walterboro, SC [Fred.Tritapoe@sc.usda.gov]
Sent: Wednesday, August 27, 2008 1:04 PM
To: Jackson, Elizabeth G SAW@SAC
Subject: Town of Edisto Feasibility Study

Elizabeth,

Long time but good day and how are you doing? Thank you for giving us a chance to comment. Vitex, the common invasive specie creeping it's way along the coast is truly my main concern in regard to beach nourishment. We need to rid our coast of this nightmare. Introduced as an ornamental, beach property owners thought vitex was beautiful and what they needed to stabilize the loose ground around their houses.NOT!! In completing this study, a professional who can identify any hotspots along Edisto's coast needs to assist in this study. Once identified, the rascal(Vitex) needs to be zapped.It will take over if left unchecked. Once all areas are clear, then coastal natives can be established.Got to go.Good day!--fred

Fredric K. Tritapoe--NRCS
District Conservationist
531 Robertson Blvd.-Suite B
Walterboro, S.C. 29488
(843)549-1821

Catawba Indian Nation
Tribal Historic Preservation Office
1536 Tom Steven Road
Rock Hill, South Carolina 29730
803.328.2427 Fax 803-328-5791

9 September 2008

Charleston District
Corps of Engineers
69 A Hagood Avenue
Charleston, South Carolina 29405

THPO #	P/N	Project Description
2008-1-235		Letter from Planning Branch / Town of Edisto Re. feasibility study to examine alternatives for reduction of hurricane and storm damages. Also evaluating potential for environmental benefits associated with providing protection of the beach, maritime forest and marsh habitats, Edisto Beach State Park area

Dear Mr. Jones,

The Catawba have no concerns at this time with regard to traditional cultural properties, sacred sites or Native American archaeological sites within the boundaries of the proposed project areas. **However, the Catawba are to be contacted when and if a borrow pit or other actual ground disturbance occurs, regardless of which plan is chosen.**

If you have questions, please contact Sandra Reinhardt at 803-328-2427 ext. 233, or email sandrar@ccppcrafts.com.

Sincerely,

Sandra Reinhardt for

Wenonah G. Haire
Tribal Historic Preservation Officer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

January 27, 2010

Mr. Mark J. Messersmith
Biologist
U.S. Army Corps of Engineers - SAW@SAC
69A Hagood Avenue
Charleston, SC 29403-5107

Re: Edisto Beach Shore Protection Feasibility Study Area

Dear Mr. Messersmith:

This letter is in response to your January 6, 2010, email to Craig Aubrey of the U.S. Fish and Wildlife Service (Service) in which you asked the Service to ascertain if the proposed borrow site for the above-referenced project is located within the John H. Chafee Coastal Barrier Resources System (CBRS). After reviewing your email and the official maps for the CBRS, we have determined that the proposed borrow site is not located in the CBRS. Should you have any questions, please call Mr. Aubrey of my staff at (843) 727-4707 ext. 301.

Sincerely,

Diane L. Lynch
Acting Field Supervisor

DLL/CWA

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

June 4, 2010

Planning and Environmental Branch

Ms. Caroline Wilson
Review and Compliance Coordinator
SC Department of Archives and History
8301 Parklane Rd.
Columbia, SC 29223

Dear Ms. Wilson,

The US Army Corps of Engineers is working with the Town of Edisto on a feasibility study to examine alternatives for the reduction of hurricane and storm damages. In addition, we are also evaluating the potential for environmental benefits associated with providing protection of the beach, maritime forest and unique marsh habitats that exist along the Edisto Beach State Park area.

We would like to initiate consultation for Section 7 of the National Historic Preservation Act. We are in the planning phase for this project and just want to ensure that we include your office early on. Enclosed are the initial documents required by your office except for the existing and proposed site drawings. This will be supplied as we finalize the scope of the project. Please let us know if your office has any materials and/or data that would be applicable to this project. If you have any questions please contact Mark Messersmith at 843-329-8162, by phone or email him at mark.j.messersmith@usace.army.mil.

Respectfully,

Patrick E. O'Donnell
Chief, Planning and Environmental Branch

Encls.
- USGS topographic map
- Map of Area of Potential Effects
- ArchSite search
- Photographs

The South Carolina Archives & History Center

History & Heritage For All Generations

July 1, 2010

Mark J. Messersmith
Department of the Army
Charleston District, Corps of Engineers
69A Hagood Avenue
Charleston, SC 29403-5107

Re: Edisto Beach Renourishment, Edisto Beach, Colleton County, SC
SHPO #: 10CW0381

Dear Mr Messersmith:

Thank you for the letter of June 4, which we received on June 7, regarding the above referenced project. We also received photos as supporting documentation for this undertaking. The State Historic Preservation Office is providing comments to the Army Corps of Engineers pursuant to Section 106 of the National Historic Preservation Act and its implementing regulations, 36 CFR 800.

After consultation with the South Carolina Institute of Archaeology and Anthropology, we believe that there is potential for underwater archaeology at the proposed borrow site. We will require an underwater archaeological survey of the borrow site before we can concur with an assessment of effect.

If you have any questions, please contact me at (803) 896-6169 or cwilson@scdah.state.sc.us.

Sincerely,

CMWilson

Caroline Dover Wilson
Review and Compliance Coordinator
State Historic Preservation Office

UNIVERSITY OF SOUTH CAROLINA

SOUTH CAROLINA INSTITUTE OF ARCHAEOLOGY AND ANTHROPOLOGY

12 April 2013

Alisha N. Means
Biologist
Planning & Environmental Branch
US Army Corps of Engineers-Charleston District
69A Hagood Avenue
Charleston SC 29403-5107

Re: Review of Edisto Beach Renourishment Project report.

Dear Ms. Means,

Our office has reviewed the draft report of the *Hardbottom and Cultural Resource Surveys, Edisto Beach Offshore Borrow Site, Edisto Beach, South Carolina*, prepared by Dial Cordy and Associates, Inc. for the Edisto Beach hurricane and storm damage protection project. Our review is focused on the submerged cultural resources aspects of the project. The report is a solid discussion of the scope, methods, research, and findings, especially in its awareness of inundated paleolandscapes bearing the potential of prehistoric cultural materials along the South Carolina coast.

We concur with the contractor's recommendations to place a 1,500 ft. buffer zone around the two arbitrary center points: Site 1—E2213373, N232446; and Site 2--E2218203, N227338 (NAD83 South Carolina State Plane East U.S. Survey Feet) as potential paleolandscape features. We also agree that no additional inspections of the magnetic, acoustic, or sub-bottom reflectors is warranted in the designated borrow site. We do, however, request that any inadvertent discovery of potential archaeological materials, i.e., wood structure, prehistoric lithics, ceramics, etc. during dredging operations cease from that area until inspections may reveal the source of this material. Please contact my office or the SHPO for further guidance in this instance. Our office has no objections from a submerged cultural resources viewpoint for dredging operations to occur in this borrow site. If plans change, please consult with our office for additional guidance.

We do though offer several editorial comments to improve the graphics for the final report:

1. Fig. 34, p. 47—please choose a color scheme to more fully reveal the trackline points, as well as to bring out the contours.
2. The above recommendation would also go for the Appendix B contour maps.
3. Please ensure the PDF images are of good quality in 100% zoom.

1321 Pendleton Street • Columbia, SC 29208-0071 • (803) 576-6566 • FAX (803) 254-1338

Thank you for this opportunity to review the report and your support of preserving the submerged archeological legacy in South Carolina waters. If you have any questions, comments, etc. about this matter please contact me.

Sincerely,

James D. Spirek
State Underwater Archaeologist
Maritime Research Division

Cc: Rebekah Dobrasko, SC SHPO

US Army Corps of Engineers®

Edisto Beach, South Carolina
Hurricane and Storm Damage Reduction
Feasibility Study - QUESTIONNAIRE

This questionnaire will be used to gain insight on the perceptions and knowledge of hurricane and storm damage reduction techniques on Edisto Beach. Additionally, the questionnaire will determine current conditions and concerns on the Beach. Please complete the questionnaire and return to one of the US Army Corps of Engineers' presenters at the end of the meeting.

Name: *[optional]* BILL ANDREWS

Question 1: Do you live in the Town of Edisto Beach? ☒ Yes ☐ No

Question 2: Are you attending this meeting as a:

☐ Government official ☐ Non-Governmental or a Not-for-Profit Official ☐ Media

☐ Developer or Realtor ☐ Recreational Visitor ☒ Resident ☐ Other

Question 3: Which area(s) of the beach do you visit?

a. South Edisto River shoreline b. Atlantic Edisto shoreline c. State Park d. All

Question 4: How many days a year do you visit the beach in Edisto Beach or Edisto Beach State Park? 300+

Question 5: Please circle the activities you participate in while at the beach.

- Surfing
- Sunbathing
- Boating / Kayaking
- Clamming / Fishing
- Scuba Diving / Snorkeling
- Camping
- Swimming
- Read / Relax/ Study
- Socialize / Meet People
- I don't go to the beach
- Other *[please specify]* ______

Question 6: Have you endured structural damages to your home/property due to storm surge events? ☐ Yes ☒ No

Question 12: What do you value most about the beach front of Edisto Beach?

THE BEAUTY AND NON-COMMERCIALISM

Question 13: Identify any dislikes about the beach front of Edisto Beach and discuss how it can be improved.

Please share additional comments with us about Edisto Beach.

Thank you. Your concerns and needs are very important to us. Please return the questionnaire to one of the U.S. Army Corps of Engineers' presenters.

US Army Corps
of Engineers®

Edisto Beach, South Carolina
Hurricane and Storm Damage Reduction
Feasibility Study - QUESTIONNAIRE

This questionnaire will be used to gain insight on the perceptions and knowledge of hurricane and storm damage reduction techniques on Edisto Beach. Additionally, the questionnaire will determine current conditions and concerns on the Beach. Please complete the questionnaire and return to one of the US Army Corps of Engineers' presenters at the end of the meeting.

Name: *[optional]* Iddy Andrews

Question 1: Do you live in the Town of Edisto Beach? ☑ Yes ☐ No

Question 2: Are you attending this meeting as a:

☐ Government official ☐ Non-Governmental or a Not-for-Profit Official ☐ Media

☐ Developer or Realtor ☐ Recreational Visitor ☑ Resident ☐ Other

Question 3: Which area(s) of the beach do you visit?

a. South Edisto River shoreline b. Atlantic Edisto shoreline c. State Park d. All

Question 4: How many days a year do you visit the beach in Edisto Beach or Edisto Beach State Park? 365 weather permitting ☺

Question 5: Please circle the activities you participate in while at the beach.

- Surfing
- Sunbathing
- Boating / Kayaking
- Clamming / Fishing
- Scuba Diving / Snorkeling
- Camping
- Swimming
- Read / Relax/ Study
- Socialize / Meet People
- I don't go to the beach
- Other *[please specify]* ____________

Question 6: Have you endured structural damages to your home/property due to storm surge events? ☐ Yes ☑ No

Question 12: What do you value most about the beach front of Edisto Beach?
The natural beauty + lack of development

Question 13: Identify any dislikes about the beach front of Edisto Beach and discuss how it can be improved. People who litter or destroy vegetation

Please share additional comments with us about Edisto Beach.
We Love Edisto!

Thank you. Your concerns and needs are very important to us. Please return the questionnaire to one of the U.S. Army Corps of Engineers' presenters.

US Army Corps of Engineers®

Edisto Beach, South Carolina
Hurricane and Storm Damage Reduction
Feasibility Study - QUESTIONNAIRE

This questionnaire will be used to gain insight on the perceptions and knowledge of hurricane and storm damage reduction techniques on Edisto Beach. Additionally, the questionnaire will determine current conditions and concerns on the Beach. Please complete the questionnaire and return to one of the US Army Corps of Engineers' presenters at the end of the meeting.

Name: *[optional]* ______________________________

Question 1: Do you live in the Town of Edisto Beach? ☒ Yes ☐ No

Question 2: Are you attending this meeting as a:

☐ Government official ☐ Non-Governmental or a Not-for-Profit Official ☐ Media

☒ Developer or Realtor ☐ Recreational Visitor ☒ Resident ☐ Other

Question 3: Which area(s) of the beach do you visit?

a. South Edisto River shoreline b. Atlantic Edisto shoreline c. State Park d. All

Question 4: How many days a year do you visit the beach in Edisto Beach or Edisto Beach State Park? at least 3 times A week

Question 5: Please circle the activities you participate in while at the beach.

- Surfing
- Sunbathing
- Boating / Kayaking
- Clamming / Fishing
- Scuba Diving / Snorkeling
- Camping
- Swimming
- Read / Relax / Study
- Socialize / Meet People
- I don't go to the beach
- Other *[please specify]* ______________________________

Question 6: Have you endured structural damages to your home/property due to storm surge events? ☐ Yes ☒ No

Question 12: What do you value most about the beach front of Edisto Beach?

SAND

Question 13: Identify any dislikes about the beach front of Edisto Beach and discuss how it can be improved.

Please share additional comments with us about Edisto Beach.

Thank you. Your concerns and needs are very important to us. Please return the questionnaire to one of the U.S. Army Corps of Engineers' presenters.

US Army Corps
of Engineers®

Edisto Beach, South Carolina
Hurricane and Storm Damage Reduction
Feasibility Study - QUESTIONNAIRE

This questionnaire will be used to gain insight on the perceptions and knowledge of hurricane and storm damage reduction techniques on Edisto Beach. Additionally, the questionnaire will determine current conditions and concerns on the Beach. Please complete the questionnaire and return to one of the US Army Corps of Engineers' presenters at the end of the meeting.

Name: *[optional]* ______________________________

Question 1: Do you live in the Town of Edisto Beach? ☑ Yes ☐ No

Question 2: Are you attending this meeting as a:

☑ Government official ☐ Non-Governmental or a Not-for-Profit Official ☐ Media

☐ Developer or Realtor ☐ Recreational Visitor ☐ Resident ☐ Other

Question 3: Which area(s) of the beach do you visit?

a. South Edisto River shoreline b. Atlantic Edisto shoreline c. State Park d. All

Question 4: How many days a year do you visit the beach in Edisto Beach or Edisto Beach State Park? Live Here Permanently

Question 5: Please circle the activities you participate in while at the beach.

- Surfing
- Sunbathing
- Boating / Kayaking
- Clamming / Fishing
- Scuba Diving / Snorkeling
- Camping
- Swimming
- Read / Relax/ Study
- Socialize / Meet People
- I don't go to the beach
- Other *[please specify]* ______________________________

Question 6: Have you endured structural damages to your home/property due to storm surge events? ☐ Yes ☑ No

Question 12: What do you value most about the beach front of Edisto Beach?

Question 13: Identify any dislikes about the beach front of Edisto Beach and discuss how it can be improved.

Please share additional comments with us about Edisto Beach.

Thank you. Your concerns and needs are very important to us. Please return the questionnaire to one of the U.S. Army Corps of Engineers' presenters.

Edisto Beach, South Carolina
Town Public Meeting
October 29, 2009
7:00 PM

US Army Corps of Engineers®

Name	Address	Email Address	Contact Number
Mayor Burley Lyons	Edisto Beach	Edistomaster@bls.net	843-869-2505
Bill + Addy Andrews	21 Rice Lane	biandrews@comcast.net	843631-1066
Tommy + Dale Mann	2005 Myrtle St. Edisto Beach	tmann@truvista.net	803-261-5911
Pete Anderson	"	Pete@Edistotele.com	7294774
K. Patrick Brown	2414 Murray St.	edistobrown@bellsouth.net	869-2505
Iris Hill	2414 Murray St	edistohill@bellsouth.net	869 2505
Archie Johnston	P.O. Box 460	archiejohnston@hotmail.com	869-3789
Jeanine Rhodes	3619 Yacht Club Edisto	jgrhodes@lowcountry.com	843-893-7702
E. Larry Hutto	2402 Palmetto Blvd.	[illegible]2b2b59@earthlink.net	843-869-4013
Wanda McCarley	3927 Catherine St.	edisislo@bellsouth.net	843 869-1308

Edisto Beach, South Carolina
Town Public Meeting
October 29, 2009
7:00 PM

US Army Corps of Engineers®

Name	Address	Email Address	Contact Number
Susan Spell	8377 State Park Rd Edisto Isl. SC 29532	sspell@ sprt.com	843-869-4425

U. S. ARMY ENGINEER DISTRICT, CHARLESTON
CORPS OF ENGINEERS
CHARLESTON, SOUTH CAROLINA

Page 1

Subject: Edisto Beach

Computation ____ No. ____

Computed by ____ Checked by ____ Date 1/20/10

NAME	AGENCY/ASSOC.	Telephone
Brian Williams	U.S. Army Corps of Engineers	843-329-8153
Mark Caldwell	US FWS	843 727 4707 x215
Susan Davis	SCDNR	843 953-9003
Tommy Mann	Edisto Beach Council	843/869-5251
Bill Eiser	DHEC-OCRM	843 953 0237
Matt Slagel	DHEC-OCRM	843 953-2033
Fred Mallon	DHEC.OCRM	843-953.0236
Steven Traynum	CSE	803-799-8949
WILLIAM SALTERS	DHEC-OCRM	843-953-0258
DAVID SIMMS	SCPRT - SPS	803-734-0258
Pace Wilber	NOAA Fisheries	843.953.7200
Derk Bergquist	SCDNR	843 953-9074
Bob Martore	SCDNR	843 953-9303
Barbara Neale	SCDHEC-OCRM	843-953-0245
Iris Hill	Town of Edisto Beach	843 869 2505 x211
Patrick Brown	Town of Edisto Beach	843-869-2505
Susan Hornsby	Town of Edisto Beach	843-869-3155
LARRY HUTTO	Town of Edisto Beach	843-869-4013
Pat O'Donnell	USACE	843-329-8050
Mark Messersmith		
Keely Domville		

SAC FORM 255 1 MAR 85

	Renourishment			New Groins			
	Pros	**Cons**	**Caveats**	**Pros**	**Cons**	**Caveats**	
Discussion during meeting 0n January 20, 2010	Town - beach in good shape from GROIN 15 and south - GROIN 15 and north is more of a problem - CSE - Groin 1-6 is a hotspot) - DNR - borrow site positioning on a shoal on south end is ideal vs. north end - would be a positive benefit for EBSP	Town - migrating sand around the inlet to the mouth of big bay creek -	DNR and USFWS - make sure it's done at appropriate times for turtles - suitable materials from borrow site - if construct dunes, plant vegetation - impacts to nesting shorebirds more on north end Dec - March. For turtles - work with DNR to figure something out - trade-offs with hopper vs. pipeline cutterhead dredge - NMFS - guidelines for how much to borrow and the natural filling rate of the borrow site. - Will possible causeway project affect creek flows and alter sedimentation? Derk - talk to Bud Bader and David Whitaker at SCDNR Hydrology. Susan Hornsby- rock piles in borrow area are highly used by fisherman. Can South Edisto River accretion be used as sand source for renourishing Atlantic reaches?		DNR/USFWS/NMFS are opposed. already have 34 existing groins - might be enough - EBSP would not prefer them		**Discussion during meeting 0n January 20, 2010**
USFWS - letter dated 09/11/2008	Effective protection - minimal harm to flora/fauna - beneficial to turtle nesting success	Short term - dredging window	Nov-Apr dredging window, compatible sediments, inlets not appropriate for large borrow areas, CBRA unit	None	Potential to cause more impacts to fish and wildlife resources - limited protection benefit - increase erosion downdrift - not aesthetically pleasing - safety hazard		**USFWS - letter dated 09/11/2008**
SCDNR - letter dated 09/08/2008	Preferred method of shore protection		Use appropriate materials, dredging windows Nov-Apr, only use Hopper from Dec-Mar, avoid mining of sands from active beach areas	Discouraged - not opposed to maintenance of existing groins	Significant direct impacts to nesting sea turtle females and nesting success - heavy machinery is detrimental - degrades nesting habitat		**SCDNR - letter dated 09/08/2008**
SCDNR - Dubose Griffin - email dated 09/03/2008			Should occur from Nov-Apr (outside of turtle nesting season, Hopper dredge only used from Dec-Mar when sea turtles not present				**SCDNR - Dubose Griffin - email dated 09/03/2008**
SCDHEC - OCRM - letter dated 10/14/2008	A means of beach preservation and restoration		SC policy to promote carefully planned nourishment projects		If improperly designed - they are harmful to adjacent beaches	Only constructed after thorough analysis demonstrates that the groin will not impact downdrift - only allowed on beach with high erosion rates threatening development or parks - can only be constructed in furtherance of on-going beach renourishment - must have binding commitment to remove if causes adverse impacts	**SCDHEC - OCRM - letter dated 10/14/2008**
NRCS - email dated 08/27/2008			Beach vitex - make sure a professional eradicates any of this nuisance species				**NRCS - email dated 08/27/2008**
Catawba- letter dated 09/09/2008	No concerns	No concerns	No concerns	No concerns		No concerns	**Catawba- letter dated 09/09/2008**

Modified Groins			Structure Relocation/Elevation			Dune Stabilization (sand fencing and grassing)		
Pros	**Cons**	**Caveats**	**Pros**	**Cons**	**Caveats**	**Pros**	**Cons**	**Caveats**
CSE -not looking at increasing height. lengthening would provide some toe protection and stabilize the underwater portion [assume to mean of the beach], create a platform for beach to build on and to create and maintain dunes - OCRM - groins are protecting the houses - without them the first row of houses would not likely be present	CSE - removing/notching would not be recommended	NMFS - removal or notching them would be recommended (NMFS - wants to see the notching of groins modeled - at least pick one option) - CSE - depends on wave climate to determine the position of the fillets - USFWS - need to determine if existing groin is exacerbating the problem and model whether lengthening will cause downdrift impacts	USFWS - eco tourism? (state park has record of day use)	Town - it would negatively impact tourism and impact town revenue - CSE - it would revert to an eroding beach, dunes would erode away - all - expensive	traffic counts for recreational use - would also have to remove infrastructure - all houses on septic -	Town - sand fencing has worked in portions of Atlantic Reach S and N -		CSE - Need wide dry portion of beach to be effective
None	Potential to cause more impacts to fish and wildlife resources - limited protection benefit - increase erosion downdrift - not aesthetically pleasing - safety hazard		Highest and best economic and environmental benefits - artificial erosion control structures would not be necessary - coastal area of Edisto would revert to more natural beach/dune system - increased	None		Dunes and vegetation are an effetive enhancement measure - sand investment protection - allows use of beach/dune system to turtles and		Only use native vegetation
Discouraged	Significant direct impacts to nesting sea turtle females and nesting success - heavy machinery is detrimental - degrades nesting habitat					Use sand fencing and grassing to accomplish this		Performed in accordance with OCRM regulations - only use native vegetation
	Only constructed after thorough analysis demonstrates that the groin will not impact downdrift - only allowed on beach with high erosion rates threatening development or parks - can only be constructed in furtherance of on-going beach renourishment - must have binding commitment to remove if causes adverse impacts					Encouraged	Will not stop beach erosion	Installed in a manner that will not interfere with sea turtle nesting - should only be used in conjunction with other beach restoration measures
No concerns		No concerns	No concerns		No concerns	No concerns	No concerns	No concerns

	Offshore Breakwaters			Artificial Reefs			Seawall		
	Pros	Cons	Caveats	Pros	Cons	Caveats	Pros	Cons	Caveats
Discussion during meeting 0n January 20, 2010		generally regarded as a negative impact to the project		NMFS has supported piles of sand used for reef construction (talk to SAM and SAS - doug clark at ERDC) - DNR - at folly pier the reefs caused accretion near the pier (anecdotal) - sand will fill in the holes in the reef balls - economic plus - edisto push for eco tourism. DNR (Martore) - The holes in reef balls are not big enough for a turtle to	USFWS - impediments to sea turtles accessing the beach for nesting - navigational problems - DNR - could change the beach profile and cause it to become flatter and extend outward more.	Town - shrimpers have 1/2 mile limit from pavilion north to inlet - extends out to 1 mile at the pavilion south. -	could provide protection to second row houses	OCRM - illegal - unlawful on ocean side of 40 year setback line - Town - town ordinance that says no seawalls	town provision for allowing revetments - OCRM - state does not distinguish (includes bulkheads, revetments, and seawalls)
USFWS - letter dated 09/11/2008	May reduce wave energy	More risk than benefit to beach/dune system - may prevent turtles from accessing beachfront - navigational hazard - and recreational hazard					None	Discouraged	
SCDNR - letter dated 09/08/2008		Not well known in this state - interferes with aquatic life movement - recreational impacts - navigational hazard					None	Discouraged	
SCDNR - Dubose Griffin - email dated 09/03/2008									
SCDHEC - OCRM - letter dated 10/14/2008		SC has limited experience - interferes with natural transport of sediment							
NRCS - email dated 08/27/2008									
Catawba- letter dated 09/09/2008	No concerns		No concerns	No concerns		No concerns	No concerns		No concerns

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
69A HAGOOD AVENUE
CHARLESTON, SOUTH CAROLINA 29403-5107

REPLY TO
ATTENTION OF

January 20, 2012

Planning and Environmental Branch

Mr. Jay Herrington
U.S. Fish and Wildlife Service
South Carolina Ecological Services
176 Croghan Spur Road - Suite 200
Charleston, SC 29407

Dear Mr. Herrington,

The US Army Corps of Engineers is working with the Town of Edisto on a feasibility study to examine alternatives for the reduction of hurricane and storm damages. Over the last several years we have coordinated with your staff and other agencies to receive input on a variety of possible measures to protect structures and restore habitat along the beach face. As a result of this coordination and the process so far, we are moving forward with evaluating the following measures: beach nourishment, dune vegetation, groin lengthening, submerged artificial reefs, demolition, floodproofing structures, and elevating structures. The end result of our study will be an integrated Feasibility Report / Environmental Assessment that among other items, documents the affected environment and the impacts of the various alternative plans, and will include an assessment of impacts to fish and wildlife resources.

As you know USACE and USFWS have a Memorandum of Agreement for conducting Fish and Wildlife Coordination Act activities. The purpose of this letter is to document our remaining compliance under section 2(a) of the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C §§ 661 et seq.). After discussions with Mark Caldwell, of your staff, we propose that continued coordination and input from your office throughout the remainder of the project, as well as USFWS submission of Planning Aid Letters (PALs) when needed, will suffice it to substitute for a separate and exhaustive Coordination Act Report (CAR). The following specific coordination will take place:

a. The USACE intends to hold another agency meeting this coming spring/summer to present various alternatives to the interagency team and to receive more detailed comments on the potential impacts/benefits.
b. The USACE intends to route the draft Feasibility Study/Environmental Assessment/ Finding of No Significant Impact through a state and federal agency review when ready.
c. The USACE will hold a public meeting prior to release of a final document.

It is anticipated that future PALs would be appropriate to be received after (a) and (b), above. The USACE intends to use any PALs received from your office as input to better the project. Please let us know if you concur with the outlined coordination to comply with the FWCA. If you have any questions, please contact Mark Messersmith at (843) 329 – 8162 or by email at Mark.J.Messersmith@usace.army.mil.

Respectfully,

Patrick O'Donnell
Chief, Planning and Environmental Branch

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

January 25, 2012

Mt. Patrick O'Donnell
Chief, Planning and Environmental Branch
U.S. Army Corps of Engineers
69A Hagood Avenue
Charleston, SC 29403-5107

Attn: Mark Messersmith

Re: Town of Edisto Feasibility Study, Colleton County, SC
FWS Log No. 2012-CPA-0060

Dear Mr. O'Donnell:

The U.S. Fish and Wildlife Service (Service) submits this letter in response to the U.S. Army Corps of Engineers (USACE) request regarding future coordination for the Town of Edisto storm damage reduction feasibility study. You have requested that future coordination under the Fish and Wildlife Coordination Act (FWCA) be fulfilled through ongoing coordination and submission of Planning Aid Letters as the project progresses. In consideration of the project's characteristics and scope, the USACE believes this will suffice and substitute for a Coordination Act Report and satisfy section 2(a) of the FWCA. The Service concurs that our continued coordination and submission of necessary documentation or assessments will ensure that potential resource concerns will be adequately addressed.

Please note our concurrence does not negate the Service's or the USACE responsibilities or requirements mandated by other resource laws such as the Endangered Species Act, National Environmental Policy Act, or the Coastal Zone Management Act. We look forward to continued coordination with the USACE toward the development of this project. If you have any questions or need clarification of Service comments, please contact Mr. Mark Caldwell at (843) 727-4707 ext. 215 and reference FWS Log No. 2012-CPA-0060.

Sincerely,

Jay B. Herrington
Field Supervisor

JBH/MAC

From:	Allan Strand
To:	Messersmith, Mark J SAW@SAC
Subject:	RE: Sea beach amaranth
Date:	Thursday, October 29, 2009 4:59:37 PM

Hi Mark,

If you talk to most botanists in the state (at least the loudly vocal ones), they will say that seabeach amaranth has never been found southwest of Charleston Harbor. Of course that's wrong, there are herbarium records from Kiawah in the University of Georgia Herbarium. I have not seen, however, any records of plants found naturally below Kiawah.

We did introduce some plants to Seabrook in 03, I think. They did not do well, and I suspect did not export any meaningful number of seeds.

cheers,
a.

On Thu, 2009-10-29 at 13:32 -0400, Messersmith, Mark J SAW@SAC wrote:
> We are looking into a shore protection project on Edisto Beach. I am looking
> for information documenting the extent of Seabeach Amaranth's range. It's not
> listed on the USFWS T&E list for Colleton Co, so I assume it must not quite
> reach down that far south. I remember you gave a talk once on the seed
> dispersal of this plant, and I was curious if you had data or any lit on its'
> range. Also what do you think of the plants' ability to be introduced on
> Edisto Island? If it's not found there naturally, are there any adverse
> impacts that could be anticipated from introducing it? Also, if it's not
> found there, what are the contributing factors to it not germinating on that
> beach (i.e., currents, temperature, grain size, etc.)?
>
> Thanks for your time. - Mark
>
>
>
>
> Mark J. Messersmith
> Biologist
> US Army Corps of Engineers - SAW@SAC
> (843) 329-8162
> mark.j.messersmith@usace.army.mil
>
>
> -----Original Message-----
> From: Allan Strand [mailto:stranda@cofc.edu]
> Sent: Thursday, October 29, 2009 1:25 PM
> To: Messersmith, Mark J SAW@SAC
> Subject: Re: Sea beach amaranth
>
> Hi Mark,
>
> Sad to say, I don't. I might be able to answer some questions though.
> cheers,
> Allan
>
> On Thu, 2009-10-29 at 13:11 -0400, Messersmith, Mark J SAW@SAC wrote:

> > Dr. Strand,
> >
> > I came across the attached draft of a seabeach amaranth survey from
> > 2003. Do you have a final publication on this research that you can
> > send to me?
> >
> >
> > <<South Carolina Sea Beach Amaranth Survey - 2003.pdf>>
> >
> > Thanks -
> >
> > Mark J. Messersmith
> > Biologist
> > US Army Corps of Engineers - SAW@SAC
> > (843) 329-8162
> > mark.j.messersmith@usace.army.mil
> >
> >
>
>

From:	Andrea J Grabman
To:	Messersmith, Mark J SAW@SAC
Subject:	FW: Artifical reef deployment
Date:	Friday, January 15, 2010 4:08:25 PM

...and one more comment with some additional input- this time from FL. I still think that it's a good idea to try to combat erosion, but maybe a reef could be constructed with a Turtle Excluder Device (TED) similar to the ones on shrimp nets?
Still planning to send you the erosion photos...

Andrea Grabman
Interpretive Program Manager
Edisto Beach State Park
8377 State Cabin Rd.
Edisto Island, SC 29438

Ph: 843.869.4426

Shaping & Sharing a Better South Carolina
At Tax Time, "Check Off" for SC State Parks!<http://www.checkoff4scparks.com/>

____
From: Sea Turtle Biology and Conservation [CTURTLE@LISTS.UFL.EDU] On Behalf Of Michael Barnette [Michael.Barnette@NOAA.GOV]
Sent: Thursday, January 14, 2010 5:43 PM
To: CTURTLE@LISTS.UFL.EDU
Subject: Re: Artifical reef deployment

I don't believe there is any literature to date (due to inherent difficulty in evaluating the issue, lack of monitoring/reporting, and the limited time span the "evidence" exists to document the issue at any given site), however there may be potential issues depending on the type of material and the location.

Typically, rock or rubble material is not expected to introduce any issues.

There have been several instances of turtles entrapped in modules. Sally mentioned one from off SC in October 1995, which was from a metal "pup tent" or "lean-to" module, which had a large circular opening on each of the panels. The sides of this module are open, but the turtle (I remember it being larger than a juvenile) wedged itself firmly into the round opening and was found freshly dead. There has also been a documented turtle mortality in another metal module off Pensacola, and a suspected entrapment of a turtle in a concrete tetrahedron (also off FL), which had an open bottom that apparently allowed the turtle to wiggle under, gain entrance, and drown.

Then there are potential issues with vessels, many of which are associated with entanglements in lost anchor lines and monofilament. I have images of several examples of this interaction, which were forwarded on to the STSSN.

Cheers,
Mike

Michael C. Barnette

On Jan 14, 2010, at 10:14 AM, "Stetzar Edna (DNREC)" <Edna.Stetzar@STATE.DE.US<mailto:Edna.Stetzar@STATE.DE.US>> wrote:

All-

Are you aware of any literature pertaining to injury of sea turtles from the deployment of artificial reef materials on existing artificial reefs? I've conducted a literature search but have found limited information. It may be possible that it is a non-issue?

Any information would be greatly appreciated,
Sincerely,
Edna

Edna J. Stetzar
Biologist/Environmental Review Coordinator
Natural Heritage and Endangered Species Program
Division of Fish and Wildlife
Delaware Department of Natural Resources and Environmental Control
4876 Hay Point Landing Rd
Smyrna, DE 19977
(302) 653-2880 ext. 101
<mailto:Edna.Stetzar@state.de.us>Edna.Stetzar@state.de.us<mailto:Edna.Stetzar@state.de.us>

From:	Andrea J Grabman
To:	Messersmith, Mark J SAW@SAC
Subject:	photos3- overwash from Hurricane Bill
Date:	Saturday, January 16, 2010 3:35:26 PM
Attachments:	Hurrican Bill erosion 2.jpg Hurrican Bill erosion 9.jpg Hurrican Bill erosion 7.jpg Hurrican Bill erosion 6.jpg

---

Erosion in action! Attached photos show the extreme overwash from the Hurricane Bill storm tides. First two photos show the overwash on the boardwalk at the ranger station. Normally the steps are exposed. In the second photo, you can really see how far the tide came in! (The main road in the town flooded.) Also attached are photos of the sand fencing that was pulled down by the storm tides. This sand fencing is on the high area of the beach. We normally have this area roped off to keep the public from trampling the primary dune line.

Andrea Grabman
Interpretive Program Manager
Edisto Beach State Park
8377 State Cabin Rd.
Edisto Island, SC 29438

Ph: 843.869.4426

Shaping & Sharing a Better South Carolina
At Tax Time, "Check Off" for SC State Parks!<http://www.checkoff4scparks.com/>

From:	Bill Post
To:	Messersmith, Mark J SAC
Cc:	Moran, Joseph SAC
Subject:	RE: edisto sturgeon counts (UNCLASSIFIED)
Date:	Thursday, May 02, 2013 3:45:25 PM

Mark,
Through the ongoing multi-state telemetry study, we've documented 13 Atlantic sturgeon and 2 shortnose sturgeon passing thru the borrow pit area.
The Atlantic sturgeon were observed during February-May and again October-November. The shortnose were observed in March.
In addition, through the same telemetry study, there have been 32 Atlantic sturgeon and 4 shortnose sturgeon that more than likely passed through that same area during north/south migrations along the coast. Remember, these are only fish with transmitters that have been detected, there are no doubt others in the vicinity.
Hope this answers your question.

Bill

Bill Post
S.C. Department of Natural Resources
Diadromous Fishes Coordinator
217 Fort Johnson Rd.
Charleston, SC 29412
Office: (843)953-9821
Cell: (843)209-1644
Fax: (843)953-9820

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Thursday, May 02, 2013 10:21 AM
To: Bill Post
Subject: edisto sturgeon counts (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Bill - attached is a map of the project area. The orange box is the proposed borrow site. the red line is the extent of the project. Do you have any numbers and/or literature for sturgeon in this area (both species)?

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

From: Bill Post
To: Messersmith, Mark J SAC
Subject: RE: edisto sturgeon counts (UNCLASSIFIED)
Date: Friday, May 03, 2013 9:18:24 AM

Mark,

If you are citing the what's reflected in the text below, yes I'm fine with that.

Bill

Bill Post

S.C. Department of Natural Resources

Diadromous Fishes Coordinator

217 Fort Johnson Rd.

Charleston, SC 29412

Office: (843)953-9821

Cell: (843)209-1644

Fax: (843)953-9820

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Friday, May 03, 2013 8:42 AM
To: Bill Post
Subject: RE: edisto sturgeon counts (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

Thanks Bill. I'd like to use this information in our Biological Assessment, with a "may affect, not likely to adversely affect" determination. Are you comfortable with me citing this via "personal communication"?

Mark

-----Original Message-----

From: Bill Post [mailto:PostB@dnr.sc.gov <mailto:PostB@dnr.sc.gov>]

Sent: Thursday, May 02, 2013 3:44 PM

To: Messersmith, Mark J SAC

Cc: Moran, Joseph SAC

Subject: RE: edisto sturgeon counts (UNCLASSIFIED)

Mark,

Through the ongoing multi-state telemetry study, we've documented 13 Atlantic sturgeon and 2 shortnose sturgeon passing thru the borrow pit area.

The Atlantic sturgeon were observed during February-May and again October-November. The shortnose were observed in March.

In addition, through the same telemetry study, there have been 32 Atlantic sturgeon and 4 shortnose sturgeon that more than likely passed through that same area during north/south migrations along the coast. Remember, these are only fish with transmitters that have been detected, there are no doubt others in the vicinity.

Hope this answers your question.

Bill

Bill Post

S.C. Department of Natural Resources

Diadromous Fishes Coordinator

217 Fort Johnson Rd.

Charleston, SC 29412

Office: (843)953-9821

Cell: (843)209-1644

Fax: (843)953-9820

-----Original Message-----

From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil

<mailto:Mark.J.Messersmith@usace.army.mil>]

Sent: Thursday, May 02, 2013 10:21 AM

To: Bill Post

Subject: edisto sturgeon counts (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

Bill - attached is a map of the project area. The orange box is the proposed borrow site. the red line is the extent of the project. Do you have any numbers and/or literature for sturgeon in this area (both species)?

Thanks - Mark

Mark Messersmith

Planning and Environmental Branch

US Army Corps of Engineers

Charleston District

69A Hagood Ave

Charleston, SC 29403

(p) (843) 329 - 8162

(f) (843) 329 - 2231

mark.j.messersmith@usace.army.mil <mailto:mark.j.messersmith@usace.army.mil>

Classification: UNCLASSIFIED

Caveats: NONE

Classification: UNCLASSIFIED

Caveats: NONE

From:	Bob Martore
To:	Messersmith, Mark J SAW@SAC
Subject:	RE: artificial reefs
Date:	Friday, February 05, 2010 3:00:07 PM
Attachments:	SC Artificial Reef User 2006 Final Rpt.pdf

Mark,

Robert M. Martore
South Carolina Department of Natural Resources
Marine Resources Division
Office of Fisheries Management
phone (843) 953-9303
fax (843) 953-9849
martoreb@dnr.sc.gov

-----Original Message-----
From: Messersmith, Mark J SAW@SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Friday, February 05, 2010 2:47 PM
To: Bob Martore
Subject: artificial reefs

Mr. Martore - Real quick email (it's Friday afternoon) In your opinion... what type of design would be the most ideal for a multi-use reef that we're considering? Would some type of rubble stone accomplish the same thing as the reef balls?

Thanks - Mark

Mark J. Messersmith
Biologist
US Army Corps of Engineers - SAW@SAC
(843) 329-8162
mark.j.messersmith@usace.army.mil

From:	Craig_Aubrey@fws.gov
To:	Messersmith, Mark J SAW@SAC
Subject:	RE: Edisto Beach and CBRA zones
Date:	Wednesday, January 27, 2010 3:23:33 PM

sorry. The letter is being formatted by the secretary and given to the supervisor for signature. May be signed this afternoon. More likely Thursday.

Craig

Inactive hide details for "Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>"Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>

"Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>

01/27/2010 03:08 PM

To

<Craig_Aubrey@fws.gov>

cc

Subject

RE: Edisto Beach and CBRA zones

Craig - I hope I'm not expressing my ignorance here, but what is "surnaming"?

My assumption is that it means that it's being routed internally for signatures, or some other process of formalizing the letter... but maybe it's a typo.

-----Original Message-----
From: Craig_Aubrey@fws.gov [mailto:Craig_Aubrey@fws.gov]
Sent: Wednesday, January 27, 2010 2:58 PM
To: Messersmith, Mark J SAW@SAC
Subject: RE: Edisto Beach and CBRA zones

letter is in surnaming.

Craig

Craig W. Aubrey
Coastal Program Coordinator
U.S. Fish and Wildlife Service
Charleston Field Office
176 Croghan Spur Road, Suite 200
Charleston, SC 29407

Phone: (843) 727-4707, ext. 301
Fax: (843) 727-4218
Inactive hide details for "Messersmith, Mark J SAW@SAC"
<Mark.J.Messersmith@usace.army.mil>"Messersmith, Mark J SAW@SAC"
<Mark.J.Messersmith@usace.army.mil>

"Messersmith, Mark J SAW@SAC"
<Mark.J.Messersmith@usace.army.mil>

01/27/2010 01:55 PM

To

<Craig_Aubrey@fws.gov>

cc

Subject

RE: Edisto Beach and CBRA zones

69A Hagood Ave.
Charleston, SC 29403-5107

Mark J. Messersmith
Biologist
US Army Corps of Engineers - SAW@SAC
(843) 329-8162
mark.j.messersmith@usace.army.mil

-----Original Message-----
From: Craig_Aubrey@fws.gov [mailto:Craig_Aubrey@fws.gov]
Sent: Wednesday, January 27, 2010 1:54 PM
To: Messersmith, Mark J SAW@SAC
Subject: Re: Edisto Beach and CBRA zones

what's your mailing address?

From: David Simms
To: Messersmith, Mark J SAW@SAC
Subject: Edisto
Date: Friday, October 23, 2009 10:07:27 AM

Mark:

: Good speaking with you today. Please keep me posted on this project.

David R. Simms, P.E.

Chief of Engineering and Construction

SC State Park Service

SC Department of Parks, Recreation & Tourism

1205 Pendleton St., Suite 251

Columbia, SC 29201

Phone: (803) 734-0258

Mobile: (803) 360-3938

From:	Dobrasko, Rebekah
To:	Messersmith, Mark J SAC; SPIREK, JIM
Cc:	Patrick, Dudley SAC; Walters, Bret L SAC
Subject:	RE: Edisto Beach borrow area surveys (UNCLASSIFIED)
Date:	Thursday, November 08, 2012 11:11:25 AM
Attachments:	Edisto - Cultural Resources - Hardbottom - Subbottom SOW 30Oct 2012 SHPO Comments.doc

---

Mark,

Just a few comments from us to clarify standards and National Register of Historic Places determinations.

Rebekah

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]

Sent: Tuesday, November 06, 2012 12:53 PM
To: SPIREK, JIM; Dobrasko, Rebekah
Cc: Patrick, Dudley SAC; Walters, Bret L SAC
Subject: Edisto Beach borrow area surveys (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Jim and Rebekah - Attached is a draft SOW for cultural and hardbottom resource surveys at the proposed Edisto Beach borrow area to be used for a future Federal project at the Town of Edisto Beach. Please review this draft and let me know if you see any problems with the SOW prior to us submitting it for proposals. If you can provide comments by November 16 we would greatly appreciate it. If there are any known surveys of the borrow area from any past work can you please let us know as well? As always, feel free to call me with any questions.

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

From:	DuBose Griffin
To:	Messersmith, Mark J SAC
Subject:	RE: Edisto sea turtle nests (UNCLASSIFIED)
Date:	Wednesday, September 19, 2012 4:52:12 PM
Attachments:	edistonestdata2010-2012.xls

Here is the data. The nests that have unknown dates (00-00-2010) is because we do not know the date it was laid. These are nests that are found at hatching and were originally missed.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, September 19, 2012 4:12 PM
To: DuBose Griffin
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

2010,2011,2012 .

As for the disorientations. Did you get a chance to look at the town's new beachfront management plan? OCRM completed it for them sometime in the early spring this year. Not sure what it has in there for beach lighting, but that would be a good start. What are some other issues that USACE can address if we move forward with a beach nourishment?

Thanks - Mark

-----Original Message-----
From: DuBose Griffin [mailto:GriffinD@dnr.sc.gov]
Sent: Wednesday, September 19, 2012 3:53 PM
To: Messersmith, Mark J SAC
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Hi Mark,

I am sorry for the delay. I am going to put this data together for you this week! What years do you want exactly? We also need to use any opportunity we have to work with the town to reduce orientations. They were really bad this year.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Monday, August 20, 2012 3:36 PM
To: DuBose Griffin
Subject: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Dubose - hope you've been doing well. I'm preparing for a meeting with our HQ folks on the Edisto Beach Feasibility Study. Could you please send me the sea turtle nesting data from the last few years. I've been on this site, http://www.seaturtle.org/nestdb/?view=2 , and it'd be nice to have the spreadsheet or database that the info is pulled from. In 2009 you sent me an xls of the statewide data.

Also, do you have coordinates (GIS data) for the locations of the nests? If so, does it have attributes associated with it? I'd like to see if one particular section of beach results in greater nesting success, false crawls, etc to see if there are any trends. Feel free to call me.

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

From:	DuBose Griffin
To:	Messersmith, Mark J SAC
Cc:	Melissa_Bimbi@fws.gov
Subject:	RE: Edisto sea turtle nests (UNCLASSIFIED)
Date:	Thursday, September 20, 2012 7:42:44 AM

Mark,

I think this would be great. I have added Melissa to this email so she can let us know her availability. I will put together the disorientation data from this year for you guys as well. My only hang up is that next week is full. I have October 1 and 5 of the following week.

Melissa - can we meet for coffee with Mark to discuss the Edisto Town beach nourishment.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Thursday, September 20, 2012 6:53 AM
To: DuBose Griffin
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Thanks DuBose. Would you and Melissa be able to meet for coffee one day next week? We could meet at the Starbucks at South Windemere one morning.

Mark

-----Original Message-----
From: DuBose Griffin [mailto:GriffinD@dnr.sc.gov]
Sent: Wednesday, September 19, 2012 4:51 PM
To: Messersmith, Mark J SAC
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Here is the data. The nests that have unknown dates (00-00-2010) is because we do not know the date it was laid. These are nests that are found at hatching and were originally missed.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, September 19, 2012 4:12 PM
To: DuBose Griffin
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

2010,2011,2012 .

As for the disorientations. Did you get a chance to look at the town's new beachfront management plan? OCRM completed it for them sometime in the early spring this year. Not sure what it has in there for beach lighting, but that would be a good start. What are some other issues that USACE can address if we move forward with a beach nourishment?

Thanks - Mark

-----Original Message-----
From: DuBose Griffin [mailto:GriffinD@dnr.sc.gov]
Sent: Wednesday, September 19, 2012 3:53 PM
To: Messersmith, Mark J SAC
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Hi Mark,

I am sorry for the delay. I am going to put this data together for you this week! What years do you want exactly? We also need to use any opportunity we have to work with the town to reduce orientations. They were really bad this year.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Monday, August 20, 2012 3:36 PM
To: DuBose Griffin
Subject: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Dubose - hope you've been doing well. I'm preparing for a meeting with our HQ folks on the Edisto Beach Feasibility Study. Could you please send me the sea turtle nesting data from the last few years. I've been on this site, http://www.seaturtle.org/nestdb/?view=2 , and it'd be nice to have the spreadsheet or database that the info is pulled from. In 2009 you sent me an xls of the statewide data. Also, do you have coordinates (GIS data) for the locations of the nests? If so, does it have attributes associated with it? I'd like to see if one particular section of beach results in greater nesting success, false crawls, etc to see if there are any trends. Feel free to call me.

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

From:	DuBose Griffin
To:	Messersmith, Mark J SAC
Subject:	RE: Edisto sea turtle nests (UNCLASSIFIED)
Date:	Wednesday, September 19, 2012 4:49:34 PM

There are ordinances in place for lighting. It is a matter of getting the town to do a better job bringing property owners' homes into compliance.

DuBose

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, September 19, 2012 4:12 PM
To: DuBose Griffin
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

2010,2011,2012 .

As for the disorientations. Did you get a chance to look at the town's new beachfront management plan? OCRM completed it for them sometime in the early spring this year. Not sure what it has in there for beach lighting, but that would be a good start. What are some other issues that USACE can address if we move forward with a beach nourishment?

Thanks - Mark

-----Original Message-----
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Sent: Wednesday, September 19, 2012 3:53 PM
To: Messersmith, Mark J SAC
Subject: RE: Edisto sea turtle nests (UNCLASSIFIED)

Hi Mark,

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DuBose

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From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Monday, August 20, 2012 3:36 PM
To: DuBose Griffin
Subject: Edisto sea turtle nests (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Dubose - hope you've been doing well. I'm preparing for a meeting with our HQ folks on the Edisto Beach Feasibility Study. Could you please send me the sea turtle nesting data from the last few years. I've been on this site, http://www.seaturtle.org/nestdb/?view=2 , and it'd be nice to have the spreadsheet or database that the info is pulled from. In 2009 you sent me an xls of the statewide data. Also, do you have coordinates (GIS data) for the locations of the nests? If so, does it have attributes associated with it? I'd like to see if one particular section of beach results in greater nesting success, false crawls, etc to see if there are any trends. Feel free to call me.

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

From:	Mark_Caldwell@fws.gov
To:	Messersmith, Mark J SAC
Subject:	Re: Edisto (UNCLASSIFIED)
Date:	Wednesday, August 22, 2012 9:22:15 AM

Mark,

This is to confirm that integration of the Edisto Beach renourishment project CAR into the feasibility study/EA is acceptable.

Mark A. Caldwell
U.S. Fish and Wildlife Service
South Carolina Ecological Services
176 Croghan Spur Road - Suite 200
Charleston, SC 29407
843-727-4707 ext. 215
843-727-4218 - facsimile

"Messersmith, Mark J SAC" <Mark.J.Messersmith@usace.army.mil>

08/21/2012 09:40 AM To
Mark Caldwell <Mark_Caldwell@fws.gov>
cc
Subject
Edisto (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Mark - a while ago we spoke about the CAR for Edisto... we talked about it being okay to integrate it into the feasibility study/EA. Just want to confirm that this is still okay with your office?

Thanks - Mark

Ps. Sorry for not having any meetings the last few weeks!

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED

Caveats: NONE

From:	Melissa_Bimbi@fws.gov
To:	Messersmith, Mark J SAW@SAC
Cc:	Mark_Caldwell@fws.gov
Subject:	Re: Piping plovers
Date:	Tuesday, January 12, 2010 9:25:56 AM

Hi Mark,

I do have PIPL info for SC, but I don't have anything specific for Edisto. The South Carolina Shorebird Project report is in the process of being finalized. It contains all the SC info from 2006-2008. There are also International Non-breeding Piping Plover Census reports and our latest status review online. I would expect plovers on the State park end if the disturbance is minimal. It may be worth another site visit.

Melissa Bimbi
Endangered Species Biologist
U.S. Fish & Wildlife Service
Ecological Services
176 Croghan Spur Road, Suite 200
Charleston, SC 29407
(843) 727-4707 x 217
(843) 727-4218 Fax
Inactive hide details for "Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>"Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>

"Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>

01/12/2010 09:06 AM

To

<Melissa_Bimbi@fws.gov>

cc

Subject

Piping plovers

Melissa,

Do you have historical/yearly piping plover counts for SC, specifically Edisto Beach?

I'm going to try to attend your talk at the library tomorrow.

Hope you've been doing well.

Mark

Mark J. Messersmith
Biologist
US Army Corps of Engineers - SAW@SAC
(843) 329-8162
mark.j.messersmith@usace.army.mil

From:	Melissa_Bimbi@fws.gov
To:	Messersmith, Mark J SAC
Subject:	paper
Date:	Monday, July 26, 2010 5:01:20 PM
Attachments:	Stewart and Wyneken 2004.pdf

(See attached file: Stewart and Wyneken 2004.pdf)

Melissa Bimbi
Endangered Species Biologist
U.S. Fish & Wildlife Service
Ecological Services
176 Croghan Spur Road, Suite 200
Charleston, SC 29407
(843) 727-4707 x 217
(843) 727-4218 Fax

From: Myra Brouwer
To: Messersmith, Mark J SAC
Subject: RE: trawl line data
Date: Monday, June 07, 2010 10:33:03 AM

Hey Mark! Thanks for sending this info. I'm glad you were able to get it from the DNR.
Things are going to be a bit sketchy this week: we are in Orlando for the Council meeting and we are expecting hordes of angry fishermen to show up because of the whole red snapper issue, etc. Yikes!
Take care,
Myra

From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Mon 6/7/2010 10:14 AM
To: Myra Brouwer
Subject: FW: trawl line data

Myra - We spoke awhile ago about trawling boundaries in SC. I was able to get the attached data from DNR. Just wanted to pass it on to you and your office. Also, check out the following link. Hope you've been doing well.

http://www.dnr.sc.gov/licenses/pdf/TrawlingFY2010.pdf

- Mark

Mark J. Messersmith
Biologist
Planning and Environmental Branch
US Army Corps of Engineers - Charleston District
(843) 329-8162
mark.j.messersmith@usace.army.mil

From:	Pace Wilber
To:	Messersmith, Mark J SAC
Subject:	Re: EFH for Edisto Beach
Date:	Tuesday, June 08, 2010 12:12:21 PM

Hi Mark.

A couple of pints (and I apologize for our web site not making these clear) . . .

For South Carolina waters, there are three federal entities that manage fish: the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and NMFS. SAFMC is by far the bigger player, so it is not unusual for people to think they are the only player, but this is not the case.

The species you list are managed by SAFMC, with the exception red drum. It is a long story, but in November 2008, the federal government backed out of managing Atlantic stocks of red drum and deferred all mgmt of this species to the states. As such, the red drum FMP, along with its EFH designations, was repealed. Your list suggests that red drum is in the same FMP as snapper/grouper, which is not the case. Snapper/grouper have their own FMP.

MAFMC manages bluefish and summer flounder north of NC, but the EFH that MAFMC designates for these species extends southward into Georgia (for summer flounder) and central Florida (for bluefish). Essentially MAFMC designates "estuarine waters" as EFH for these species and does not designate any HAPCs. In practice, nothing is lost from an EFH assessment when summer flounder and bluefish are excluded because of the overlap with the designations for SAFMC-managed species, so it is seldom that we get picky when an assessment does not list summer flounder or bluefish. But if you are looking to be complete and a model for others, summer flounder and bluefish should be included.

Separately from the Councils, NMFS manages highly migratory species (~billfish, tunas, and sharks). Info on these species and their EFH can be found at:
http://www.nmfs.noaa.gov/sfa/hms/EFH/index.htm
Due to overlaps with SAFMC-managed species, projects limited to state waters and away from inlets often do not omit anything consequentional from at EFH assessment if the highly migratory species are left out, but highly migratory species should be included in the assessment.

On to maps . . . . the GIS data available from SAFMC's website and NMFS' "EFH Mapper" website should be used very cautiously (to be frank, we usually advise applicants to not use these data for inshore projects--the EFH Mapper website does not go to this extreme, but you may have noticed all the caution icons). The data have scale issues (many small areas of EFH are missing) due to the coarseness of the data and some data layers depict areas in manners that are inconsistent with the text-based EFH designations; and the rule is quite clear that the text-based designations take precedence. I know this mismatch is a source of frustration (it is for us too!!), but it will be with us for some time. If you'd like, I'd be glad to proof any maps you are developing to make sure what is shown in consistent with how we comment on EFH in SC.

Pace

Messersmith, Mark J SAC wrote:
> Hi Pace -
>
> Hope you enjoyed your Memorial Day weekend. Just wanted to inform you that
> I'm working on an EFH for the Edisto Beach project that you're familiar with.
> We're still exploring nourishment, groin modification, and artificial reefs
> as potential measures for protecting the beach. I have pulled a bunch of info
> from the NMFS website on EFH and want to make sure that I include everything
> that I should. I have pdfs of the following:
>
> - coastal migratory pelagic EFH FMP
> - dolphin wahoo FMP
> - other inverts, corals, live bottom EFH
> - Penaeid shrimp EFH
> - red drum, snapper-grouper EFH
> - south atlantic golden crab habitat plan
>
> I believe that is all that came up for SC. Am I missing anything? Do you have
> a list of species particular to coastal SC that I should focus on? I also
> pulled all the GIS layers to make some nice maps.
>
> Thanks, and hope you've been doing well. - Mark
>
>
> Mark J. Messersmith
> Biologist
> Planning and Environmental Branch
> US Army Corps of Engineers - Charleston District
> (843) 329-8162
> mark.j.messersmith@usace.army.mil
>
>
>

--

Pace Wilber, Ph.D.
Atlantic Branch Chief, Charleston (F/SER47)
Southeast Regional Office, NOAA Fisheries
PO Box 12559
Charleston, SC 29422-2559

Street address:
219 Ft Johnson Road
Charleston, SC 29412

843-953-7200
FAX 843-953-7205
pace.wilber@noaa.gov

http://sero.nmfs.noaa.gov/hcd/hcd.htm

From:	Prescott.Brownell@noaa.gov
To:	Messersmith, Mark J SAW@SAC
Cc:	O"Donnell, Patrick E SAC; Pace.Wilber@noaa.gov
Subject:	Re: Edisto Beach storm damage reduction meeting
Date:	Monday, January 04, 2010 9:32:14 PM

Hello Mark and Patrick,
I will discuss the meeting with Pace Wilbur in our office, and one of us will plan to attend the meeting on January 20. Thank you for keeping us informed of the project.

Best Regards
Prescott Brownell
843-953-7204

----- Original Message -----
From: "Messersmith, Mark J SAW@SAC" <Mark.J.Messersmith@usace.army.mil>
Date: Monday, December 21, 2009 8:59 am
Subject: Edisto Beach storm damage reduction meeting
To: "smtp-Brownell, Prescott" <Prescott.Brownell@noaa.gov>
Cc: "O'Donnell, Patrick E SAC" <Patrick.E.ODonnell@usace.army.mil>

> Mr. Brownell,
>
> Hope you've been doing well. As you know, the US Army Corps of
> Engineers is
> working with the Town of Edisto on a feasibility study to examine
> alternatives for the reduction of hurricane and storm damages. In addition,
> we are evaluating the potential for environmental benefits associated
> with
> providing protection of the beach, maritime forest and marsh habitat
> that
> exists along the Edisto Beach State Park area. We spoke awhile ago about
> involving your agency and others in the planning process for this
> study. On
> Wednesday, January 20 from 0900 - 1100 we would like you to join us
> at our
> office to discuss the project. During this meeting we will present the
> various project reaches that we have defined. We will also discuss
> the pros
> and cons of various measures to address the erosion problem along Edisto
> Beach. Such measures may include: no action, renourishment (varying beach
> profiles), fencing and grassing, groin construction, existing groin
> modification, multi-purpose reefs, and structure relocation. Your
> participation in this meeting would be very much appreciated. If you
> have an
> opinion one way or the other regarding these measures, please try to
> provide
> some evidence in support of your opinion. Thanks for your involvement
> in this
> process. Please let me know whether or not you will be attending.
>
> What: Edisto Storm Damage Feasibility Study Alternative Formulation Meeting
> Date: January 20, 2010 (Wednesday)
> Time: 0900 - 1100
> Location: US Army Corps of Engineers, 69A Hagood Ave, Charleston, SC

> 29403
>
> Respectfully,
>
> Mark J. Messersmith
> Biologist
> US Army Corps of Engineers - SAW@SAC
> (843) 329-8162
> mark.j.messersmith@usace.army.mil
>
>
>

From:	Ray Stevens
To:	Messersmith, Mark J SAC
Subject:	RE: Edisto Agency Meeting (UNCLASSIFIED)
Date:	Thursday, June 14, 2012 4:29:12 PM
Attachments:	image001.png

Mark

As you had mentioned it has been a while. Can you please remind me the exact content/project of the meeting?

Thanks,

Ray T. Stevens

Regional Chief, Coastal Region

SC Department of Parks Recreation and Tourism

2555 Sea Island Parkway

Hunting Island, South Carolina 29920

Phone (843) 838-4868

Mobile (843) 441-2542

IP Phone 6864

rstevens@scprt.com

Description: Description: SPSlogo

-----Original Message-----
From: Messersmith, Mark J SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Tuesday, June 12, 2012 1:40 PM
To: Collins.Garyw@epa.gov; Jaclyn Daly; Susan Davis; Andrea J Grabman; MartoreB@dnr.sc.gov; Ray Stevens; Susan Spell; ihill@townofedistobeach.com; Mark_Caldwell@fws.gov
Cc: Gravens, Mark B ERDC-CHL-MS; Williams, Brian P SAC; McGuire, Julie W SAM; Lackey, Ben SAW; Fersner, Jeffery W SAC; Lin, Jeffrey P SAW; O'Donnell, Patrick E SAC
Subject: Edisto Agency Meeting (UNCLASSIFIED)

Classification: UNCLASSIFIED

Caveats: NONE

All - I only heard back from 2 people on their availability for this meeting. Rather than having a small meeting, I'd like to open up availability to more dates. Please use the "Doodle" link to add your availability by June 22. Thanks.

http://www.doodle.com/meb3bmsarrr8ubsa <http://www.doodle.com/meb3bmsarrr8ubsa>

Mark

Here is my last email and rough meeting information:

It's been a while since we've last been in contact as a group on this project. We are currently close to holding our "Feasibility Scoping Meeting" with our Division and HQ offices. This process will result in the approval of the without project condition and our "measures" to carry forward to the next stage. We'd like to have another meeting with you all to discuss these components and gain your input. SCPRT indicated a while back that they were not in a position to cost share on the project, but I think it'd be valuable for them to stay engaged. An agenda will be forthcoming. By COB Friday, May 18, please send me the dates of your availability for a 2-3 hour meeting in mid to late June at the Charleston District Office. Telecon and webinar can be arranged if needed.

Mark Messersmith

Planning and Environmental Branch

US Army Corps of Engineers

Charleston District

69A Hagood Ave

Charleston, SC 29403

(p) (843) 329 - 8162

(f) (843) 329 - 2231

mark.j.messersmith@usace.army.mil <mailto:mark.j.messersmith@usace.army.mil>

Classification: UNCLASSIFIED

Caveats: NONE

From:	Ray Stevens
To:	edistohill@bellsouth.net
Cc:	Susan Spell; James Thompson; Phil Gaines; David Simms; Messersmith, Mark J SAW@SAC
Subject:	FW: ACOE Feasibility
Date:	Tuesday, January 19, 2010 9:01:25 AM

Iris,

Susan forwarded your email on the feasibility study and your request for the State to consider funding the remaining amount of $281,000. We did discuss and consider the request however at this time the State Park Service is unable to contribute funding to the feasibility study. Hopefully at a later date economic times and budgets will allow us to partner with the town if and when a plan is implemented. If we can be of assistance with providing information from our end or answering questions during the planning process we will be happy to do so.

Respectfully,

Ray T. Stevens

Regional Chief, Coastal Region

SC Department of Parks Recreation and Tourism

2555 Sea Island Parkway

Hunting Island, South Carolina 29920

Phone (843) 838-4868

Mobile (843) 441-2542

IP Phone 6864

rstevens@scprt.com

From: Iris Hill [edistohill@bellsouth.net]

Sent: Wednesday, January 06, 2010 11:46 AM

To: Susan Spell

Subject: ACOE Feasibility

Susan:

The Town has already paid the ACOE $594,000 with $281,000 remaining. We request that the State consider funding this remaining amount.

(excerpt below from Patrick O'Donnell ACOE)

Right now, we're looking at several alternatives- beach renourishment, groin modifications, and artificial reefs. We'll look at each as a stand-alone and see what it could do to reduce storm damage, and we'll look at them in combination. For the different reaches, we're looking at (1)the state park as one reach; (2)about one mile of your beach from the beginning of Palmetto Blvd. southward as another reach; (3)the rest of the Atlantic coast as a third reach; and (4) the Edisto River side of town as the fourth reach. We will look at the costs and benefits of doing a project at each reach, and then combined- all reaches, the three reaches along the Atlantic, just the two reaches in the Town of Edisto.

We'll end up with a lot of different options.

We also want to know if there is any other agency that would like to help pay for the cost of the study, design, and construction. We're thinking that it might be possible to have state parks, DNR, or some other state agency help pay for a project if it has a good habitat value by creating artificial reefs. If the reefs also reduce storm surges to Edisto, we could have a project that helps in more than one way.

FYI. CSE (Dr. Kana) is coming to Edisto on Feb 12 to present their 3rd year beach monitoring report post renourishment. Please come if you can. Meeting starts at 10:00 am.

Iris Hill

Town Administrator

Town of Edisto Beach

2414 Murray Street

Edisto Beach, South Carolina 29438

(P) 843 869 2505

(f) 843 869 3855

email edistohill@bellsouth.net

[cid:image001.jpg@01CA8EC5.ECA813A0]

From: Shannon K. Berry
To: Messersmith, Mark J SAW@SAC
Subject: Edisto Data
Date: Thursday, October 29, 2009 1:19:35 PM
Attachments: Messersmith.xls

Mark

If you need past year please let me know.

Shannon

Shannon Berry
Program Coordinator
Beach Monitoring
803-898-3541

Each day I'll do a golden deed.

From:	SPIREK, JIM
To:	Messersmith, Mark J SAC
Cc:	Dobrasko, Rebekah
Subject:	RE: Edisto Beach borrow area surveys (UNCLASSIFIED)
Date:	Thursday, November 15, 2012 4:10:12 PM

Mark,

Please find below our comments regarding the SOW for the Edisto Beach borrow area survey project. We also concur with the SHPOs comments to provide SCIAA with copies of the draft/final reports.

1--In reference to the side scan sonar--we recommend that this instrument is operated concurrently with the magnetometer, which is the primary cultural resources survey instrument, at the 20m lane spacing for efficiency sakes.

2--In the General Requirements section the graphically illustrated letter report with preliminary findings should also include a magnetic contour map along with the sonar mosaic--also mag/acoustic anomalies should be cross-referenced to each other if applicable. Any potential cultural resources should also be identified for potential historical/archaeological significance. This is mentioned in the Cultural Resources Analysis section but should be referenced in the Gen. Reg. section as well.

3--Recommendations: While a meeting prior to implementation of Phase 2 is appropriate, this meeting should only occur after all appropriate materials have been produced by the Contractor consisting of the graphic report as well as historical/archaeological information in order to more fully discuss/understand the findings--i.e., magnetic/acoustic anomalies in connection to historic record. Would preferably occur after the Rough draft has been submitted for reviewed by the SHPO/SCIAA.

4--A deliverable in the report should include a magnetic contour map.

5--In the accompanying figure, assume Appendix A mentioned in the SOW--I see the refined borrow area (RBA) but the .25 mi buffer zone does not extend all around the RBA? Why not?

If you have any questions, etc. about our comments please contact me. Thanks for your efforts in protecting submerged cultural resources in South Carolina waters.

Sincerely,

Jim

James D. Spirek
State Underwater Archaeologist
Maritime Research Division
South Carolina Institute of Archaeology and Anthropology
University of South Carolina
1321 Pendleton Street
Columbia, SC 29208 USA
Office phone: (803) 576-6566
Fax: (803) 254-1338
E-mail: spirek@sc.edu
SCIAA Web Site: http://www.cas.sc.edu/sciaa/
Maritime Research Division Website: http://www.cas.sc.edu/sciaa/mrd/mrd_index.html

From:	SPIREK, JIM
To:	Messersmith, Mark J SAC; Dobrasko, Rebekah
Cc:	Means, Alisha N SAC
Subject:	RE: Edisto: Cultural/Hardbottom Report Review (UNCLASSIFIED)
Date:	Wednesday, February 20, 2013 4:50:49 PM

Mark,

Thanks for the update. I have in contact with the contractors about arranging a visit to the SC Archaeological Site Files and gathering some reports of interest.

Jim Spirek
SCIAA

From:	SPIREK, JIM
To:	Means, Alisha N SAC; Messersmith, Mark J SAC
Cc:	"Dobrasko, Rebekah"
Subject:	Review of draft report of Edistor beach renourishment project
Date:	Friday, April 12, 2013 2:50:04 PM
Attachments:	SCIAA_DC_review_13.pdf

Dear Alisha,

Please find attached a PDF of our response letter to the above re: project report. We agree with the contractors recommendations, offer a few editorial comments, and find no objections to dredging in the proposed borrow site. If you have any questions, comments, etc. please do not hesitate to contact me.

Sincerely,

Jim

James D. Spirek

State Underwater Archaeologist

Maritime Research Division

South Carolina Institute of Archaeology and Anthropology

University of South Carolina

1321 Pendleton Street

Columbia SC 29208 USA

Office phone: (803) 576-6566

Fax: (803) 254-1338

E-mail: spirek@sc.edu <mailto:amerc@sc.edu>

SCIAA Web Site: http://www.cas.sc.edu/sciaa/ <http://www.cas.sc.edu/sciaa/>

Maritime Research Division Website: http://www.cas.sc.edu/sciaa/mrd/mrd_index.html <http://www.cas.sc.edu/sciaa/mrd/mrd_index.html>

From: Susan Spell
To: Messersmith, Mark J SAW@SAC
Subject: RE: Edisto Beach hurricane and storm damage reduction project
Date: Wednesday, October 21, 2009 3:08:23 PM

Mr. Messersmith,

As I mentioned in my earlier email, I have forwarded the emails to our engineer, David Simms but I wanted to go ahead and give you his contact number (803-270-0258).

Susan

Susan Spell
Manager, Edisto Beach State Park

SC Department of Parks, Recreation & Tourism

8377 State Cabin Road

Edisto Beach, SC 29438

Phone: (843) 869-4425

From: Messersmith, Mark J SAW@SAC [mailto:Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, October 21, 2009 8:12 AM
To: Susan Spell
Subject: Edisto Beach hurricane and storm damage reduction project

Ms. Spell,

Sorry to belabor the point, but since we are having a public meeting on this project next Thursday, Oct. 29 at 7pm at the Edisto Beach Civic Center, I wanted to let you know about it in case you wanted to attend. Ideally, I would like to discuss this project with someone from PRT beforehand. I just started working on this project, but I'm not sure if we've gotten any feedback from PRT regarding our letter we sent last summer. Please let me know who I should talk to in Columbia, or feel free to call me at the number below. Thanks.

Respectfully,

Mark J. Messersmith
Biologist
US Army Corps of Engineers - SAW@SAC
(843) 329-8162
mark.j.messersmith@usace.army.mil

-----Original Message-----
From: Messersmith, Mark J SAW@SAC
Sent: Thursday, October 15, 2009 10:01 AM
To: 'Susan Spell (sspell@scprt.com)'
Cc: Shirey, Alan D SAW@SAC
Subject: Edisto Beach Shore Protection Project

Ms. Spell,

This email is in response to our recent phone conversation....

I was hoping to speak to someone from SCPRT regarding a feasibility study that the US Army Corps of Engineers is undertaking with the Town of Edisto Beach and Colleton County as the sponsors. For this project we would like to coordinate with PRT to see if there are any options we can explore to help: (1) ease the erosion problems, (2) create more and higher quality habitat for various species, (3) protect the salt marsh on the north end of the island on the beach side of the State Park, and (4) increase recreational opportunities as an incidental benefit of the project. Please let me know who would be the most appropriate person for me to talk to regarding this effort. Thank you.

Respectfully,

Mark J. Messersmith
Biologist
US Army Corps of Engineers - SAW@SAC
(843) 329-8162
mark.j.messersmith@usace.army.mil

From: Susan Spell
To: Messersmith, Mark J SAC
Cc: Ray Stevens
Subject: RE: Edisto meeting (UNCLASSIFIED)
Date: Wednesday, July 18, 2012 2:16:42 PM

Mr. Messersmith,

I'm afraid will not be able to attend. I am out of town on some personal business.

Susan

Susan D Spell
Manager,
Edisto Beach State Park
8377 State Cabin Road
Edisto Island, SC 29438
Office 843-869-4425
Fax 843-869-4428
www.southcarolinaparks.com

From: Messersmith, Mark J SAC [Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, July 18, 2012 2:08 PM
To: Susan Spell
Subject: Edisto meeting (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Ms. Spell - Will you be able to attend tomorrows USACE meeting on the Edisto Beach Storm Damage Reduction study?

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

From:	Susan Spell
To:	Messersmith, Mark J SAC
Cc:	Ray Stevens
Subject:	RE: Edisto meeting (UNCLASSIFIED)
Date:	Thursday, July 19, 2012 10:04:00 AM

Mark,

I feel certain our position on this is the same. There is not money in the budget for this.

On the subject of Andrea, I don't really know where she went. I heard she was married recently. I'm assuming she will be staying in the Charleston area but I don't know that.

Sorry,

Susan

Susan D Spell
Manager,
Edisto Beach State Park
8377 State Cabin Road
Edisto Island, SC 29438
Office 843-869-4425
Fax 843-869-4428
www.southcarolinaparks.com

From: Messersmith, Mark J SAC [Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, July 18, 2012 2:37 PM
To: Susan Spell
Cc: Ray Stevens
Subject: RE: Edisto meeting (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Ok... awhile ago your agency mentioned that there was no money in the budget to cost share a nourishment on your beach. Is this still the case? I'm fighting hard to keep yall in the mix.

My family and I were camping there last weekend and I noticed some substantial dunes at the RV area, but heading north to Jeremy inlet was still looking rough. What are your thoughts? Lastly, I heard that Andrea has left PRT. She was a good interpreter. Where is she working now? (I went to grad school with her).

Thanks - mark

-----Original Message-----
From: Susan Spell [mailto:sspell@scprt.com]
Sent: Wednesday, July 18, 2012 2:17 PM
To: Messersmith, Mark J SAC
Cc: Ray Stevens
Subject: RE: Edisto meeting (UNCLASSIFIED)

Mr. Messersmith,

I'm afraid will not be able to attend. I am out of town on some personal business.

Susan

Susan D Spell
Manager,
Edisto Beach State Park
8377 State Cabin Road
Edisto Island, SC 29438
Office 843-869-4425
Fax 843-869-4428
www.southcarolinaparks.com

From: Messersmith, Mark J SAC [Mark.J.Messersmith@usace.army.mil]
Sent: Wednesday, July 18, 2012 2:08 PM
To: Susan Spell
Subject: Edisto meeting (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Ms. Spell - Will you be able to attend tomorrows USACE meeting on the Edisto Beach Storm Damage Reduction study?

Thanks - Mark

Mark Messersmith
Planning and Environmental Branch
US Army Corps of Engineers
Charleston District
69A Hagood Ave
Charleston, SC 29403
(p) (843) 329 - 8162
(f) (843) 329 - 2231
mark.j.messersmith@usace.army.mil

Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX J

HARDBOTTOM AND CULTURAL RESOURCE SURVEYS

Contract No. W912HN-12-D-0016
Delivery Order No. DW02

U.S. Army Corps of Engineers
Charleston District

HARDBOTTOM AND CULTURAL RESOURCE SURVEYS

EDISTO BEACH OFFSHORE BORROW SITE
EDISTO BEACH, SOUTH CAROLINA

Prepared for:
Charleston District
US Army Corps of Engineers
69 Hagood Avenue
Charleston, SC 29403

Prepared by:
Dial Cordy and Associates Inc.
201 N. Front Street, Suite 307
Wilmington, NC 28401

and

Panamerican Consultants Inc.
91 Tillman Street
Memphis, TN 38111

April 2013

Hardbottom and Cultural Resource Surveys of the Edisto Beach Offshore Borrow Site Edisto Beach, South Carolina

APRIL 2013

Prepared for:

Charleston District
US Army Corps of Engineers
69 Hagood Avenue
Charleston, SC 29403

Prepared by:

Dial Cordy and Associates Inc.
201 N. Front Street, Suite 307
Wilmington, NC 28401

and

Panamerican Consultants Inc.
91 Tillman Street
Memphis, TN 38111

ABSTRACT

Dial Cordy and Associates Inc. and Panamerican Consultants Inc. performed a remote survey of the proposed sand borrow area during the month of February 2013 for the Edisto Beach hurricane and storm damage protection project. The project purpose was to determine the presence or absence of cultural and hardbottom resources within the proposed borrow site so as to assist in project planning, impact assessment, and for compliance with applicable federal regulations. The survey included the use of sidescan sonar, magnetometer, and a subbottom profiler to characterize resources within the study area.

Eighteen magnetic anomalies, thirty-one sidescan sonar targets, and two subbottom impedance contrast features in the form of paleolandform areas were recorded during the current survey. Out of all the anomalies, sonar targets, and subbottom impedance contrast features, no anomalies were considered to potentially represent significant historic cultural resources. Several sidescan sonar contacts and subbottom features were considered to represent vestiges of paleolandforms that have the possibility of containing prehistoric cultural resources sites. Two areas of potential paleolandscape settings that should be avoided from future dredging include an area of exposed paleolandscape with multiple logs (or stumps) that has one feature of possible upright posts indicating a possible structure and a portion of a buried paleochannel. Since the first site may contain potentially eligible pre-Contact cultural resources, it should be avoided by a distance of 1,500 feet around an arbitrary point at E2213373, N232446. The second area, based on the subbottom record, is a buried paleochannel feature with horizontal margins within the study area at the far southeastern corner. Because the age of this feature is unknown, it is recommended that it should be avoided by a radius of 1,500 feet around an arbitrary center point at E2218203, N227338, or studied in more detail.

Based on review of available marine resource GIS data sources and review of the collected sidescan records, there is not likely to be any hardbottom habitat within the borrow site survey area. Based on coordination with the United States Army Corps of Engineers, Charleston District, following completion of the remote survey, no further investigation is deemed necessary. Review and concurrence with the National Marine Fisheries Service, Charleston Office, is required to conclude consultation on this Essential Fish Habitat resource type.

In a letter received on the draft report from the South Carolina Institute of Archaeology and Anthropology on 12 August 2013, Mr. James Spirek, State Underwater Archaeologist, concurred with the above findings. The agency did, however, request that any inadvertent discovery of potential archaeological materials, i.e., wood structure, prehistoric lithics, ceramics, etc. during dredging operations cease from that area until inspections may reveal the source of this material. Further, the agency had no objections from a submerged cultural resources viewpoint for dredging to occur within the proposed borrow area.

TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF ACRONYMS

ARCOOP	Archaeological Research Cooperative
AWOIS	Automated Wreck and Obstruction Information System
calybp	Calibrated Years Before Present
DC&A	Dial Cordy and Associates Inc.
DGPS	Digital Global-based Positioning Software
GIS	Geographic Information Systems
GPS	Global-based Positioning Software
LGM	Late Glacial Maximum
MSK	Minimum-Shift Keying
MST	Marine Sonic Technology
MWP	Meltwater Pulses
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Panamerican	Panamerican Consultants, Inc.
PIDBA	Paleoindian Database of the Americas
RNC	Raster Navigation Charts
ROW	Right of Way
SEAMAP	Southeast Area Monitoring and Assessment Program
SOW	Scope of Work
SCDAH	South Carolina Department of Archives and History
SCIAA	South Carolina Institute of Archaeology and Anthropology
US	United States
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
ybp	Years Before Present

1.0 INTRODUCTION

Dial Cordy and Associates Inc. (DC&A), through their DCA/GEC A Joint Venture LLC, was contracted by the United States Army Corps of Engineers (USACE), Charleston District to perform a remote survey of the proposed sand borrow site located offshore Edisto Beach, Colleton County, South Carolina (Figure 1). The purpose of this study was to identify magnetic and or sonar anomalies that may represent historic or prehistoric resources that would affect use of the survey area as a proposed source of sand for storm and hurricane damage protection along Edisto Beach. A secondary project purpose was to identify, map, and characterize any hardbottom habitat based on analysis of sidescan sonar records and, if found, confirm by towed video. The data compiled during this study will be used to refine the borrow area footprint for use and to avoid or minimize impacts to cultural and/or biological resources. This information is required to comply with Section 106 of the National Historic Preservation Act of 1966, as amended (PL 89-665); the National Environmental Policy Act of 1969; the Archaeological Resources Protection Act of 1987 as amended; the Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties (36 CFR Part 800); the Abandoned Shipwreck Act of 1987; and for hardbottom resources the Magnuson Stevens Fisheries Conservation and Management Act. The Scope of Work (SOW) for this task order is provided in Appendix A.

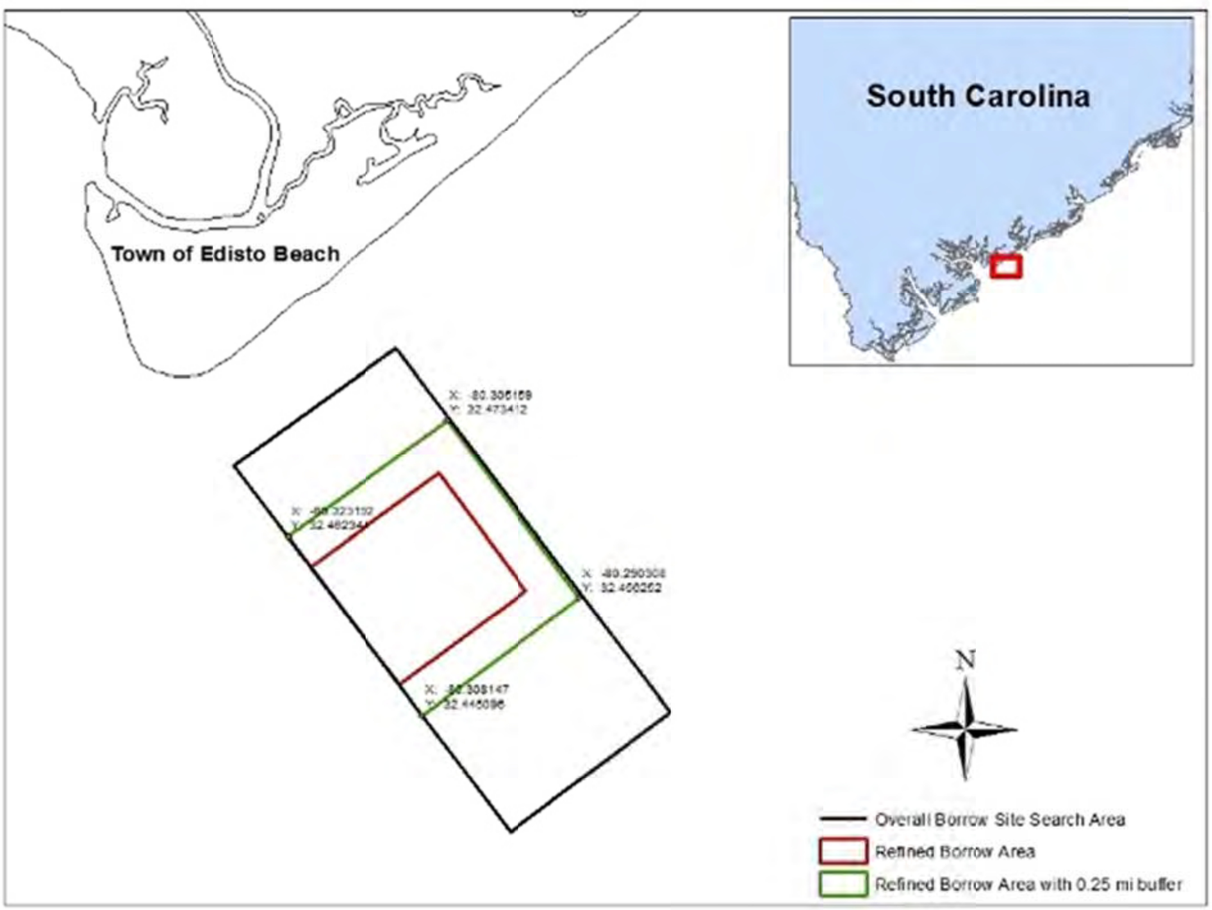

Figure 1. Edisto Beach Remote Survey Location Map

In order to assist the USACE, Charleston District, with meeting compliance requirements, DC&A along with Panamerican Consultants, Inc. (Panamerican), of Memphis, Tennessee conducted a comprehensive submerged cultural and hardbottom resources investigation of the Edisto Beach borrow area in response to the USACE's SOW entitled *Hardbottom and Cultural Resource Surveys of the Edisto Beach Offshore Borrow Site, Edisto Beach, South Carolina*. The area surveyed for the proposed borrow site, including a buffer area, was 1.25 nautical miles by 1.13 nautical miles within the area coordinates listed in Table 1 below and shown in Figure 1. This report includes sections pertaining to Historic and Prehistoric Overview, Methods employed, Investigative Findings, Conclusions, and References used.

Table 1. Edisto Beach Borrow Site Survey Area Coordinates.

Boundary	X	Y
North Corner	80.305159	32.473412
South Corner	80.308147	32.445096
East Corner	80.290308	32.456252
West Corner	80.323192	32.462344

Coordinates in NAD83 South Carolina State Plane East U.S. Survey Feet.

2.0 PREHISTORIC AND HISTORIC OVERVIEW

Divided into three major sections, this background narrative is written to present information relevant to surveying for and identifying prehistoric and historic submerged cultural resources in the form of prehistoric archaeological sites and shipwreck sites. In the first section, the geologic setting and local sea level history are described in order to reconstruct paleoenvironmental and paleolandscape conditions of the Project Area in order to better understand past paleolandscapes in the Project Area. Next, a cultural historical narrative is presented that describes the evolution of human occupation of the Project Area as it progressed from the late Pleistocene through the early Historic periods. In this case, Paleoindian through Late Middle Archaic prehistoric culture groups were around while the survey area was subaerially exposed. Last, the navigation history of the area is presented to establish the type, frequency, and time periods of expected shipwreck sites.

2.1 Paleoenvironmental Setting

2.1.1 Geology

The Edisto Beach borrow survey area is located offshore the modern South Edisto River, South Carolina; one of several tide dominated drainage channels and passages between barrier islands in the center of a large, curved, embayment called the Georgia Bight that stretches from Myrtle Beach, South Carolina in the north to St. Marys River, Florida in the south (Figure 2). To the west, along the coast, are a series of drumstick barrier islands, and their marsh land lagoons that first formed about 40,000 years ago with higher sea levels and then again over the last 6,000 years with Holocene sea level rise and continental shelf transgression (Booth et al. 1999). The survey area is 1.2 to 2.7 statute miles (1.9 to 4.3 kilometers) offshore in 3 to 15 feet of water (1 to 3 meters), on the "inner" shelf. To the east and extending offshore, a large expanse of continental shelf gradually slopes to the shelf break located 75 statute miles (120 kilometers) offshore, where coastlines were at full glacial times.

The Georgia Bight is referred to as a "passive" continental margin meaning that it is not tectonic or isostatically influenced, although evidence for isostasy farther from the ice margins than expected seems to be gaining consensus—even as far south as the Project Area in South Carolina (Baldwin et al. 2006; Colquhoun et al 1995;6). The Georgia Bight is the result of "paleo-

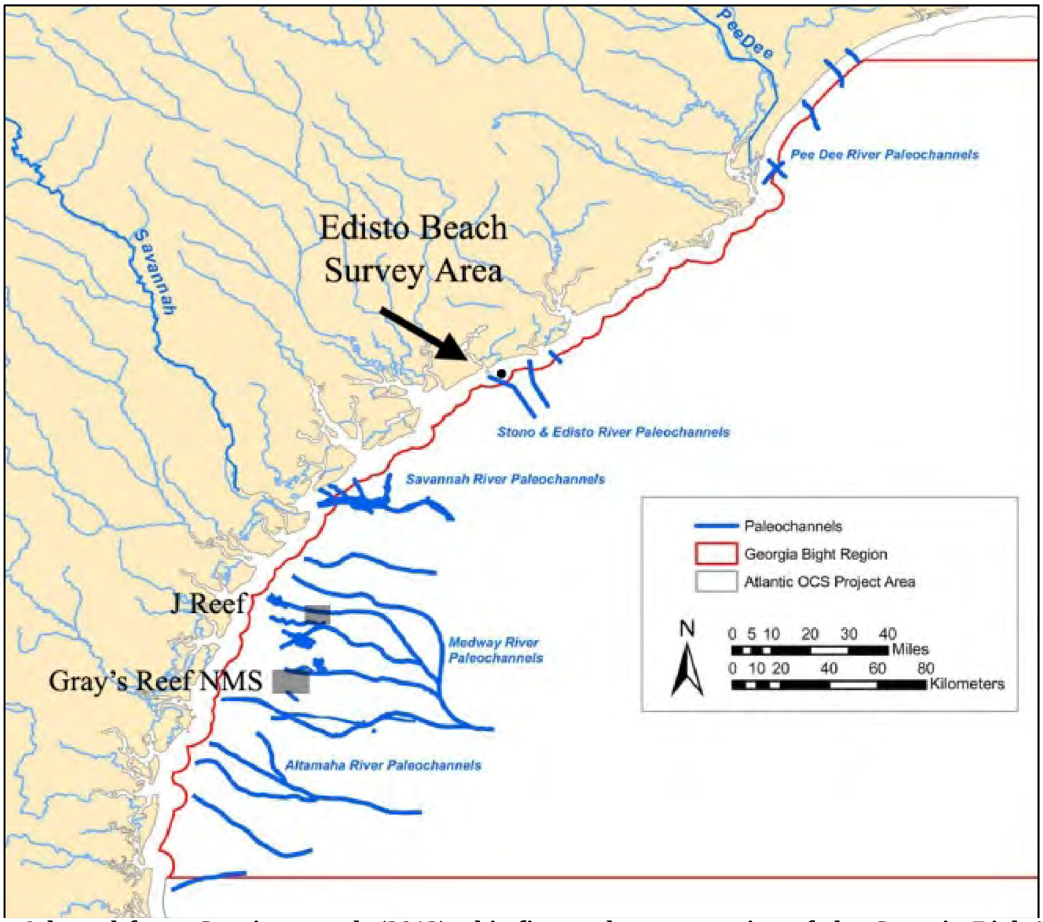

Figure 2. Adapted from Garrison et al. (2012), this figure shows a portion of the Georgia Bight's known paleochannels, J Reef and Gray's Reef, and the location of the Edisto Beach survey area.

oceanographic processes" (Garrison et al. 2012:109) which is to say regression and transgression over several cycles of glaciation and deglaciation; exposing, then flooding, and creating patterned paleolandscape settings formed from reworking and development of marine derived and terrestrially derived sediments. These glacial-interglacial "couplets"—11 over the past 2.8 million years—are caused by Earth orbit parameters (Emiliani et al. 1975), but it is only the last, "Flandrian," latest Pleistocene-early Holocene melting of huge expanses of glaciers and concomitant transgression of the continental shelves by rising sea levels that is of concern for this Project Area. This is because the earliest vestiges of human occupation of the region, outlined below, are constrained to these times. Basically, glacial melting started globally about 17,000 calibrated years before present (calYBP), slowed substantially by 6,000 calYBP, and has fluctuated in relatively minor ways (geologically) since. Sea levels for this project are discussed in more detail below.

The continental shelf of the Georgia Bight is covered with a significant amount of transgressive lag deposits in the form of a marine sediment bed drape. Ravinement (erosion) is dominant during transgression, meaning that terrestrial deposits are truncated and redeposited into marine dominated sediments with sea level rise.

Much of the Georgia Bight is covered with a 1- to 2-meter (thin) veneer of sandy sediments (Harris et al. 2005; Garrison et al. 2012). These are the "… eroded relicts of earlier subaerial coastal landforms characterized by dunes, wetlands, coastal rivers and forest much like today"

(Garrison et al. 2012:109). These sediments have been reworked within the sand and shell marine dominated sediments that form the "palimpsest sand sheet" that blankets the continental shelf. This sand sheet is also reworked and moved by bottom currents generated by storms, tides, and wind depending.

These large areas of sand offshore are interspersed with rocky outcrops of "harbottom" (Garrison et al. 2012:111) that are Miocene- and Pliocene-aged limestones scattered as erosional remnants, ledges, and "ramps." Some of these features indicate weathering in subaerial (exposed) conditions, including evidence for stream erosion and karst formation (Garrison et al. 2012:111). Notches in the Pliocene-aged Raysor Formation at the 20-meter isobath, indicate a still stand, but its age of formation is unknown. These limestone outcrops are the main geomorphic features that occur in the Georgia Bight, some having live bottoms like Gray's Reef and J Reef shown in Figure 2, indicating sustained exposure of the outcrop.

Other geomorphic features more relevant to the Edisto Beach study area include Pleistocene - and Holocene-aged shoal complexes made up of silt to gravel-sized sediments of terrigenous origin, abundant shell, and areas of dispersed peat (Sexton et al. 1992). The seaward relief of these features can be steep, with the near-coastal portions less of a slope. The shoal complex seaward of the Santee/PeeDee Delta is the largest—a deltaic deposit with shore parallel scarps that are evidence of pause or still stand during Holocene sea level rise. The islands are supposed to be migrating along with sea level rise, but abandoned examples could be expected given the magnitude and rapidity of some sea level rise estimates.

Sources of terrigenous sediments are the rivers draining the coastal plain, including reworking from previous high stand materials as parent materials for subaerial pedogenesis and landforms, with reworking again with Holocene transgression. Sediment packages build up in the lagoon on the lee side of the islands, and if those were preserved offshore, they could be expected to retain stratigraphic integrity and be at or near locations of human activities and refuse.

Drowned coastal stream and river paleochannels occur, but most are truncated and buried under the sand sheet drape such that they are not usually apparent on the surface in the bathymetry (Figure 3). Therefore, they cannot be adequately remotely sensed with bathymetric or sidescan sonar devices; rather, they need be remotely sensed with seismic subbottom profiler devices (Baldwin et al. 2006). Studies by Garrison et al. (2008) and others (Baldwin et al. 2006; Harris et al. 2005) confirm that these paleochannels are buried, albeit shallowly, under the reworked marine sediment drape cover (Garrison et al. 2012). Baldwin et al. (2006) used a dense pattern of subbottom profiler lines over great space to reconstruct and offer ages for the paleochannels offshore South Carolina.

Figure 2 above shows the Garrison et al. (2012) compilation of Geographic Information System (GIS) data for the Paleo-Altamaha, Paleo-Savannah, and Paleo-Meway rivers offshore Georgia, and the Stono-Edisto and Pee Dee paleochannels offshore South Carolina. Several generations of the ancestral Pee Dee River system have been mapped beneath and along the coast and inner continental shelf revealing a complex pattern of paleochannels of different ages (Baldwin et al. 2006). Figure 2 also shows the location of the Edisto Beach study area. The Investigative Findings chapter of this document reports another channel segment vestige or segment.

During sea level low stands, drainage valleys are shallowly incised into the continental shelf and backfilled with various sediment types, depending on local conditions and sea level rise and fall rates. Paleovalleys have backfilled during cyclic changes in sea level with sediment types ranging from estuarine muds to clean shelly sands (Harris et al. 2005 in Garrison et al. 2012:116). Quaternary paleochannels tend to be filled with muds, sandy muds, and muddy

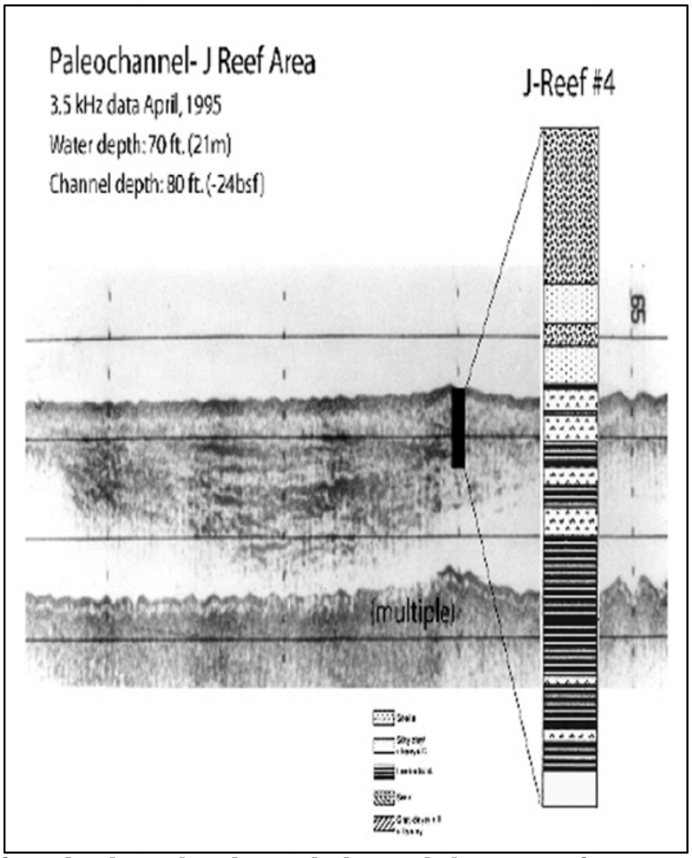

Figure 3. An example of a paleochannel underneath the sand sheet cover from Garrison et al. (2008) that is analogous to the paleochannel feature recorded in this survey project.

sands; whereas, tidally scoured paleochannels general contain clean shelly sands (Harris et al. 2005:511). Prior to 7,000 years ago, the islands would have been part of the mainland, hill-like ridges with valleys in between with tributary gullies cutting into the hills (Figure 4). The marshes surrounding the Project Area would have been dryer swales. In a similar way, Garrison and Tribble (1981) model the paleolandscape of the marshland during the late Pleistocene-Early Holocene as grassland and savannas with non-tidal perched streams and possible spring connections. If these spring locations could be identified, there may be archaeological remains around them.

The age of a peat bed marking coastal marsh at Cracker Tom Marsh on St. Catherine's Island, Georgia was around 6,800 calYBP (Booth and Rich 1999; Rich and Booth 2011:134). But in the coastal plains of the Project Area, archaeological sites are lacking in this middle Holocene (and earlier) age frame (Turck et al. 2011). Sites earlier than 6,800 calYBP are either missing or possibly located in buried stratigraphic units buried by later Holocene transgression and sedimentary processes, or in areas offshore that have been submerged. An exposed paleolandscape setting 28 feet below the river water level found in a St. Augustine River study area confirms the potentials for this kind of buried archaeology. The radiocarbon age of an in-place stump there was 8,100 calYBP (7300 +/- 40 YBP; Beta 36234; James et al. 2012).

The earliest Holocene salt marsh in this newly submerged area, recently discovered at a location along the southwestern edge of St. Catherine's Island, has been radiocarbon dated to 4,060 ± 50 YBP [shell, United States Geological Survey (USGS) #WW1262]. This provides the best available indication of when the island became isolated from the mainland (Booth et al. 1999:84) and probably the age at which the Edisto Beach study area was completely submerged.

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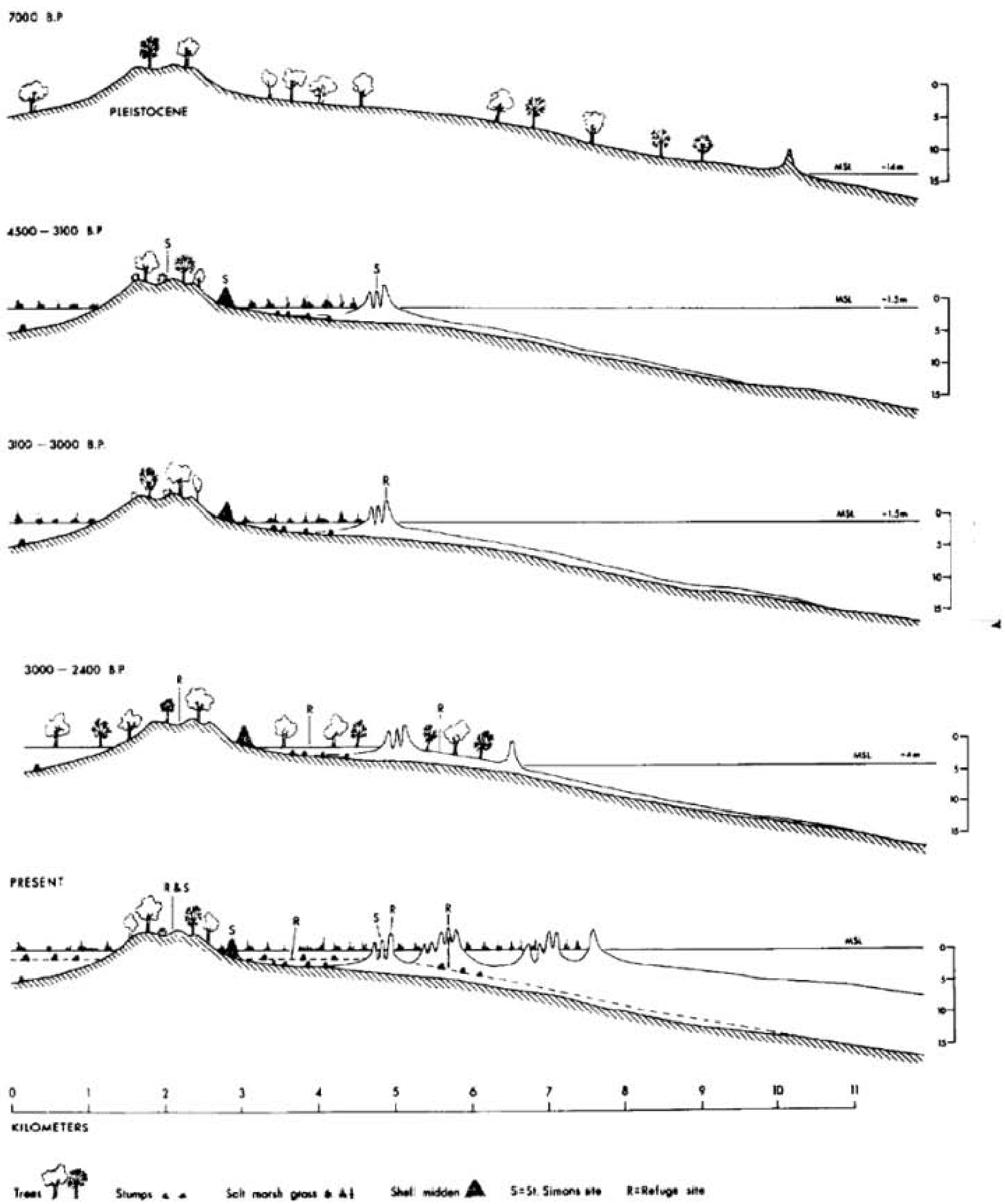


FIG. 2.—Schematic cross-section showing changes in coastal morphology and sites of Indian occupation on the Georgia coast from 7000 B.P. to present. This reconstruction is a composite of data gathered along the whole Georgia coast. The profile, however, is based on the area immediately south of the Savannah River where maximum shoreline progradation has occurred.

Figure 4. Conceptual drawing of the different land forms that the islands had at different stages of the transgression, including a proposed regression (as presented in DePratter and Howard 1981:1293:Figure 2).

The configuration of the survey area appears to be a paleobarrier feature transgressed by late Holocene sea level rise. Paleochannel margins, of late Pleistocene early Holocene age, are prime locations for submerged pre-Contact archaeological sites and barrier-marsh coastal systems are likely draws to humans for a variety of resources.

2.1.2 Sea Level History

As alluded to above, global sea levels have fluctuated over the past 2.8 million years during 11 cycles of glacially driven advancements and retreats of sea levels across the continental shelves of the world (Emiliani 1975). The last full extent of glaciers, known as the Late Glacial Maximum (LGM), occurred at 26,500 and 19,000 calYBP, resulting in coastlines 100 meters or more lower in elevation than today. At that time, global eustatic (glacially controlled) sea levels fluctuated at the continental shelf break 100 kilometers (65 miles) from the survey area.

Sea levels have been rising continuously since 17,000 calYBP (Table 2 and Figure 5), but this continuous melting has been punctuated by three significant Meltwater Pulses (MWP 1a, 1b, and 1c; Blanchon 2011; Blanchon and Shaw 1995). These pulses indicate major rapid ice events resulting from ice sheet collapse (Blanchon and Shaw 1995) as well as sources of displaced populations retreating from the high water during storm front and other erosional processes (Waters 1992).

Blanchon (2011) has published recently on the magnitudes and rates of these three MWPs as estimated from drowned corals around the world: MWP 1a is estimated to have been 13.5 meters of sea level rise over 290 years at 14,600 calYBP (12,600 YBP); MWP 1b was a 7.5-meter rise of sea level in 160 years at 11,400 calYBP (10,000 YBP); and MWP 1c is a recent addition to the reconstruction of glacial melting that is estimated to have occurred at 8,000 calYBP (7,200 YBP) with 6.5 meters of sea level rise in less than 140 years at 8,000 calYBP.

Marine terraces are markers of paleoshoreline still stands of sea level at times of relative stability or stasis. Several paleoshorelines occur above today's coastline and Clovis or Younger Dryas shorelines have been identified in the Gulf of Mexico (Faught and Donoghue 1997) and the North Atlantic Bight (Nordjford 2006). In general, terraces are "bounded by a steeper ascending slope on the landward side and a steeper descending slope on the seaward side. Due to its reasonably flat shape, the terrace is often used for anthropogenic structures like settlements and infrastructure." Drowned shorelines can be locations of prehistoric archaeological sites, although the potential for truncation and reworking is high. Apparently there is no scarp-like feature in the Georgia Bight to correlate with these.

Local geologic conditions, proximity to the weight of the glaciers, or other factors can affect the relative apparent local sea level. This is especially true for the coastal portions of the Georgia Bight, in those areas of the inner lagoonal systems (Colquhoun and Brooks 1986; Colquhoun et al. 1995).

The survey area is 1.2 to 2.7 statute miles offshore in 3 to 15 feet of water. Table 2 shows that this area would have been subaerially exposed through all three MWPs and probably submerged between 5,500 and 4,500 calYBP (5,000 and 4,000 YBP).

Relative sea levels have fluctuated along South Carolina's coast after 6,000 YBP as sea levels began to affect the modern barrier islands. DePratter and Howard (1981) and Colquhoun and Brooks (1986) have shown a high stand and subsequent regression that Gayes et al. (1992) constrained between 5,300 and 3,600 YBP (Colquhoun et al. 1995). These fluctuations are shown

Table 2. Characterization of Late Pleistocene and Holocene Transgression Sequence, Magnitude and Rates.*

Time Period (YBP)	Description
Late Glacial Maximum 26,500 to ~19,000 calYBP Melting begins 17,000 calYBP Meltwater Pulse 1a 14,600 calYBP 13.5 meters in 290 years	Full glacial conditions, sea levels at maximum lowering and full exposure of the continental shelf offshore 120-60m. Glacial melting begins after 14,000 with a major pulse of melting at 14,600 calYBP (Blanchon 2011) at a rate and magnitude of 13.5 meters in 290 years. Almost half of the total glacial melting occurred between MWP 1a and MWP 1b. Sea levels rose somewhere between 40- and 60-meter isobaths depending on regional particulars (Balsillie and Donoghue 2004; Lowery et al. 2012; Siddall et al. 2003).
Younger Dryas (YD) 13,000 to 11,400 calYBP Reduction in melting	Younger Dryas return to glacial conditions. The abrupt initiation of climate change is absolutely coterminous with the appearance of Clovis Paleoindian cultural groups.
Meltwater Pulse 1b 11,400 to 9,000 calYBP 7.5 meters in 160 years	Dramatic glacial melting occurred a second time known as MWP 1b. Early Archaic cultural time frame.
Meltwater Pulse 1c at 8,000 calYBP 6.5 meters in less than 140 years	MWP 1c is the last pulse of meltwater.
After 5,000 less than 5 m below today, fluctuations	High and low stands proposed

*From Blanchon 2011

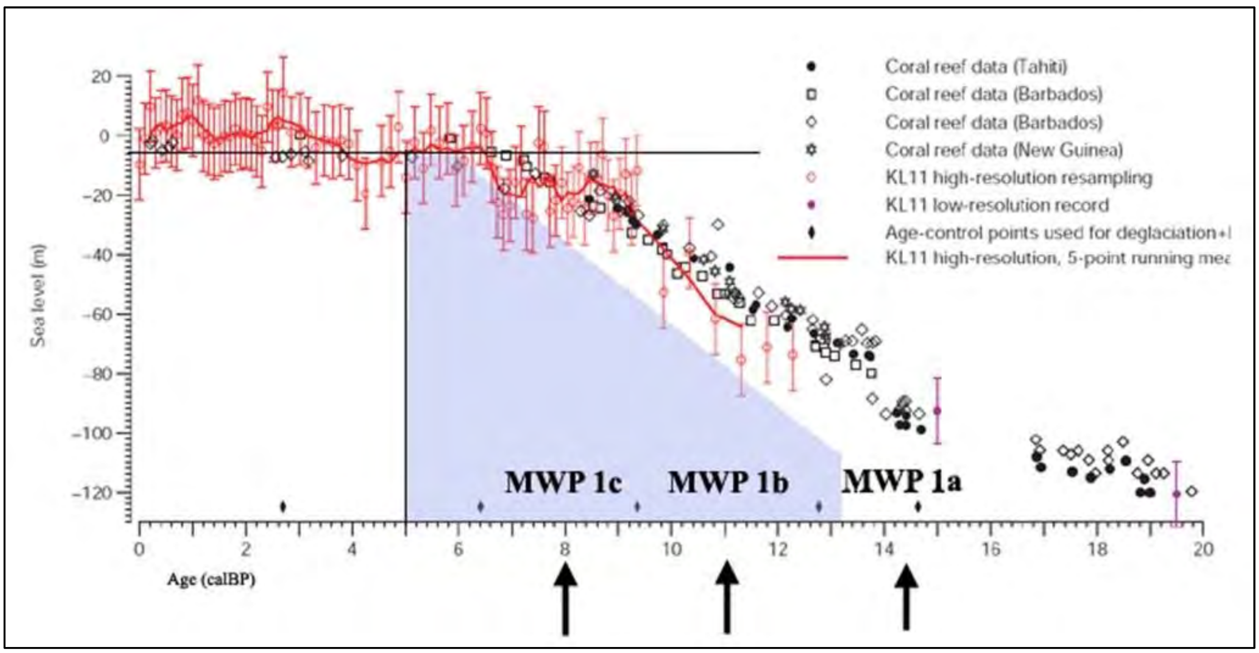


Figure 5. Global eustatic sea level curve from Siddall et al. (2003) with Blanchon (2011) chronology of MWPs 1a, 1b, and 1c shown. The horizontal line represents the survey area depths, indicating submergence after 5,000 calYBP.

in the sea level curve in Figure 6 and they have been reconstructed using archaeological site distributions in combination with other radiocarbon evidence. The implication is that the study area was terrestrial before 8,000 calYBP and probably near coastal after that, until submergence between 5,000 and 4,000 YBP.

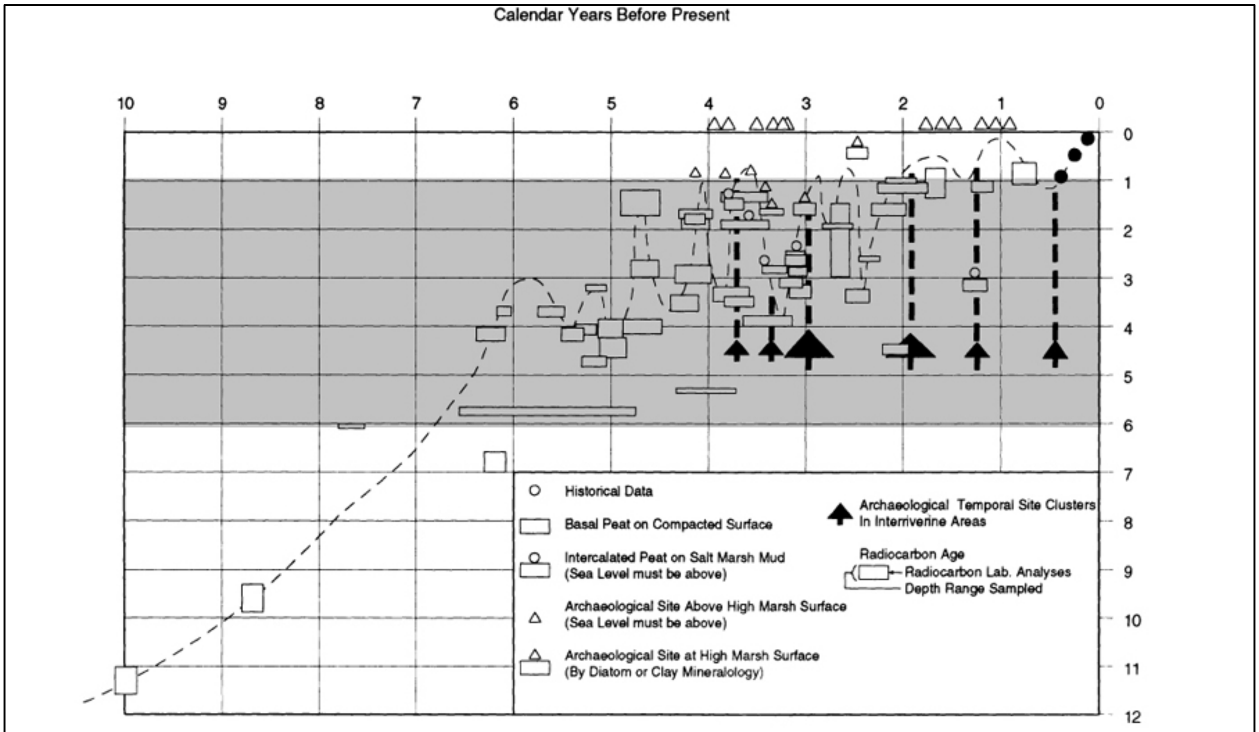


Figure 1. Historic and Holocene high marsh and estuarine associated archeologic sea level indicators relative to the present high marsh surface, South Carolina coastal zone (after COLQUHOUN and BROOKS, 1986).

Figure 6. Fluctuating sea level curve for South Carolina from Colquhoun et al. (1995) relevant to the Project Area showing depths recorded in the Edisto Beach study area. The implication is that the study area was terrestrial before 8,000 calYBP and probably near coastal after that, until submergence between 5,000 and 4,000.

2.2 Prehistoric Context

2.2.1 Paleoindian and Early Archaic Culture Groups

The chronological and spatial distributions of archaeological sites in the local area inform on when and where sites might be located offshore in the Edisto Beach survey area, whereas the cultural material assemblages and diagnostic artifacts inform on the chronology and cultural historical group encountered.

Given the details described above in the sections on Geology and Sea Level History, the time-use-range of the survey area when it was subaerial would include latest Pleistocene pre- or proto-Clovis Paleoindians, Clovis and later lanceolate using Paleoindians, and early Holocene, Clovis related notched point making people until about 9,000 calYBP, as well as Middle and possibly early Late Archaic people.

Pre- or perhaps we might say “proto-″ Clovis sites are proposed at Mile Point in Maryland, Topper in South Carolina, Page Ladson in Florida, and, even though far away, Buttermilk Creek in Texas (Dunbar 2006; Lowery et al. 2010; Waters et al. 2011). Theoretically, sites of these ages (pre-13,000 calYBP) could have existed all the way out to the shelf break/LGM coastline, where at least one artifact and some megafaunal remains have been discovered (Lowery et al. 2010), and human activities could be represented around the survey area if it offered resources or topography conducive to human presence.

Regardless of whether there are pre-Clovis sites in the Southeast or not, this region (the Southeast) has produced the most abundant numbers of diagnostically early artifacts (fluted and unfluted lanceolates) of anywhere in North America. These data indicate Clovis Paleoindian intrusion sometime in the late Pleistocene, settling in the Early Holocene, and shared lithic reduction strategies and artifact assemblages that indicate survival and cultural continuity well into middle Holocene time and therefore, in a general sense, very likely to have had forays on and around the Edisto Beach study area (Anderson et al. 1996; Kimball 1996; Ledbetter et al. 1996; Sassaman 2010).

Figure 7 shows contours of the frequency of fluted and unfluted lanceolates contoured in Surfer (at 2 points per interval), using data with county level positioning data from the Paleoindian Database of the Americas (PIDBA) that can be found online. The filled circles in Figure 7 represent the locations of sites with diagnostics, stratigraphic exposures, age estimates of 9,000 calYBP (8,000 YBP) or older, or some combination of all of the above, especially those described by O'Steen (1996) and Ledbetter et al. (1996).

Three time frames have been estimated to date the Clovis and Clovis-related projectile point types that, if found, would be diagnostic: Early Paleoindian fluted lanceolate points forms (ca. 13,000 to 12,700 calYBP); Middle Paleoindian fluted and unfluted lanceolates such as Cumberland, Suwannee, Simpson, Quad, and Beaver Lake (ca. 12,700 to 12,500 YBP), and finally, Late Paleoindian incipient corner- and side-notched forms like Dalton, Greenbriar, Hardaway Side Notched (ca. 12,500 to 11,400 YBP; Anderson et al. 1990:6-9; 1996:7-8).

Even though the evidence is rare in the Southeast, and the degree to which hunting megafauna contributed to Paleoindian subsistence is assumed rather than confirmed, the remains of extinct Pleistocene animals have been found in submerged contexts that are indicative, potentially, of co-existence with early human populations and in contexts when sea levels were lower. For instance, in Florida, a Bison antiquus skull with an embedded projectile point fragment was found in the Wacissa River as well as other evidence of association (Webb et al. 1984). Dunbar and Webb (1996:333-350) have reported several worked mammoth, mastodon, and horse bones as well as carved-ivory implements made from mammoth tusks, presumably while the ivory was still in a green state. Wright (1976:319) reported remains of *Mammut americanum* dredged up at the Surfside Springs site in South Carolina, as well as *Bison*, *Cervus*, and *Ursus* from the deposits that also contained two bifacially modified artifacts (see Goodyear et al. 1989:6).

Closer to the study area, a proximal fragment of a proboscidean rib was found on Edisto Beach, apparently from a submerged context (Goodyear et al. 1989:9). One edge of the rib displays a fairly continuous series of grooves or incisions that are proposed to have been produced by human action.

While the degree to which megafauna contributed to Paleoindian subsistence in the Southeast remains conjectural, it is certainly agreed that post-Paleoindian, post-late Pleistocene, Early Archaic, and early Holocene assemblages indicate a wide range of activities including exploitation of local mammals and birds such as found at Dust Cave in northern Alabama; as modification with the makers of fluted points almost 2,000 years earlier. Any coastal adaptations would be located on the outer continental shelf, well away from the survey area.

Figure 7. A composite of ARCOOP (Archaeological Research Cooperative) data of archaeological sites earlier than 9,000 calYBP (black dots) and distribution of Paleoindian lanceolates contoured from PIDBA data. Note the cluster of late Paleoindian and Early Archaic sites up the Savannah and Pee Dee rivers.

Diagnostics from a pan-regional sequence of early Holocene Early Archaic projectile point traditions that cover two millennia (11,400 to 9,000 calYBP) would represent a means of determining the chronology and cultural association of a submerged prehistoric site or isolated find from the dredge material. This early group includes the Side-Notched Tradition (11,400 to 10,500 calYBP), Corner-Notched Tradition (10,500 to 10,200 calYBP), and the Bifurcate Tradition (10,200 to 9,000 calYBP), although the latter is more common to the north (Elliott and Sassaman (1995:21 26).

Inspection of the Georgia Bight coastal areas in Figure 8 shows that diagnostics and early sites have been found most frequently inland, along the Savannah River between Georgia and South Carolina and in the Oconee River behind the Wallace Dam. The best stratigraphic sequence is 9GE309, which is located on the alluvial plains of the Oconee River (Ledbetter et al. 1996:272; O'Steen 1996:99-100). Excavations revealed that the bottom-most deposits contained Clovis

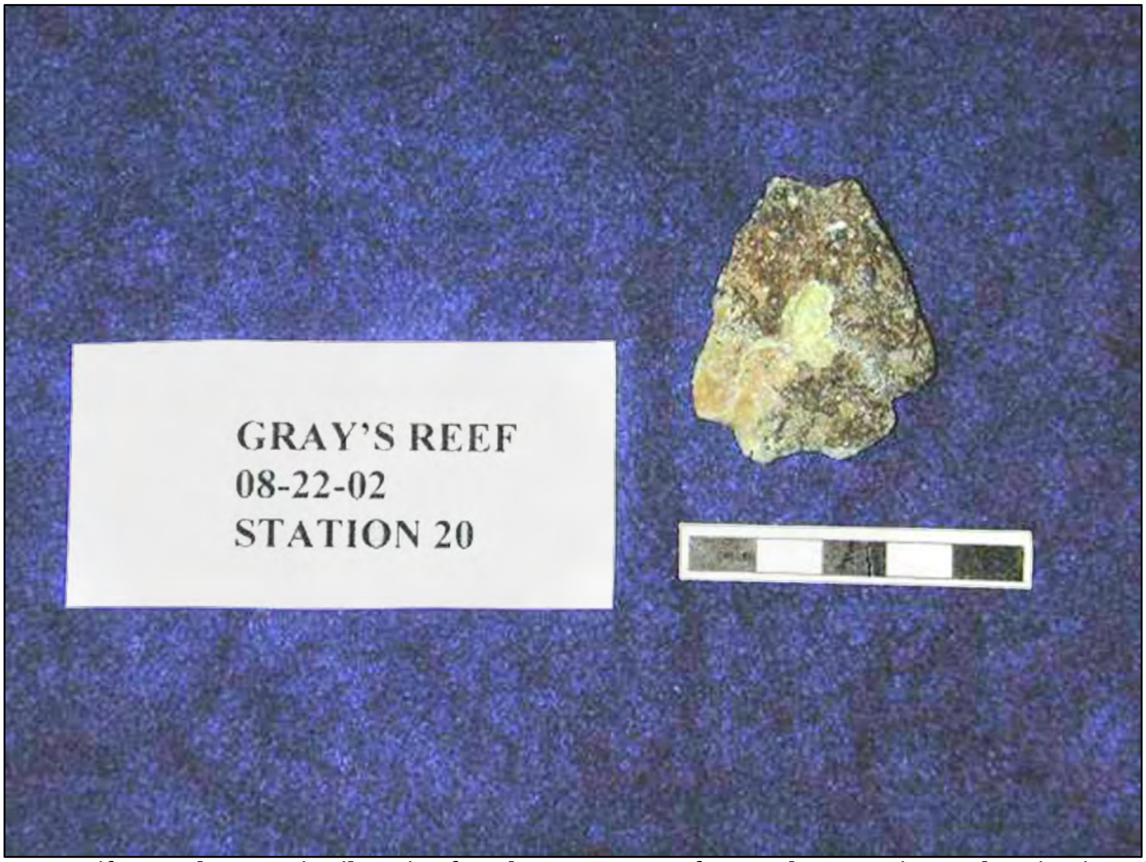


Figure 8. Bifurcate base projectile point found at Gray's Reef, note the corrosion and patination of the surface of the material from exposure to the saltwater environment (photo courtesy of E. Garrison; scale in centimeters).

points while overlying strata yielded artifacts from earliest to latest in stratigraphic order: Clovis; Dalton/Big Sandy; Kirk Corner Notched; Bifurcates; and Kirk Stemmed varieties.

Examples of any of these diagnostics could have been left in the Edisto Beach survey area in the past, when it was in a terrestrial configuration. A fluted biface was found underwater at Ossabaw that confirms this proposal (Ray 1986), as do the discoveries of ivory tool fragments and bifurcated projectile points made at Gray's Reef, indicating human presence. The Ossabaw artifact has been designated as a "Clovis" point, but it is more consistent as a fluted biface preform. It would appear from the current state of knowledge that Paleoindian and Early Archaic sites do not occur in the coastal areas of South Carolina. However, it is a potential problem that the sites are there, but buried by more recent sediments in the coastal plain and marshlands and have yet to be discovered.

2.2.2 Middle and Late Archaic Groups

The Middle Archaic in Georgia may be demarcated by the appearance of stemmed projectile points rather than notched or bifurcate base varieties (Chapman 1985:148), but the extremely low numbers of Middle Archaic sites known from the coast seem to indicate low probabilities for these sites in the inland waterways and marshes, unless they are buried by sedimentation.

Archaeological sites increase in great numbers on barrier islands in Late Archaic time frames after 5,000 calYBP, when evidence shows people exploiting a rich variety of resources in the marshland estuaries, particularly shellfish and other aquatic resources. Slightly earlier sites of these culture groups could be submerged in the Edisto Beach survey area because the environments they utilized occurred out there and then migrated inland, retreating from the rising coastline.

2.2.2.1 Middle Archaic

The Middle Archaic can include demarcation by the appearance of stemmed bifaces (Chapman 1985:148). The earliest Middle Archaic hafted biface types of this genre are the Kirk Stemmed, Kirk Serrated, and Stanley Stemmed types. On the other hand, Morrow Mountain projectile points are clearly one of the better known Middle Archaic stemmed points recovered from the South Atlantic Slope. Sassaman and Anderson (1995:24) reviewed a series of radiometric assays associated with various Morrow Mountain contexts in Tennessee, Alabama, Georgia, and South Carolina. The date estimates ranged from approximately 7,500 to 5,500 YBP, well within the range of Later Middle Archaic points that are found in the Coastal Plains of the region including the Guilford-related Brier Creek type. Sassaman and Anderson (1990:153) indicated that Brier Creek was possibly a Coastal Plain version of Guilford. They described a stratigraphic sequence at the Pen Point site in the Savannah River in which Brier Creek was found in a context lying above Morrow Mountain and below Savannah River Stemmed. Elliott and Sassaman (1995:34) suggested Guilford dates ranging from 6,000 to 5,000 YBP. They also mentioned the presence of other presumably coeval types resembling the closely related Sykes, White Springs, and Benton types. These varieties could be useful diagnostics if found in offshore contexts.

Sassaman and Anderson (1995:149) pointed out that Middle Archaic sites are not very abundant in the South Atlantic Coastal Plain. Inasmuch as a vegetation or ecotone shift related to sea level rise may have occurred during this period in which pine expanded at the expense of oak, some researchers have suggested that the pine-rich forests were not as productive and therefore less attractive for human exploitation. Be that as it may, there is sufficient evidence of Middle Archaic activities in the region to conclude that the Coastal Plain was not completely abandoned. If there were more cores in the marshes, we might have a better control on the development of the marshes as sea levels approached today's levels. Likewise, the ecotones of interest to the prehistoric inhabitants may have existed farther offshore, with slightly lower sea levels.

2.2.2.2 Late Archaic

The earliest archaeological sites along the Georgia Bight barrier islands date to about 4,000 years ago, when evidence shows people exploiting a rich variety of resources in the marshland estuaries, particularly shellfish (Turck et al. 2011). Three types of Late Archaic sites have been identified that might be used for modeling the kinds of sites expected in the Edisto Beach study area: (1) scattered sites along marsh edges and bluffs (including those not bearing substantial shell accumulations); (2) marsh shell middens; and (3) shell rings (Waring 1968). Shellfish collecting also appears to have been an important activity in riverine settings, particularly along the Savannah and Ogeechee rivers (Elliott and Sassaman 1995:143). Other common diagnostic artifacts include net sinkers, steatite vessels, and shell ornaments. In addition, there were weir features and other technologies for aquatic and avian resources (Elliott and Sassaman 1995:38-38). These features could be expected in the study area in intact situations.

Crook (2007) has described research at the Bilbo Site (9CH4) in Savannah that indicates evidence of a pile-dwelling and shell midden during the late middle Holocene about 4,000 to 3,000 YBP. Crook argues that pile dwellings "…were a central feature of the cultural adaptive system, allowing settlements to be located in wetlands that provided optimal access to the evolving food resources of multiple, dynamic environments" (Crook 2007:223). One of these may have been located in the Edisto Beach study area (described in the *Sidescan Sonar Results* section below).

There is little potential for Woodland period or later culture groups in the Edisto Beach study area and therefore no need to continue describing the local prehistoric background.

2.2.3 Potential For Submerged Prehistoric Sites

As Garrison et al. (2012) point out; the potential for sites offshore is directly related to the presence of more recent quaternary age strata, which are most often significantly eroded. Sediment packages can build up in the lagoon on the lee side of barrier islands, and if those were preserved offshore, they could be expected to retain stratigraphic integrity and be at or near locations of human activities and refuse.

The margins of paleochannels and terraces are prime locales for submerged prehistoric sites, and it is known that paleochannels can be preserved offshore (Figure 9). On the other hand, paleochannels are not perceivable by bathymetry because of the marine sediment cover, indicating that seismic (subbottom profiler) remote sensing is a critical tool for site survey and prediction (Garrison et al. 2008).

Figure 9. Cover of Thomas (2008) showing Native Americans along Georgia's coast and the array of features and structures they had built for catching, processing, and preserving marshland fauna. These kinds of features can be preserved offshore given local preservation parameters.

2.3 Historic Context

The Project Area, located just offshore the South Edisto River Inlet, represents a minor maritime approach into and out of the South Edisto River and its tributaries, and to a lesser extent into and out of St. Helena Sound and its tributaries throughout the Historic period. This involved navigating through the often hazardous and constantly changing bars found across the mouth of the Sound. Located between the major commercial maritime ports of Charleston to the north and Savannah to the south, the history and associated maritime economies of the Project Area are in large part tied to these two centers. A historical accounting of these areas is therefore relevant when it comes to a discussion of the Project Area and any potential for historic shipwreck sites.

The initial European contact within the Carolinas took place in 1514, as Luis Vasquez de Ayllon sent an agent to find a source of labor for his plantations in the Caribbean. In 1521, Francisco Gordillo, supported by de Ayllon, sailed along the American coast north of Florida. Although the adventure was unprofitable for Ayllon, he still held hopes of profiting in the region. In 1523, he received a patent from the King of Spain to explore the coast and set up a colony. After an initial reconnaissance in 1525, he fitted out four vessels with over 500 colonists and left Santo Domingo for the Carolinas in 1526 (Edgar 1998:21; Morison 1971:332). The initial landing, suspected near the Cape Fear River, was unsuccessful and they moved south and established San Miguel de Gualdape near the mouth of the Waccamaw River, South Carolina—although some place it at Punta de Santa Elena, which is the sight of modern Port Royal to the south of the Project Area. By 1527, Ayllon was dead and the colony broke up; approximately 150 survivors straggled back to Hispaniola (Coker 1987:2).

Three years after Gordillo's initial Carolina reconnaissance, Verrazano, an Italian from Florence sailing for Francois I, the King of France, left Europe on a voyage to find a route to China in January 1524. His vessel *La Dauphine*, named after the French heir to the throne, was 100 tons and manned by a crew of 50. After a tempest-tossed crossing, he fetched up close to Cape Fear, North Carolina in early March. Verrazano initially coasted south along the eastern coast of present day South Carolina for approximately 100 miles, but then turned north to avoid the Spanish who had dominant control over the Caribbean (as well as Floridian) waters. After some brief reconnaissance along the coast, he continued on his voyage north and eventually returned to France in July. Being a competent seaman and navigator, Verrazano was able to conclude that he did not reach China, but a New World (Morison 1971:314). The French, however, did not follow up on Verrazano's discovery of these lands.

Hernando de Soto explored the southeastern coast starting from north of Florida to the Mississippi River. Part of de Soto's itinerary took him through the sand hills and piedmont region of South Carolina. His travels aided in reinforcing the Spanish claim to the lands north of Florida. In 1559, King Philip II of Spain ordered a settlement be placed at Punta Santa Elena in Port Royal Sound, the best natural harbor in the Southeast (just south of St. Helena Sound and the Project Area). This settlement was to act as a buffer to other encroaching European powers. The settlement was a failure however, as a hurricane destroyed three of the four vessels and 26 of the ~100 men involved in the expedition died (Edgar 1998:22-26).

During 1562, the French sent two more vessels to explore along the Carolina coast. Jean Ribaut took possession of the area in the name of the King of France Charles IX. The original settlement at Port Royal did not survive long, as there was internal dissention and the post was abandoned. The French were not to be discouraged and two years later a second attempt, under Rene de Laudonniere, established a settlement at Fort Caroline, on the St. Johns River in Florida (Coker 1987:3).

The French settlement in Florida was a danger to the Spanish homeward fleets carrying New World wealth to Spain. King Philip II of Spain dispatched Menendez de Aviles to eradicate the problem in 1565. Fort Caroline was taken by a land assault and, after a promise of fair treatment; the defenders were all put to death. The French avenged the treachery three years later when the fort was retaken and all Spanish prisoners were murdered (Morison 1971:470). The Spanish, in an attempt to maintain sovereignty over the region, resettled at Port Royal in 1566. When Francis Drake captured and burned St. Augustine in 1586, the post was abandoned.

Being on the edge of Empire, South Carolina took on a frontier characteristic. The English, late into the colonization lottery, established some New World colonies and concentrated north of Virginia. There were attempts to settle the area between Virginia and Spanish-controlled Florida, but all failed until the 1660s. On March 24, 1663, King Charles II of England granted a charter to eight men to be the "absolute lords and proprietors" of a colony between Virginia and Spanish Florida (Edgar 1998:39). The same year Captain William Hilton, for which Hilton Head Island is named, along with Robert Sanford would explore the Port Royal Sound and identify the area as suitable for a settlement. Prompted by the discoveries, a settlement was begun on the Ashley River on a bluff called Albemarle Point.

The same year, with the aid of the local Indians, the English established their first permanent South Carolina settlement at Charles Towne in 1670. A decade later it was reported that there were between 1,000 and 1,200 residents in town (Coker 1987:8). As Charleston became an English commercial center, advantageously situated just off the Gulf Stream, it attracted a various number of entrepreneurs. Close proximity to the Spanish and French positions in the Caribbean encouraged trade, both legal and illegal. During the early Colonial period, piracy was an activity that was tolerated, if not encouraged; if the intended targets were of the mother country's adversary and there was an advantage to be gained (Ritchie 1986:11-26). Throughout the years, men such as Drake and Morgan were lionized by the English for their activities against the Spanish. In America, New York, Boston, Newport, and Charleston were havens for many pirates (Cordingly 1995:15). Coker (1987:10) states, at Charleston, "The authorities of the fledgling colony were in no position to challenge them. In fact, they may have encouraged these outlaws of the sea, since their booty was scattered around generously." At first, these coastal ports took advantage of the "wealth" created by these individuals. Nevertheless, as frontier status moved inland and coastal ports expanded as economic and cultural centers, attitudes changed. By the end of the seventeenth century, views towards piracy began to change.

English pressure continued to increase on the northern Spanish border as the seventeenth century progressed. In 1680, an attack on the town of Santa Catalina was repelled, but the inhabitants were ordered to pull back to the south, out of attack range. This move may have protected Spanish settlements from English attack, but the Spanish departure also encouraged the Yamasee to revolt under the leadership of Chief Altamaha in 1683. This revolt resulted in a Spanish order to withdraw from the Guale area entirely and into the Spanish territory of Florida. With the Spanish out of Guale and the English coming in from the north out of Charles Towne, some Yamasee moved into central Georgia, while others moved into the interior of South Carolina and Florida (McKivergan and Fryman 1996:70; Coleman 1991:13).

In 1702, European politics spilled over into the colonies when Queen Anne's War (The War of Spanish Succession) erupted in 1702. This war had a devastating effect on Spanish colonial holdings in America. In this war, the Governor of Carolina, James Moore, swept through Guale and into Florida. When the war ended in 1713, most Spanish missions in Georgia and Florida were completely destroyed, as was St. Augustine. Only the fortress at St. Augustine escaped destruction by Moore's force.

Immediately following Queen Anne's War, the Yamasee rebelled against what they felt were unfair trading practices by British traders, despite having, just two years earlier in 1711, fought on the side of the British in the Tuscarora War. This revolt, known as the Yamasee War, was characterized by repeated attacks on English frontier outposts and settlements. Over 400 colonists and an unknown number of Yamasee were killed (Braley et al. 1985:4). Much of this was played out near the Project Area when, after several massacres in Colleton County and across the Edisto River, Governor Craven on Good Friday 1715 dispatched the militia which defeated a band of eight to ten Indian canoes at the southern tip of Daufuskie Island. After the defeat of the Yamasee, the General Assembly of South Carolina opened Indian lands for settlement. With the establishment of Georgia in the 1730s as a defensive buffer between Spanish Florida and English planters in Charles Towne, the Yamasee were permanently relocated with the Spanish in Florida, who then moved some of them to Cuba and Veracruz, Mexico, as slaves, with the exception of a few scattered remnants of the Yamacraw. This signaled the removal of the last significant numbers of native people from the coastal South Carolina area (Divine et al. 1995:58-60; McKivergan and Fryman 1996:70-71).

During this period, the town of Beaufort was founded based on its position to offer commerce in naval stores. With the establishment of the town, and the final 1728 raid against the Yamasee, St. Augustine signaled the beginning of settlement of the coastal lowlands and allowed the emergence of rice cultivation, which would form one of the mainstays for the area's maritime commerce along with Sea Island cotton and naval stores. Free labor was not an option at this time, as it seems that it took the terror of the slave system to compel men and women to accomplish the herculean tasks involved in rice production. The crop had managed to sink its roots into South Carolina, and by the dawn of the eighteenth century, it was well established. In less than 25 years, it would become one of the most important commodities produced in South Carolina. At first, rice had been planted in an upland setting on marshy soil, but in the first half of the eighteenth century, an irrigation method was developed that utilized the swamps so common in the area. Everything about the production of rice was labor intensive and this labor was conducted with nothing more than hand tools; from clearing swamps, planting, and cultivating, to threshing and polishing the rice. Every step involved backbreaking work (Clifton 1978).

In the upland setting, rice could be grown on a small-scale, but its production was not dependable. In the early 1750s, a new technique was developed that utilized the coastal tidal flow to move freshwater in and out of the cultivated rice fields (Clifton 1978). This technique would eventually supplant the upland method, but on the eastern coast it was only a viable option along the river systems south of Cape Fear to the Georgia coast and within 10 to 20 miles above saltwater. To make the land ready for this type of cultivation, a monumental amount of work was required. Generally, as one gang of slaves worked on clearing the area of trees and stumps, another built a large dyke around the area to be cultivated. Inside this enclosed area a smaller series of levees were built to encompass rice fields, usually about 20 acres in size. Canals and ditches were dug with trunk culverts serving as floodgates to control the water flow. Leaving an indelible mark in the maritime economies of the region, the outline of the rice plantation fields can still be seen along the banks of the South Edisto River on Jehossee and Sampson Islands.

By the eighteenth century, piracy became a liability as a national strategy and for colonial commerce as best exampled by the fate of Captain Kidd. Originally under charter with establishment patronage, Kidd was later hung as a pirate in 1701 (Ritchie 1986). Cities that once welcomed pirate loot were soon targets of their predications. The early eighteenth century saw this shift in tactics, and Charleston (formerly Charles Town) was a perfect example of the phenomena. In August 1717, a pirate known as Stede Bonnet plundered a brigantine outside Charleston Harbor (Coker 1987:20). In late 1718, Captain Vane took eight vessels off the coast of South Carolina (Cordingly 1995:111). During the same year, the famous pirate Blackbeard (Edward Teach) plundered many vessels, disturbing much trade. Blackbeard then disbanded his pirate fleet off the coast (Coker 1987:18; Cordingly 1995:136). Other pirates left their mark on Charleston during the first decades of the eighteenth century as well. The colony of South

Carolina soon looked to England and other colonies for help in ridding her waters of the sea marauders.

British initiative to stop piracy took an active role at the beginning of the eighteenth century as a new form of national policy. The penalty for piracy was death, usually hanging. Charleston saw one of the largest executions of pirates in 1717 with the demise of Captain Stede Bonnet, when he and 29 of his men were hanged (Cordingly 1995:245). By 1720, Royal navy vessels patrolled off the coast of South Carolina to keep both the marauders and the Spanish away from the colony. In 1724, George Anson was stationed at Charleston as a permanent feature of English protection. When he left his station in 1730, the colony was in a much more tranquil state (Coker 1987:29-34). However, in 1741, Spanish privateers operated in South Carolina waters and one was often seen operating in the waters of St. Helena Sound. In March 1742, one anchored in the Edisto Inlet for several days culminating in a running gun battle in the Sound between the privateer and the *Elizabeth*, a brigantine out of New York, with the brigantine escaping capture (Rowland 1996:149).

The English soon established Savannah, Georgia on the banks of the Savannah River in 1733, between South Carolina and Spanish Florida. This colony acted as a buffer to Charleston and aided in the growth and relative security of South Carolina. The final Spanish land advance north was stopped in 1742 at the Battle of Bloody Marsh on St. Simons Island, Georgia (Ginn 1987). The Treaty of Paris (1763) settled the matter, as the Spanish relinquished all claim to lands north of the St. Mary's River. With a population expanding into the interior, the production of agricultural goods for export trade began to flourish. Timber, naval stores, rice, indigo, and eventually cotton were the main agricultural products exported from coastal, and later, the interior of South Carolina.

Trade was to be the economic driving force of the colony. Situated at an important juncture along traditional sailing routes, Charleston prospered by this proximity. Vessels sailing from the Caribbean to points north and Europe could easily stop over to fill their vessels with local products. Charleston, one of only two major ports in the Southeast (the second being Savannah), extended its trade influence into Georgia and North Carolina. Just prior to the Revolution, the port cleared approximately 450 vessels and had total annual imports and exports to Great Britain of some 800,000 pounds (Labaree 1999:101-103).

Charleston also controlled the slave trade of the southern colonies. The Carolina low country produced rice and indigo, with cotton soon becoming the major cash crop. Such large tracts of land required a large work force generally made up of African slaves; hence, the slave population expanded greatly. Early in the history of the province, it was feared that the African population was becoming numerically superior. By 1703, there were actually a few more blacks in South Carolina than whites. Twenty years later, blacks outnumbered whites 2 to 1, a ratio which would continue to the Revolution (Edgar 1998:69). The reason for this was the slave trade and economic dependence on labor-intensive agriculture. "Between 1700 and 1775, 40 percent of the Africans imported into North America came through Charleston" (Edgar 1998:67).

During the American Revolution, the Carolina backcountry was a bit of an anomaly. Railing against their defacto disenfranchisement by coastal areas and more inclined to self-rule, parts of the backcounty supported the British. At first, the British counted on the support of the large Germanic community in support of England's German King George III. However, the conflict became a local hell with Tory/British supporters and Whig/Republicans committing numerous acts of cruelty upon each other in the region, disrupting settlements and agriculture (Savage 1956:207, 214-218). However, the shippers and planters along the coast were firmly in the camp of the republican cause.

While the Revolution was disastrous for Charleston, it also left its mark on the local area. Port Royal to the south saw a British invasion with Fort Lyttleton the focal point, although the invaders were beaten back. Beaufort would be taken, but would be recaptured by 1872. With the signing of the Treaty of Paris, hostilities would end, but the markets in the West Indies once open to maritime trade would be lost, subsequently inflicting an economic downturn for the area.

However, the development by Eli Whitney of the cotton gin in 1793 would bring about radical economic changes to the local landscape. With this one machine, the entire southern region would become locked into an agricultural economy based on cotton. In 1791, South Carolina raised about 1,500,000 pounds of cotton and by 1834, approximately 65,500,000 pounds were produced, an almost 4,400 % increase (Wallace 1951:364).

Virtually all of the rice and cotton from plantations along the South Carolina and Georgia coasts, as well as exported produce from the farms and landings, were handled by the coastal trade (Haunton 1968:2; Pearson 1991:488). Pearson, in a study of a Georgia coasting captain, states that:

> …the factors and commission merchants of Savannah were indispensable in the agricultural economy of the region and were the key figures in marketing crops. They acted as combination merchant, buyer, and banker for the planters, providing an outlet for plantation produce, a source of credit, which was a necessity in a staple crop agricultural economy, and a store for many of the finished and luxury goods plantation owners and their families required. The coastal ship captain was the tie connecting the planter and factor. His vessels carried the casks of rice and bags of cotton from the plantation landings to the factorage houses in Savannah and returned with building materials, machinery, farming implements, domestic goods, foodstuffs and other commodities. The commerce of the region was dependent upon this coastal fleet [Pearson 1991:488].

Most of the vessels in the coastal trade sailed between Savannah or Charleston and smaller towns and plantations along the South Carolina and Georgia coast. Their cargoes were brought to the two cities and transshipped on larger sailing vessels to the North, Europe, and throughout the Caribbean (Pearson 1991:492). Rice and cotton were the major agricultural items shipped by coastal vessels:

> "Most shipments of rice occurred between October and March, although it was not uncommon for them to continue into Savannah as late as May or June … The cotton harvest corresponded closely to that of rice, beginning in September or October … (with) the bulk of the cotton … shipped between January and April peaking a couple of months after the rice shipments" (Pearson 1991:493-496). Pearson continues that, "in addition to cotton and rice, the coasting vessels carried lesser quantities of other commodities from the coastal area: wood, resin, turpentine, hides, lime, molasses, moss, syrup, potatoes, and corn" [Pearson 1991:496].

Vessels involved in the coastal trade were primarily small sloops and schooners, generally under 100 tons burden, and most of these coastal vessels were built in small shipyards of the mid-Atlantic and Northeast coasts. The fact that vessels were built elsewhere for the area's coastal trade was a reflection of the small shipbuilding industry in the Southeast (Pearson 1991:491-492).

The Civil War was disastrous for the State of South Carolina. Port after port fell to the relentless Union attack. Port Royal, in South Carolina, was one of the first to fall; by mid-November 1861, it was in federal hands. Beaufort and Port Royal would become the South Atlantic Blockade Squadron headquarters with its naval vessels blockading the ports of Savannah and Charleston.

The economic impact of the war had a dramatic effect on the local economy and way of life including maritime trade. For many parts of the South, Reconstruction meant adjusting to an entirely new way of life, both economically and socially; however, old land-use patterns established prior to the Civil War persisted. The number of small family farms continued to grow, in part due to the establishment of farms by many freed African Americans. The timber/naval-stores industry expanded as well, though its real heyday would not arrive until the 1880s, at which time the industry drove the economy and fueled expansion and development throughout the area. The term “naval stores” refers to products produced from the resin of pine trees. Naval-store products had many uses and were a necessary part of waterproofing wooden ships. Naval-store products included resin (the raw pine gum), tar, pitch, rosin, and turpentine (Butler 1998:12). The turpentine industry is often overlooked in historical archaeology in the South, yet it was one of the most economically significant modes of commerce, a majority of the product being shipped down local rivers to the ports of Savannah and Charleston for transshipment.

Always a relatively unpopulated area, Edisto Island as with many of the lowcountry’s barrier islands, began to attract tourists in the early twentieth century. Mostly forgotten during World War II, the island’s real estate development began to increase. However, the island still boasts a very small population, with vacation homes fronting the beach opposite the Project Area.

2.3.1 Previous Investigations, Site File, Shipwreck Inventory, Automated Wreck and Obstruction Information System, and Cartographic Reviews

2.3.1.1 Previous Investigations

One of the best tools for accurately assessing the potential for unknown submerged cultural resources is to compare the Project Area with findings and results of previous investigations, including both remote sensing and cultural resource surveys that have been completed in or near the current Project Area. Varying in degree of applicability to Panamerican’s research, these studies allow us to identify potentially significant resources. The studies also help in the recognition of specific problems or aspects that are inherent in the assessment of survey data and in the identification of potential resources.

While numerous submerged cultural resource surveys (in the form of historic research and remote sensing, as well as diving investigations) have been undertaken over the past recent years in South Carolina’s inland and offshore waters (i.e., Hall 2005, 2007; Watts 1998, 2005; etc.), only a few have been conducted in the general vicinity of the current Project Area. None have included any aspect of prospecting for or identifying submerged prehistoric sites.

The archaeological investigation that perhaps has the most relevancy and proximity to the current project involved a remote sensing survey of a sand borrow area offshore Hunting Island in Beaufort County. Conducted by Tidewater Atlantic Research in 2005, the project area was just offshore the southern end of Hunting Island, which forms the southern side of St. Helena Sound, to the south of the current survey area. The report concluded that two magnetic anomalies had signal characteristics compatible with shipwrecks or shipwreck debris and were recommended for avoidance (Watts 2005). It should be mentioned that a subbottom profiler system was not employed and presence or absence of submerged prehistoric sites was not considered.

In addition to these findings, the report provides an excellent shipwreck inventory for the area that has been modified for the Edisto area and is presented below (Table 3). In the report’s review of previous investigations for the area, a shipwreck site, 38BU157, is identified onshore on (Reynolds) Hunting Island. Identified as vessel remains suggestive of a well smack, a type of fishing vessel introduced in the 1830s-1840s, its location compares favorably with a wreck notation on an 1857 chart, and is a candidate for the schooner *Tybee* listed in the shipwreck inventory below (see Table 3 and Figures 10 and 11).

Table 3. Inventory Of Known Shipwrecks in the Project Area Vicinity.*

Name	Type	Lost	Cause	Location
Unknown		1554	Wrecked	Near St. Helena
Unknown	French Ship	1578	Wrecked	Near Hilton Head or Bay Point
Unknown	Boat	19 Jan. 1739	Wrecked	North Breaker's off St. Helena Sound
Unknown	Schooner	23 Apr. 1744	Lost	St. Helena Sound
Dundee	Ship	5 Sep. 1745	Ashore	Off Edisto
Wanton	Sloop	28 Feb. 1747	Lost	St. Helena
Unknown	Schooner	13 Jul. 1748	Lost	Near St. Helena
Unknown	Brigantine	1751	Ashore	Edisto Island
Unknown	Snow	30 Sep. 1752	Beat to pieces	Near Inlet at St. Helena
Unknown	Schooner	29 Dec. 1753	Ashore	St. Helena
Unknown	Brigantine or Snow	29 Dec. 1753	Ashore	St. Helena
King of Prussia	Schooner	3 Sep. 1762	Ashore	South Edisto breakers
Pedee	Schooner	3 Sep. 1762	Ashore, possibly got off	South Edisto breakers
Mary	Schooner	24 Dec. 1762	Captured and sunk	Off South Edisto
Unknown	Brigantine	30 Mar. 1763	Ashore	St. Helena breakers
Unknown	Sloop	18 Oct. 1768	Believed lost	Off South Edisto
Patsey	Sloop	13 Feb. 1770	Beat to pieces	On the "Bird Cage," a shoal near St. Helena
Robert and Elizabeth	Brig or Brigantine	5 May 1772	Ashore	Near South Edisto
Unknown	British Sloop	28 Jul. 1779	Aground and burned	Hunting Islands
Dispatch (Despatch)	Brigantine	16 Aug. 1781	Ashore	St. Helena Sound
Anna	Sloop	26 Jun. 1804	Lost	Off South Edisto
Guilielmi	Schooner	7 Sep. 1804	Ashore "High & Dry"	On St. Helena
Unknown	Schooner	7/8 Sep. 1804	Ashore "High & Dry"	On St. Helena Island
Unknown	Schooner	14 Sep. 1810	Ashore	About 1 league north of South Edisto Bar
Munroe	Schooner	17 Sep. 1810	Ashore	Edding's Bay near South Edisto Inlet
Unknown	Sloop	Aug. 1814	Captured and burned	St. Helena Sound
William	Schooner	9 Nov. 1814	Captured and burned	South Edisto
Nancy	Sloop	10 Nov. 1814	Captured and burned	St. Helena Sound
Hornet	Pilot Boat	1 Jul. 1820	Bilged and broke up	Bird Key Bank, South Edisto River
Anna Maria	Pilot Boat	Feb. 1823	Cut adrift	11 fathoms of water off St. Helena
Tybee	Schooner	16 Nov,1851	Ashore	North end of Hunting Islands
Unknown	Brig	9 Apr. 1862	Ashore	Edisto Island
Kingfisher	Bark	28 Mar. 1864	Wrecked	Combahee Bank, south end of Otter Island, St. Helena Sound
#3	Steam Launch	8 Jun. 1865	Wrecked	St. Helena Shoals
Unknown	Boat	25 Dec. 1865	Sank	Near Edisto Island
Pet		30 Apr. 1909	Sank	St. Helena Sound

*Shipwreck data from Watts 2005.

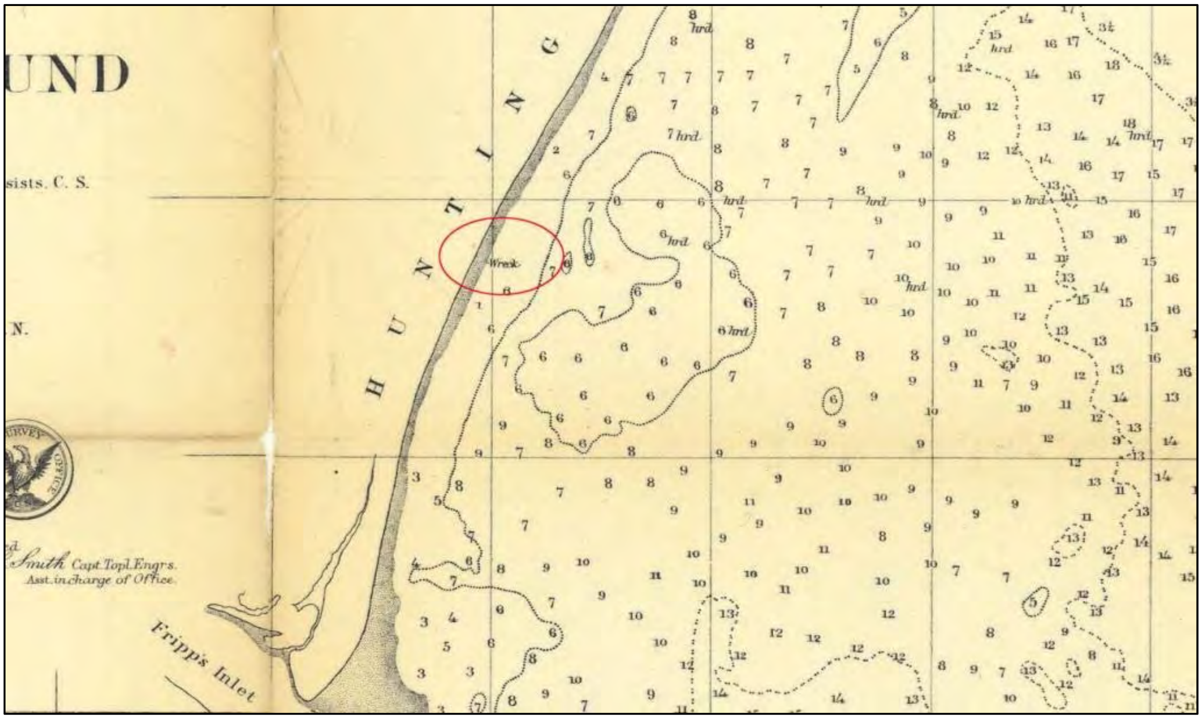


Figure 10. Excerpt from the 1857 Coastal Survey Chart "St. Helena Sound" showing single wreck notation on shore at the southern end of Hunting Island across the sound from the Project Area (Courtesy of National Oceanic and Atmospheric Administration's Office of Coast Survey's Historical Map and Chart Collection).

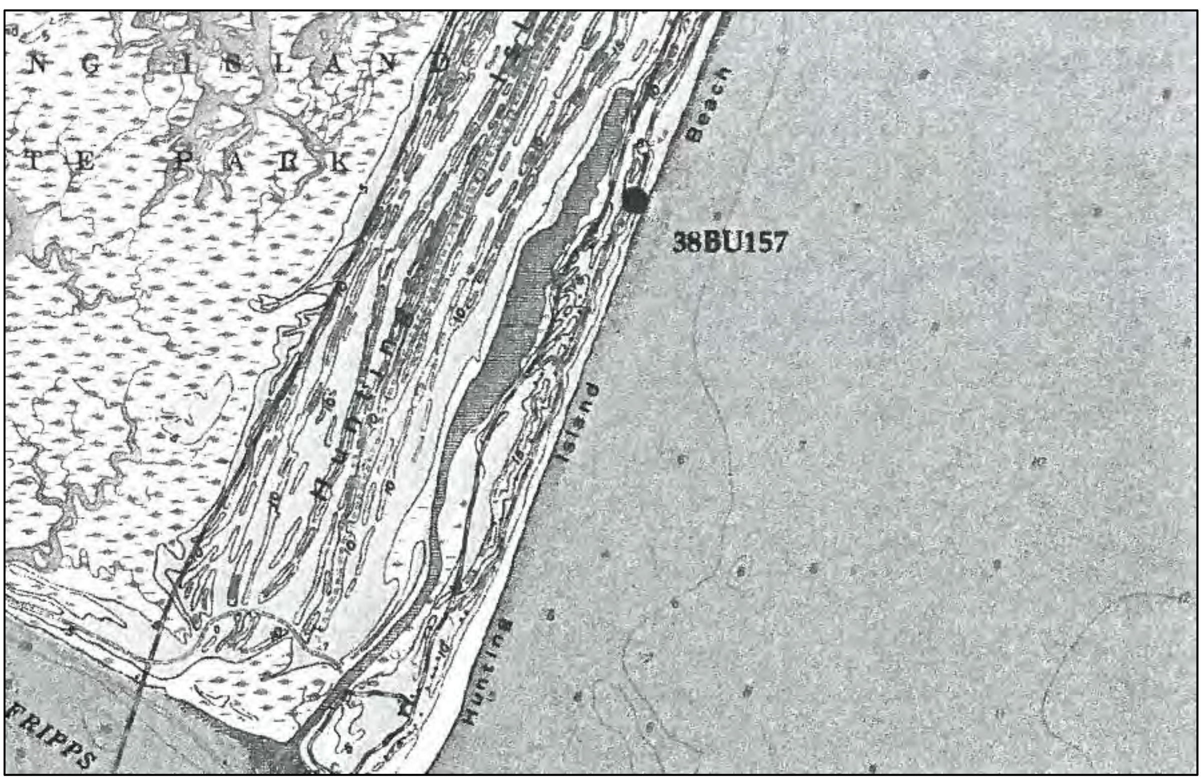


Figure 11. Location of Site 38BU157, vessel remains suggestive of a well smack, a type of fishing vessel introduced in the 1830s-1840s (as presented in Watts 2005:17). Compare the site's location with the wreck noted in Figure 10 above.

Another archaeological investigation that has relevancy to the current project involved a multi-year study by the Maritime Research Division with South Carolina Institute of Archaeology and Anthropology (SCIAA) that included remote sensing surveys of a limited number of naval shipwreck sites and activity areas primarily from the Civil War. One of the included areas was Port Royal, the next sound south of St. Helena Sound. The study surveyed several areas within and outside the Sound as well as several tidal creeks. The survey identified numerous wrecks including the Union gunboat, USS *Dai Ching* and the USS *Boston* (Spirek and Amer ed. 2004).

2.3.1.2 Site File Review

In order to ascertain the presence of previously recorded submerged archaeological sites and investigations in or adjacent to the Project Area, South Carolina's Archaeological Site File was reviewed. Obtained through ArchSite, the web-based site registry and GIS was compiled by the SCIAA in collaboration with South Carolina Department of Archives and History (SCDAH). Illustrated in Figure 12, a review of recorded cultural resources sites indicates that no submerged cultural resources in the form of shipwrecks or prehistoric sites have been recorded; only terrestrial, riverine, and maritime interface-type sites exist. None are in or immediately adjacent to the survey area.

In addition to remotely accessing ArchSite, the offices containing the South Carolina State Site File at SCIAA in Columbia were also visited. Discussions were conducted with Mr. Keith Derting, Information Management Division head, and site files were reviewed and copied, as were relevant cultural resources reports. In addition, the office of Mr. James Spirek, State Underwater Archaeologist and head of the Maritime Research Division was visited. Discussions with Mr. Spirek, as well as the site file review, indicate that no submerged cultural resources in the form of shipwrecks or submerged prehistoric sites have been recorded in or near the Project Area.

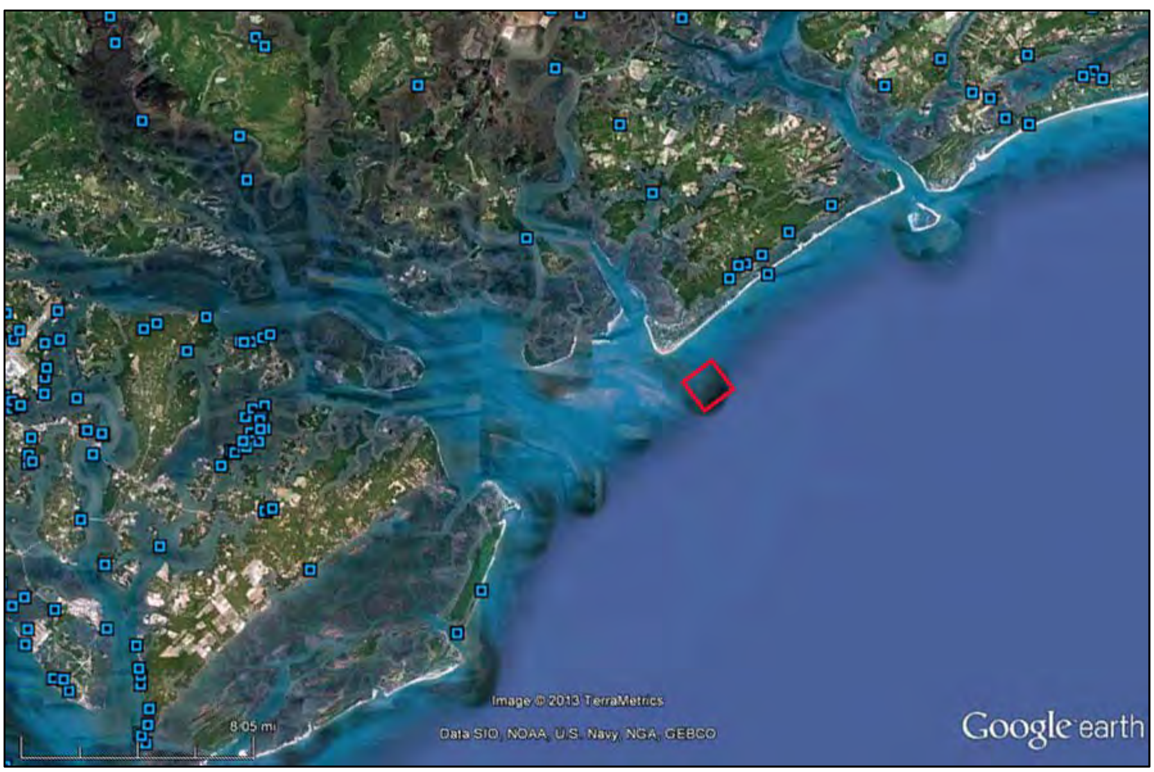


Figure 12. Recorded cultural resources sites with trinomials in relationship to the Project Area (base map courtesy of Google Earth). Note the two sites along the shore of Hunting Island to the south are shipwreck sites mentioned above.

2.3.1.3 Shipwreck Inventory

The South Carolina Site File does not list any historic shipwreck sites within or immediately adjacent to the Project Area. Past submerged cultural resources investigation reports for the region also do not list any shipwrecks within or immediately adjacent to the Project Area. The most comprehensive shipwreck inventory for the area was compiled by Gordon Watts as part of a past survey off Hunting Island south of the Project Area (Watts 2005). Table 3 is an excerpt of his inventory and lists only those wrecks located near or possibly in the current survey area off Edisto Beach. Other wrecks are known in the general vicinity, for instance the USS *Dai Ching*, USS *Boston* (Spirek and Amer eds. 2004), and USS *George Washington*. All Civil War losses, these wreck sites are up estuary rivers inland and well away from the Project Area.

2.3.1.4 Automated Wreck and Obstruction Information System

In addition to the South Carolina State Site Files and previous investigations, the current online edition of the National Oceanic and Atmospheric Administration's (NOAA's) Automated Wreck and Obstruction Information System (AWOIS) list was consulted relative to known wreck sites or obstructions within or near the current survey corridor. The AWOIS database contains information on over 10,000 wreck sites and obstructions/hangs in the coastal waters of the United States (U.S.). Information within the database includes a latitude and longitude of each feature along with any known historic and/or descriptive details. The AWOIS website, which may be accessed at http://www.nauticalcharts.noaa.gov/hsd/AWOIS_download.html, allows researchers to search for wrecks based on Latitude/Longitude coordinates for a given area. An Access Database file, a review of the AWOIS database does not indicate any wrecks or obstructions within a 5-mile radius of the Project Area.

2.3.1.5 Cartographic Review

A review of historic navigation maps and charts for the region is also another excellent tool for identifying shipwrecks within or adjacent to the Project Area. Often noting shipwrecks, obstructions, and other various hazards for the mariner, many of these maps can be accessed from NOAA's Office of Coast Survey's Historical Map and Chart Collection at http://www.historicalcharts.noaa.gov/historicals/search, while others are found in various repositories, publications, or websites. The NOAA website allows the researcher to specify a region of interest and then review all available maps for that area. A valuable utility provided by this site is the virtual magnification feature, which allows the researcher to zoom in and out of specific areas. Note that shipwreck symbols in each of the following maps, if present, are circled in red to more easily indicate their proximity to the Project Area, which is boxed in red.

All St. Helena Sound charts produced by the Coastal Survey, the first is the 1857 version. Illustrated in Figure 13, interestingly a Light Ship and buoys mark the entrance and channel into St. Helena Sound. However, there is no channel noted for the Edisto Beach borrow area Project Area, just numerous "Breakers." No wrecks are noted anywhere near the Project Area. One wreck, which was discussed above, is noted on the southern end of Hunting Island.

Illustrated in Figure 14 on the 1864 chart, the wreck symbol has disappeared from Hunting Island. The Light Ship is also no longer present, marking the Sound Channel just buoys, possibly a result or reflection of the Civil War activities. Navigation directions are present for entering South Edisto River and goes between two sets of breakers, one on each side of a very narrow channel. No wreck symbols are present.

The 1867 chart, illustrated in Figure 15, finds no change from the 1864 chart. By 1878, as illustrated in Figure 16, the South Edisto River entrance channel now has two buoys marking the channel through the breakers.

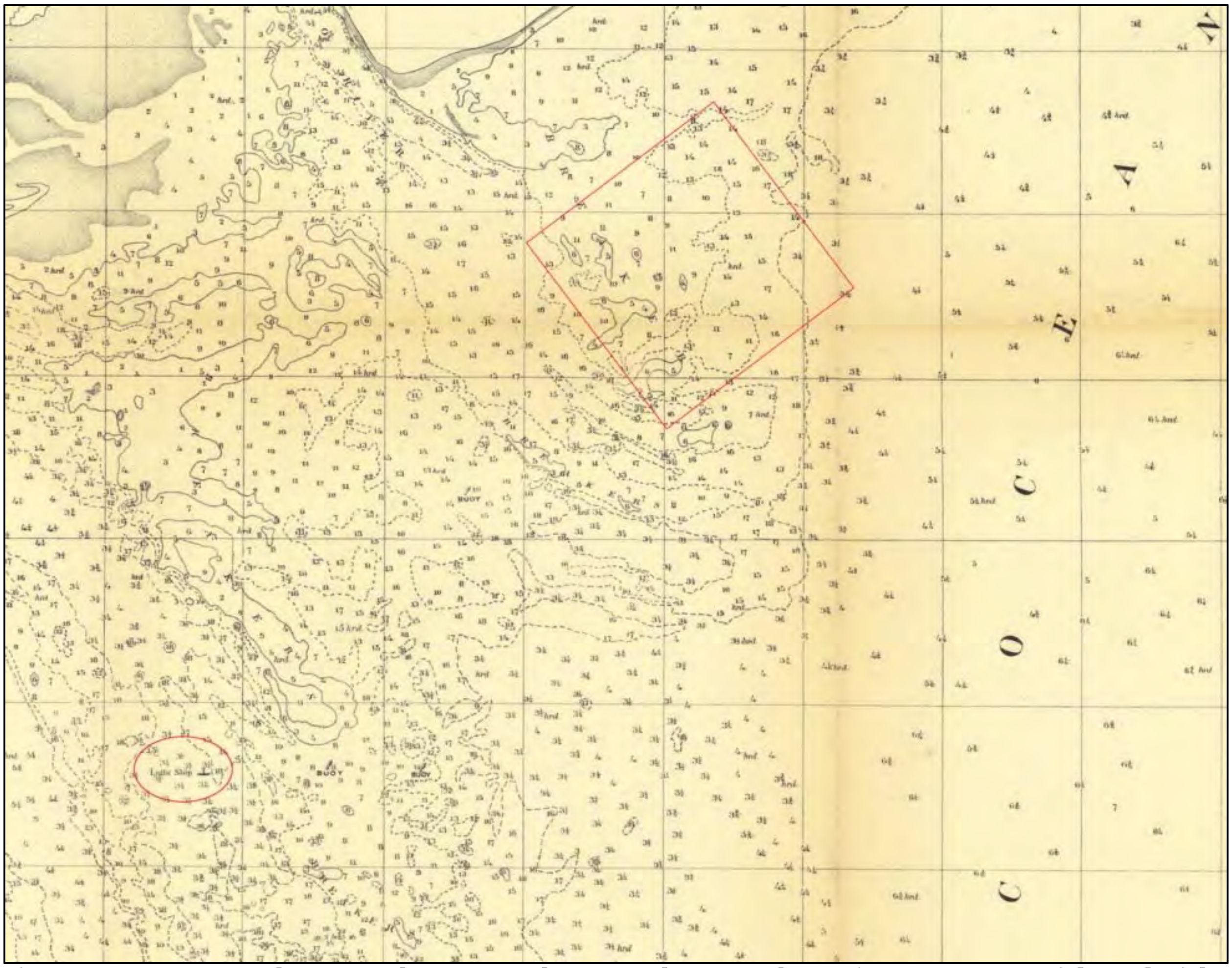


Figure 13. 1857 Coastal Survey Chart "St. Helena Sound." Note the Project Area upper right and Light Ship marking the channel into the sound circled in red at lower left. No buoys or directions are noted for entering South Edisto River, while buoys mark the entrance into the sound channel (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection; Project Area is approximate and not geo-referenced).

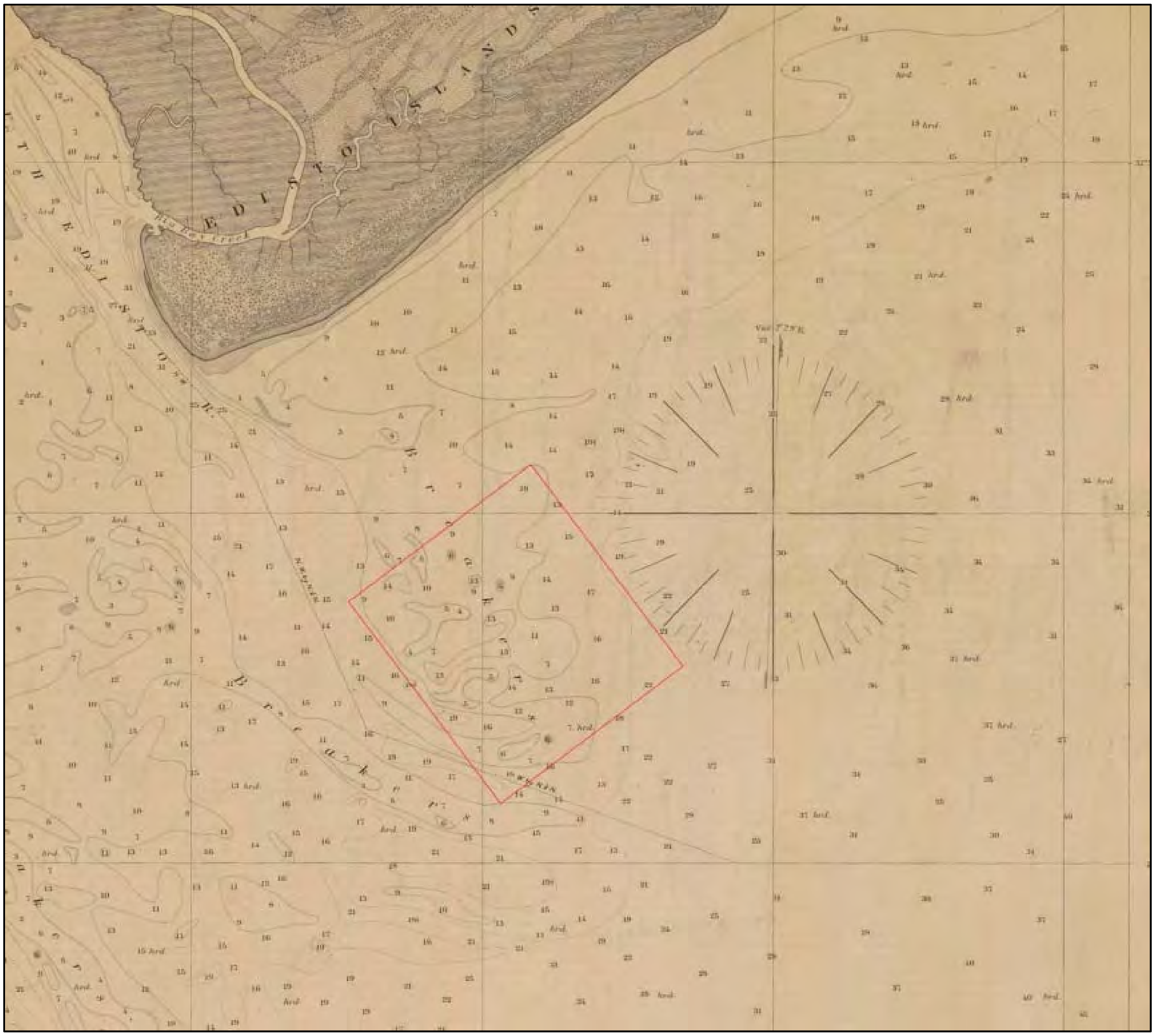


Figure 14. 1864 Coastal Survey Chart "St. Helena Sound." Note that navigation directions are present for entering South Edisto River and goes between two sets of breakers, one on each side of a very narrow channel (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

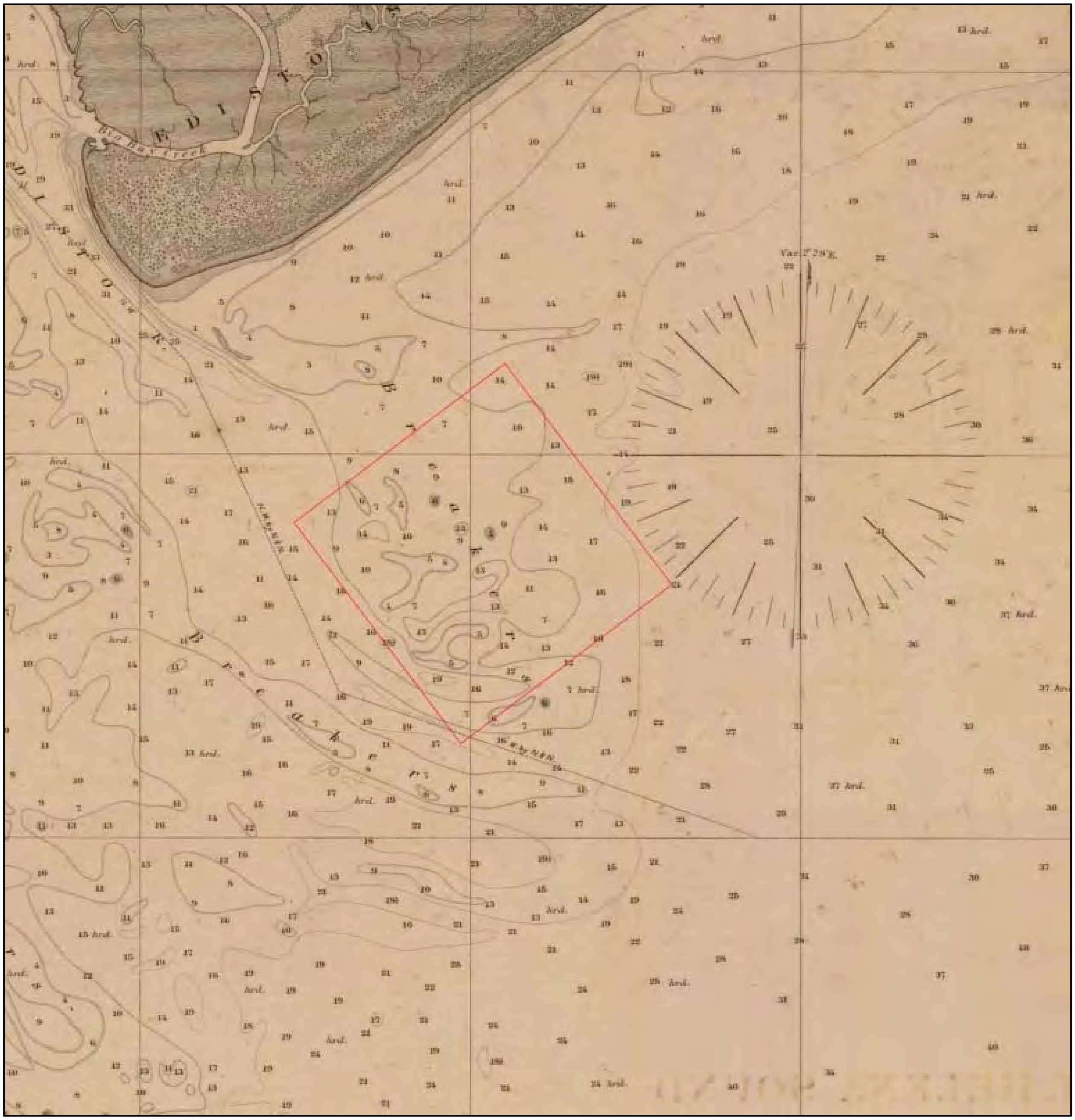


Figure 15. 1867 Coastal Survey Chart "St. Helena Sound" showing no change from the 1864 chart (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

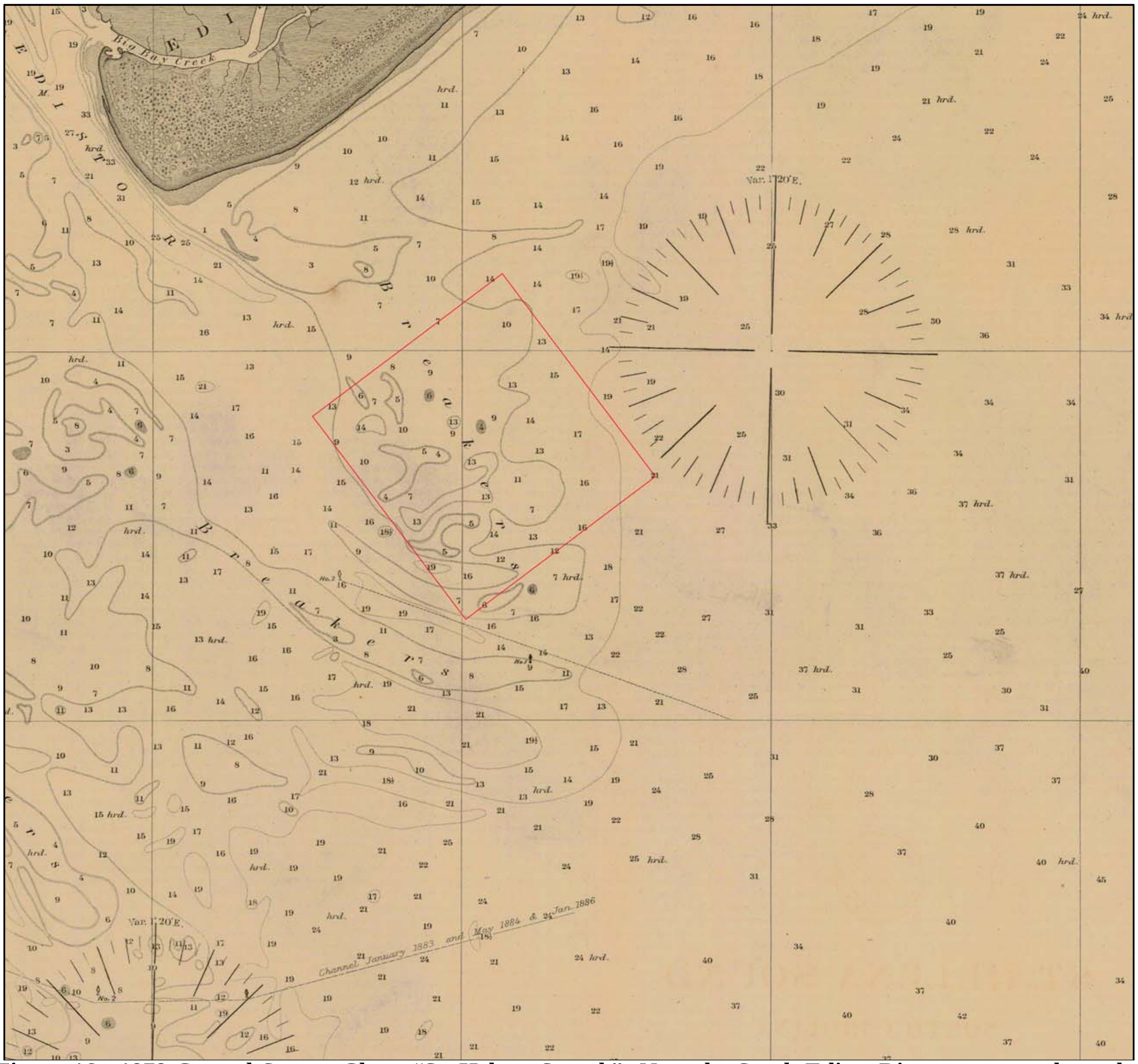


Figure 16. 1878 Coastal Survey Chart "St. Helena Sound." Note the South Edisto River entrance channel now has two buoys marking the channel through the breakers (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

By 1897, the South Edisto River entrance channel is well marked by two buoys. A "Sea Whistle" buoy is now in place offshore the entrance channels for the Sound and South Edisto River. No wreck symbols are depicted (Figure 17).

The 1903 chart, illustrated in Figure 18, finds no real changes from the 1897 chart. No wreck symbols are present.

Illustrated on the 1918 chart, the entrance into St. Helena Sound is well marked but has moved further south; the buoys once marking the South Edisto River entrance channel are not present indicating a possible closure of the channel by shifting sands or storm (Figure 19). While no wreck symbols are present, an obstruction, possibly a wreck, is noted at the head of the sound southwest of Otter Island (not pictured).

Similar to the 1918 map, the 1931 chart shows no buoys marking the channel through the breakers. Note that the beach on Edisto Island is labeled McConkie Beach. Bay Point is also labeled (Figure 20).

By 1974, the channel is marked with two channel markers. Some exposed/above high tide shoals are now noted for the area. No wreck symbols are present. Note that maps between 1931 and 1974 were not located (Figure 21).

The 2007 chart indicates the channel is well marked with very little shoaling. Breakers are still labeled on the northern side of the channel. A wreck symbol is present to the southeast of the Project Area and another is located well to the northeast closer to shore. These are not noted in AWOIS (Figure 22).

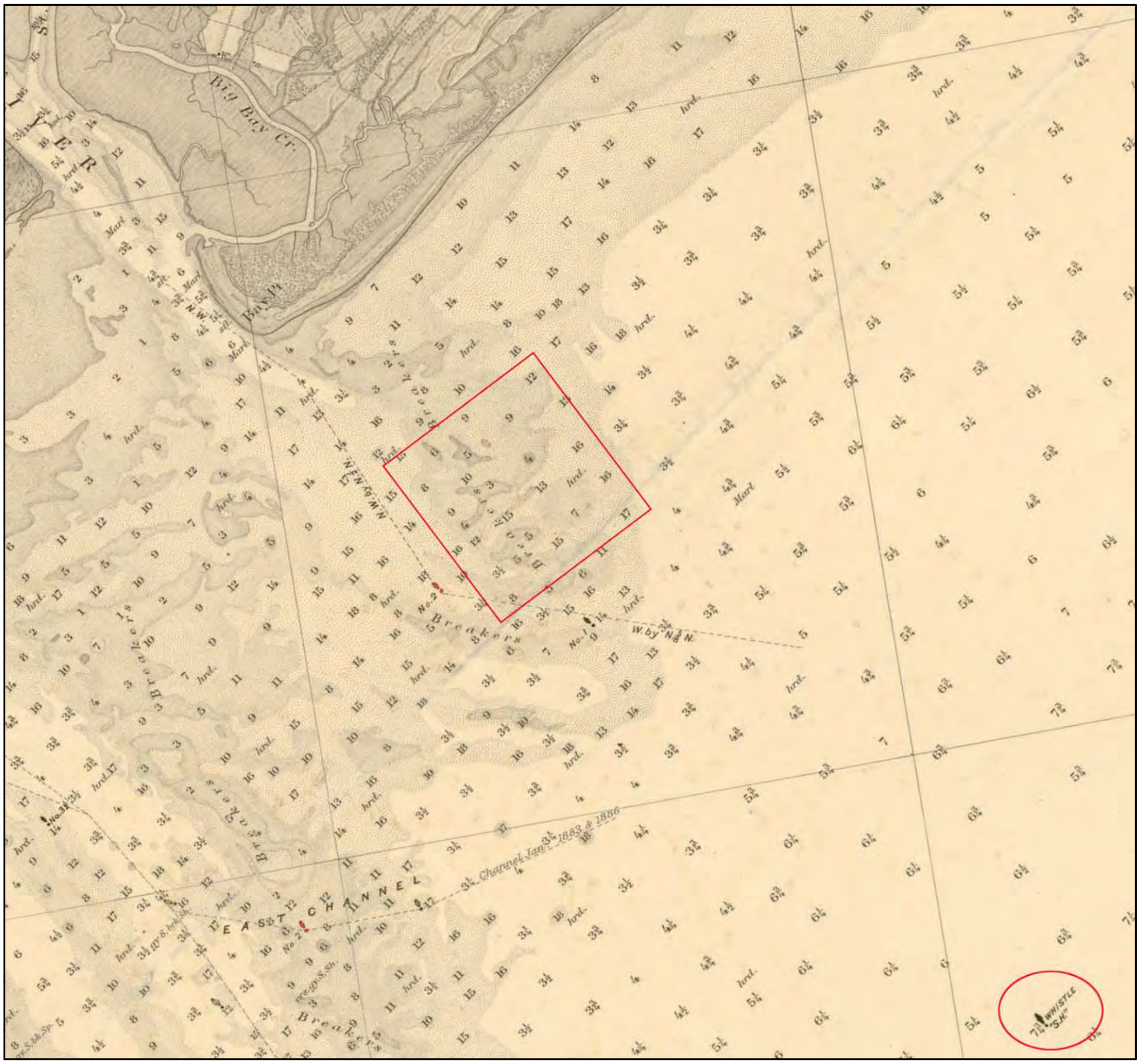


Figure 17. 1897 Coastal Survey Chart "St. Helena Sound." Note the South Edisto River entrance channel is well marked by two buoys. A "Sea Whistle" buoy is now in place offshore the entrance channels for the Sound and South Edisto River (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

Figure 18. 1903 Coastal Survey Chart "St. Helena Sound." There are no real changes from the 1897 chart, and no wreck symbols are present (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

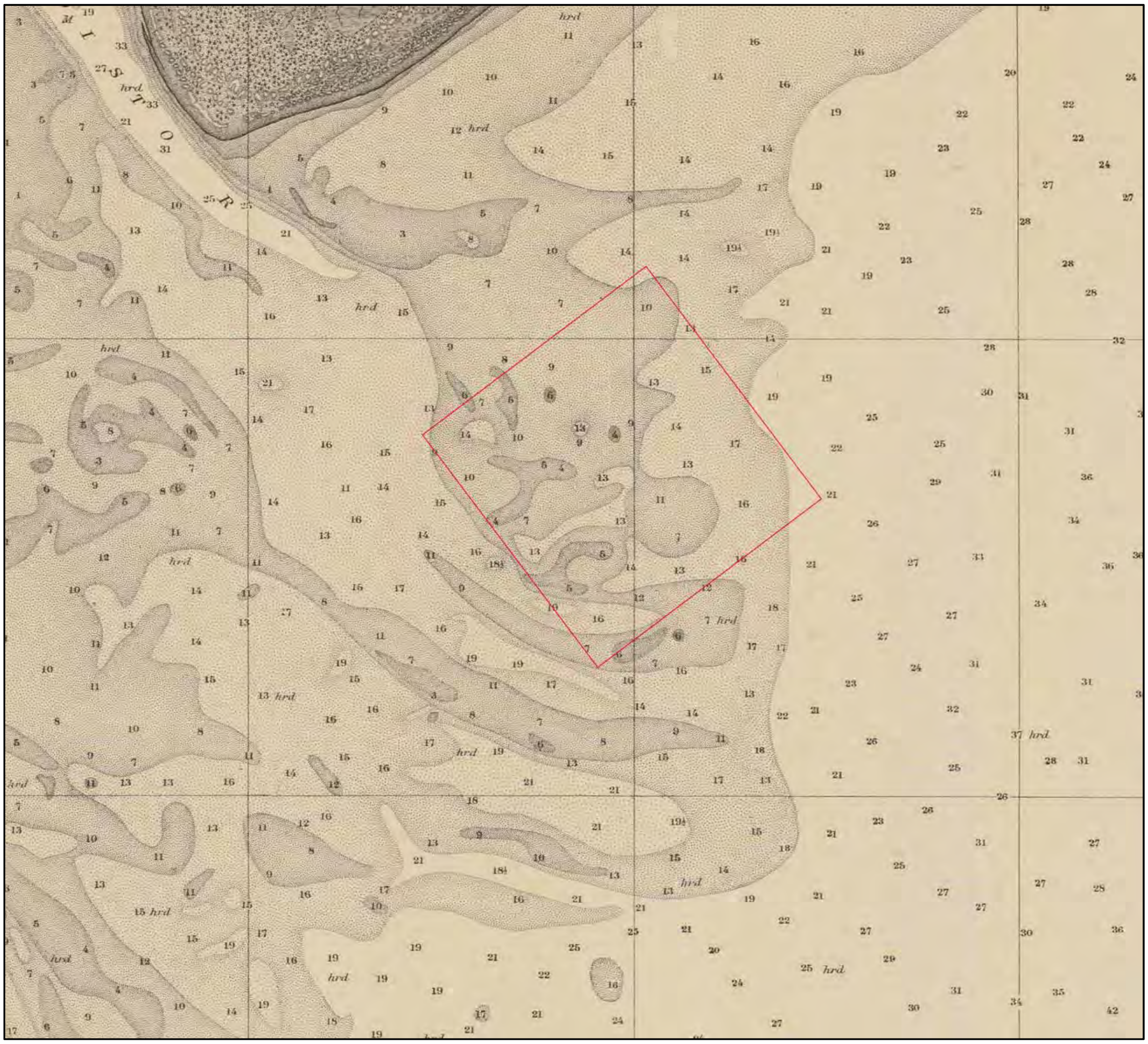


Figure 19. 1918 Coastal Survey Chart "St. Helena Sound." Note the buoys once marking the South Edisto River entrance channel are not present, indicating a possible closure of the channel by shifting sands or storm. (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

Figure 20. 1931 Coastal Survey Chart "St. Helena Sound" shows no buoys marking the channel through the breakers. Note that the beach on Edisto Island is labeled McConkie Beach. Bay Point is also labeled (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

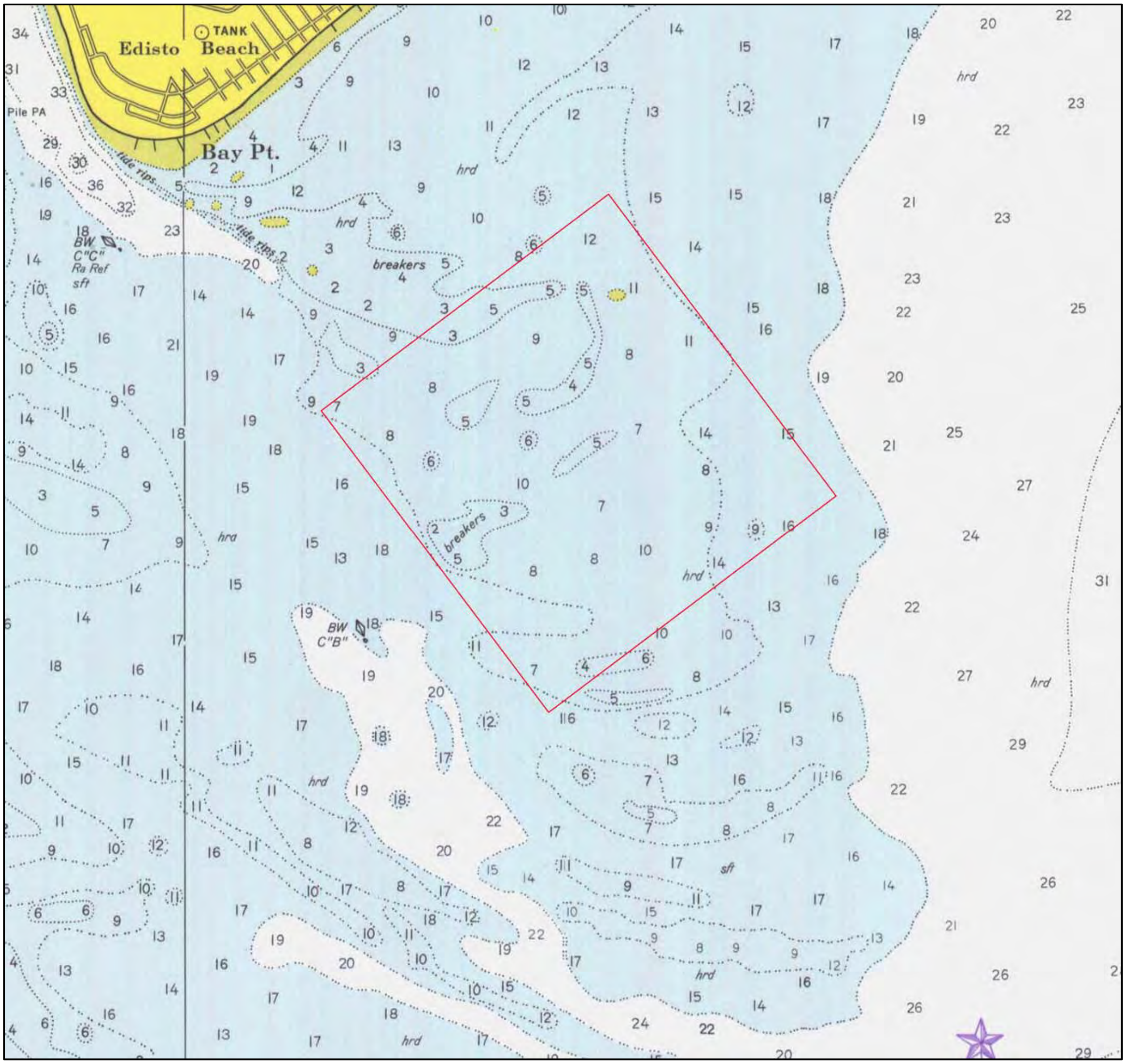


Figure 21. 1974 Coastal Survey Chart "St. Helena Sound" showing the channel is marked with two channel markers. Some exposed/above high tide shoals are now noted for the area. No wreck symbols are present (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

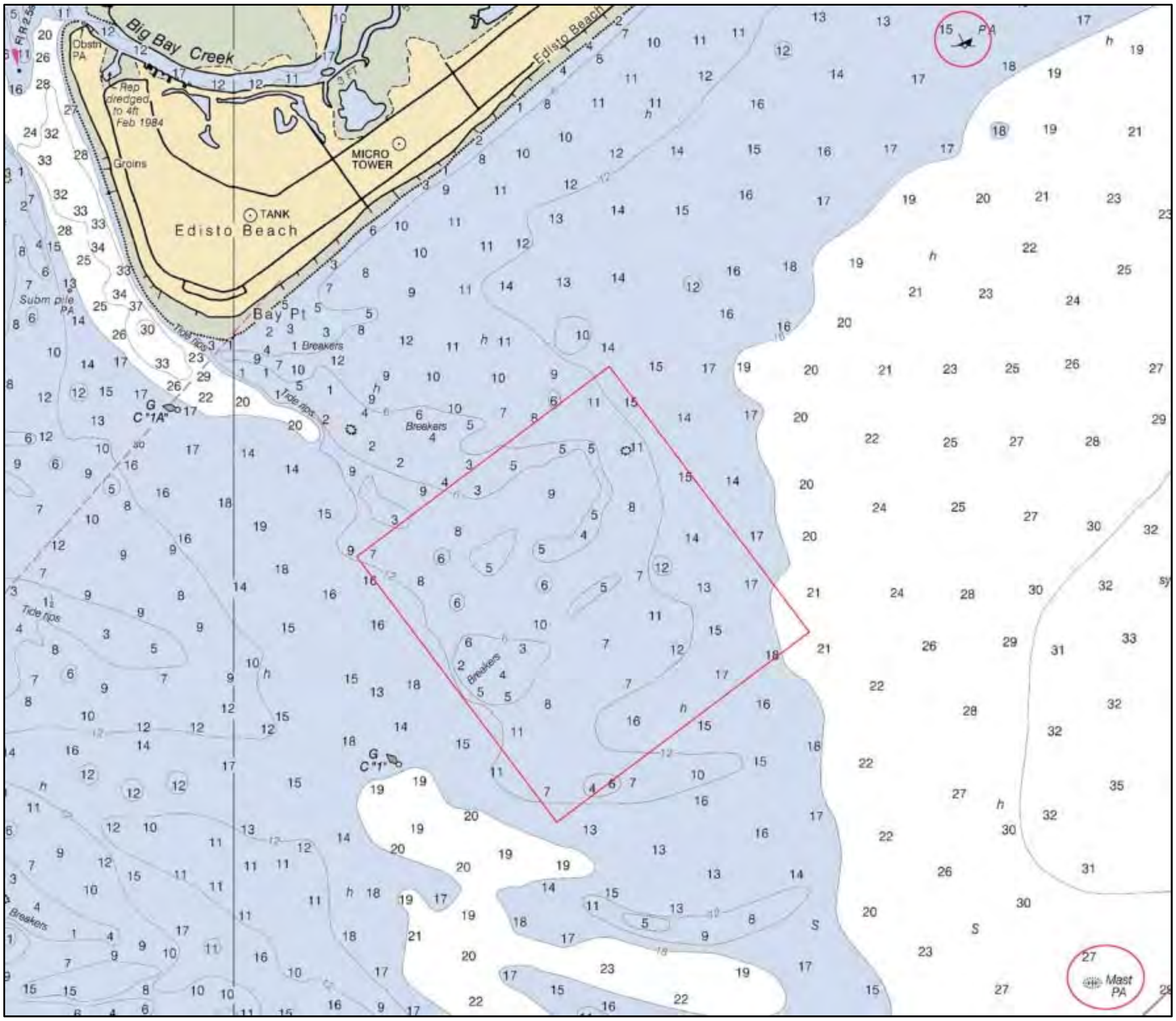


Figure 22. 2007 Coastal Survey Chart "St. Helena Sound." Note the channel is well marked with very little shoaling. Breakers are still labeled on the northern side of the channel. A wreck symbol is present to the southeast of the Project Area and another is located well to the northeast closer to shore. These are not noted in AWOIS (courtesy of NOAA's Office of Coast Survey's Historical Map and Chart Collection).

3.0 METHODS

3.1 Project Area Environment

Figure 23 conveys the environment of the Project Area just offshore Edisto Beach and illustrates the working conditions of the survey area during one of the calm days. Conducted in February, the sea state often changed from good to bad with several weather days being encountered. Because of allowable weather windows during this winter month, the survey was conducted in two periods, February 5 to 7 and then again from February 14 to 20. This latter period saw survey allowable days on February 14, 18, and 20 with the days in between too rough for allowable data.

3.2 Personnel

All personnel involved with the remote sensing survey had more than requisite experience to effectively and safely complete the project as contracted. Dr. Michael Faught (Ph.D., RPA) served as Remote Sensing Specialist along with Mr. Matt Gifford (M.A., ABT) and Mr. James Duff (M.A., ABT) serving as Remote Sensing Technicians; Mr. Robert Hunsaker, who served as the boat captain for survey operations, is also well versed in all remote sensing technologies and equipment. Dr. Faught processed and analyzed the subbottom and sidescan sonar data for cultural resources, Mr. Andrew D.W. Lydecker (M.A., RPA) processed and analyzed the magnetometer data and produced the magnetic contour and GIS maps, and Mr. Mike Rice analyzed sidescan records for hardbottom resources. Mr. Duff conducted archival research in Columbia, South Carolina.

Figure 23. Looking north towards Edisto Beach from the southern end of Project Area. Boom at left holds the subbottom profiler. The smooth sea state shown here is the exception rather than the rough norm encountered during the survey.

3.3 Remote Sensing Survey Equipment

The remote sensing tools chosen for this investigation were the magnetometer (to detect ferrous materials), sidescan sonar (to create images of the bottom), and the subbottom profiler (to reconstruct the structure of the underlying sediment beds). Locational control was conducted with Differential Global Positioning Systems (DGPS) technology. Analysis of the data was conducted with Hypack and SonarWiz.MAP, which are described in detail below.

3.3.1 Differential Global Positioning System

The primary consideration in the search for any submerged item is positioning. Accurate positioning is essential during the running of survey tracklines and it is essential in returning to recorded locations for remote sensing refinement or diver investigations. Positioning was accomplished on the project using two Trimble DSM12/212 Global-based Positioning Systems (GPS) and antennae; one was used for the subbottom; and one split to the navigation/magnetometer computer and to the sidescan (Figure 24).

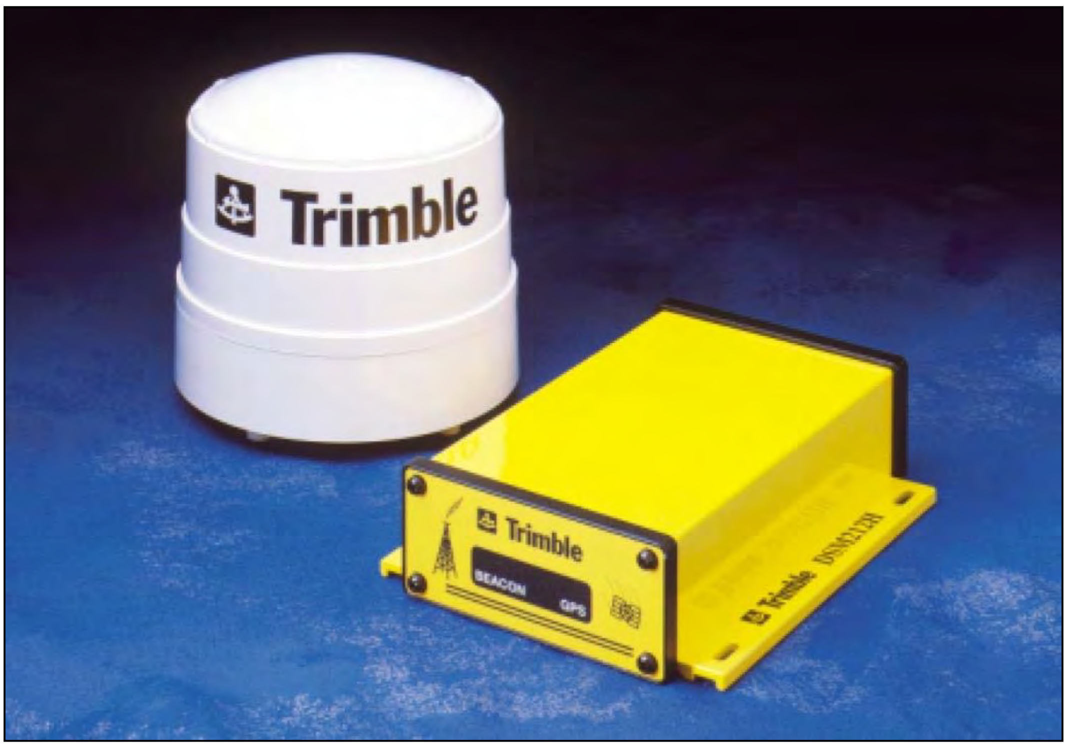


Figure 24. Trimble Navigation DSM 12/212 global-based positioning system used during the investigation.

The DSM12/212 GPS attains sub-meter precision with a dual-channel Minimum-Shift Keying (MSK) differential beacon receiver. This electronic device combines data from satellites and shore-based differential beacon stations, which increases the precision of the satellite data alone. DGPS positions were updated at one-second intervals, the same rate as the magnetic data was recorded (Trimble Navigation Limited 1998:1-2).

The USACE project was planned in the NAD83 South Carolina State Plane East, U.S. survey feet, and all sidescan, subbottom, and magnetometer target data have been converted to this datum and projection. The DGPS data streams are in geographic format, WGS84 (i.e., latitude, longitude), and converted on the fly by the navigation software.

Navigation was conducted with a Capaccino Twister PC computer, using the 2011 version of the Hypack Max for navigation, which was written and developed by Coastal Oceanographics, Inc. specifically for marine survey applications. The magnetometer data was acquired with this program as well.

All positioning coordinates are based on the position of either of the two DGPS antennae. Layback for each of the remote sensing devices was noted and used in the target location determination (Figure 25). This layback information was critical for accurate positioning of targets in the data analysis phase and in relocating any targets for additional investigations.

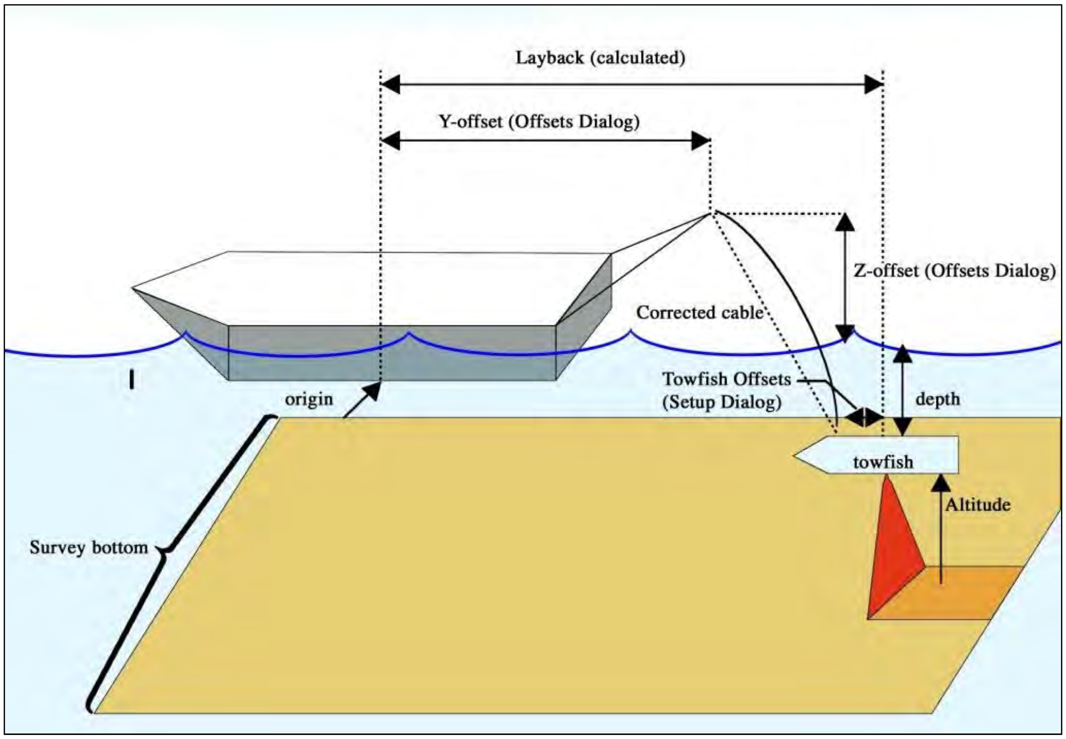


Figure 25. Equipment schematic illustrating layback (courtesy of Coastal Oceanographics, Inc.).

3.3.2 Magnetometer

Magnetometers measure the intensity of magnetic forces with a sensor that measures and records the ambient (background) magnetic strength and deviations from the ambient background (anomalies) caused by ferrous and some other sources (Breiner 1973). These measurements are recorded in nanoteslas, the standard unit of magnetic intensity.

The success of the magnetometer to detect anomalies in local magnetic fields has resulted in the instrument being a principal remote sensing tool of maritime archaeologists because of anomalies that can be components of shipwrecks and other historic debris or objects hazardous to dredging or navigation. While it is not possible to identify specific ferrous objects from the magnetic field contours, it is occasionally possible to approximate shape, mass, and alignment characteristics of wrecks or other structures based on complex magnetic field patterns (see Tables 3 and 4 for examples). In addition, other data (historic accounts, use patterns of the area, diver inspection), which overlap data from other remote sensing technologies, such as the sidescan sonar and prior knowledge of similar targets, can lead to an accurate identification of potential targets. Finally, it must be noted that other sources of magnetic field variation can overwhelm any smaller objects. These include: electrical magnetic fields that surround power transmission lines; underground pipelines; navigation buoys; or bridges and dock structures, which can be quite extensive when the feature is massive.

A Marine Magnetics SeaSPY Overhauser magnetometer was used for this survey (Figure 26). The system was powered by a 110-volt gasoline powered generator. Because water depths in the survey area were extremely shallow and ranged between 0 and just under 20 feet depending on the tide, the towfish had to be floated to keep it off the bottom. However, the sensor was never more than 20 feet off the bottom and was much closer for the majority of the survey. Data were stored in the navigation computer and archived. The SeaSPY is capable of sub-second recordation for precise locational control, but data were collected at one-second intervals, providing a record of both the ambient field and the character and amplitude of the encountered anomalies.

Figure 26. Survey instruments employed during the investigation included (from right to left) the magnetometer, the sidescan sonar, and the subbottom profiler. Honda generator employed to power the instruments is in the background adjacent to the transom.

3.3.3 Sidescan Sonar

The remote sensing instrument used to search for physical features on or above the ocean floor was a Marine Sonic Technology (MST) Sea Scan sidescan sonar system. The sidescan sonar is an instrument that, through the transmission of dual fan-shaped pulses of sound and reception of reflected sound pulses, produces an acoustic image of the bottom. Under ideal circumstances, the sidescan sonar is capable of providing a near-photographic representation of the bottom on either side of the trackline of a survey vessel.

The Sea Scan PC has internal capability for removal of the water column from the instrument's video printout, as well as correction for slant range distortion. This sidescan sonar was utilized with the navigation system to provide manual positioning of fixed or target points on the digital printout. Sidescan sonar data are useful in searching for the physical features indicative of submerged cultural and hardbottom resources. Specifically, the record is examined for features showing characteristics such as height above bottom, linearity, and structural form. Additionally, potential acoustic targets are checked for any locational match with the data derived from the magnetometer and the subbottom profiler.

The MST Sea Scan PC sidescan sonar was linked to a towfish that employed a 600-kilohertz power setting and a variable side range of 20 meters-per-channel (131 feet) on each of the survey lines. The 20 meters-per-channel setting was chosen to provide detail and 100% overlapping coverage with the 50-foot line spacing to ensure full coverage of the survey area. The power setting was selected in order to provide maximum possible detail on the record generated; 600 kilohertz was the preferred frequency.

3.3.4 Subbottom Profiler

Employed to determine the character of near-surface geologic features over the survey area, subbottom profilers generate low frequency (0.5 to 30 kilohertz) sound pulses capable of penetrating the seabed and reflecting off sediment boundaries or larger objects below the surface. The data are then processed and reproduced as cross sections based on two-way travel time (the time taken for the pulse to travel from the source to the reflector and back to the receiver). This travel time is then interpolated to depth in the sediment column by calculating at 1,500 meters-per-second (the average speed of sound in water).

Subbottom profilers have different ranges of sound wave frequency (sparkers, boomers, pingers, and chirp systems). Sparkers and boomers operate at low frequency (5 hertz to 2 kilohertz) and afford deep geologic penetration and low resolution, useful for deep geologic time. Pingers (3.5 and 7 kilohertz) are more useful to penetrate late Pleistocene- and Holocene-aged deposits or paleolandscape features of interest to prehistoric archaeologists. CHIRP systems sweep multiple frequency ranges and are the most precise and accurate of the subbottom profiler systems; they operate at ranges of between 3 to 40 kilohertz. The resolution can be on the order of 10 centimeters (6 inches) depending on sediment type and the quality of the acoustic return.

An EdgeTech 3100 CHIRP subbottom profiler system with a topside power unit, laptop processor and SB-424 towfish was used for this survey. The device was operated at a setting of 4 to 16 kilohertz, the lowest setting of the device, for maximum penetration.

Seismic cross sections reconstruct the shapes and extents of reflectors such as facies in channel sediments, rock/sediment interfaces, marine sand bed cover, and so forth. In addition to subbottom profiling, and depending on the density of data points, the first bottom return data can be used for high-resolution bathymetry. Shipwrecks can be studied with subbottom profilers once their location is known. Finding shipwrecks with a subbottom profiler survey is less useful.

High and low amplitude reflectors (light and dark returns) distinguish differences of sediment characteristics such as particle size and consolidation (Stevenson et al. 2002). Facies contacts can be identified by discontinuities in the extent, slope angle, or shape of the reflector returns. This latter fact is important when identifying the sinusoidal shapes of drowned channel systems and other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, upland areas around drainage features). Parabolic-shaped reflectors indicate individual objects of sufficient size and consolidation. The parabolic shape is the result of sound propagating outwardly from the item. There are also five types of signals that may cause misinterpretation in the two dimensional records: direct arrivals from the sound source; water surface reflection; side echoes; reflection multiples; and point source reflections. Judicious analysis is required to identify them.

Peats tend to reflect strongly, as do other fine-grained or muddy sediments. Sand and shell deposits like those around and in the South Carolina coast are less reflective, and difficult to penetrate without lower seismic frequencies such as those employed by the profiler system used here.

3.3.5 Survey Vessel

The vessel employed during the remote sensing survey was the 25-foot Parker 2520-XL *Haley Ann* (Figure 27), a modified V-hulled motor vessel powered by twin 125-horsepower Yamaha outboards. The vessel has a covered cabin and an ample covered-deck area for the placement and operation of the necessary remote sensing equipment. The vessel conforms to all U.S. Coast Guard specifications, according to class, and has a full complement of safety equipment. It carries all appropriate emergency supplies including lifejackets, spare parts kit, tool kit, first-aid supplies, flare gun, and air horns.

Figure 27. DC&A's 25-foot *Haley Ann* employed for the survey investigations.

3.4 Survey Procedures

Spaced at 65-foot (20-m) intervals and positioned in a northeast-southwest direction, 118 survey lines were programmed into the navigation computer to effectively cover the survey area (Figure 28). The magnetometer, sidescan, subbottom, and DGPS were mobilized, tested, and found operational; then the trackline running began. The helmsman viewed a video monitor linked to the DGPS and navigational computer to aid in directing the course of the vessel down the survey tracklines. The monitor displayed the pre-plotted trackline, the real time position of the survey vessel, and the path of the survey vessel. The speed of the survey vessel was maintained at approximately 3 to 4 knots for the uniform acquisition of data. As the survey vessel maneuvered down each trackline, the navigation system monitored the position of the survey vessel relative to the tracklines every second, each of which was recorded by the computer. Event marks delineated the start and end of each trackline. The positioning points along the traveled line were recorded on the computer hard drive and the magnetic data was also stored digitally.

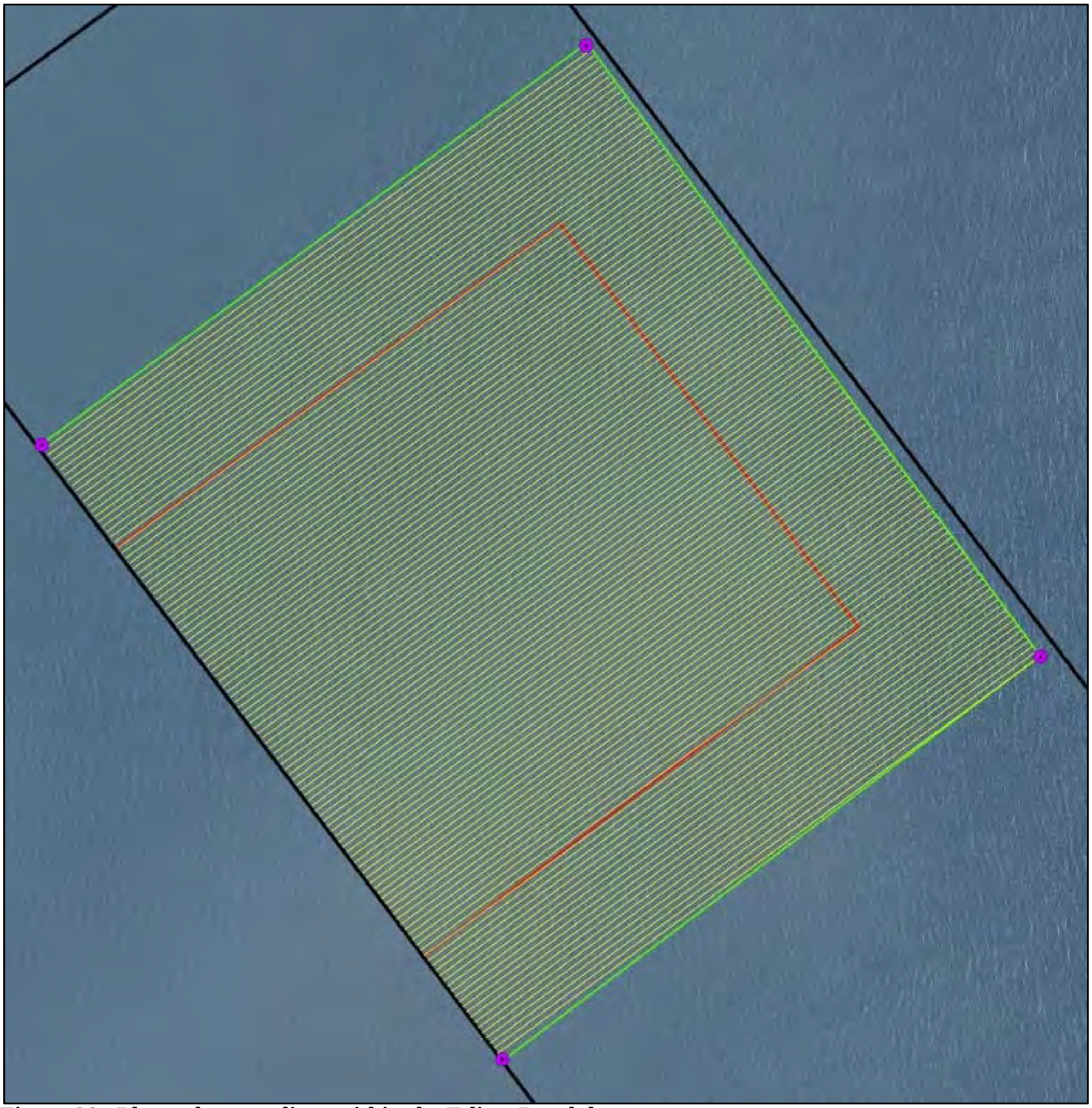


Figure 28. Planned survey lines within the Edisto Beach borrow area.

3.5 Data Analysis

3.5.1 Data Processing

Once collected, survey data was processed and analyzed using an array of software packages designed to display, edit, manipulate, map, and compare proximities of raster, vector, and tabular data. These packages included SonarWiz.MAP for mosaicing sidescan sonar and subbottom profiler data, mapping target extents and generating target reports, figure details, and GIS layers; Hypack Single Beam Editor, Hypack TIN Modeler, and Hypack Export for tabulating anomaly characteristics and contouring magnetic data, and generating GIS data layers. ESRI ArcMap and ArcView were used to display the data on background charts, to conduct a "proximity analysis" for each of the three types of targets (e.g., see which magnetometer, sidescan, and subbottom profiler anomalies are near each other and may explain each other) and to create maps and figures for this report.

3.5.2 Magnetic Data Collection and Processing

Data from the magnetometer was collected using Hypack Max. The data is stored as *.RAW files by line, time, and day. Raw data files were opened, and layback parameters were set. Contour maps were produced of the magnetic data with the TIN Modeler. The DXF file was saved and exported into the combined GIS database. The contour maps allowed a graphic illustration of anomaly locations, spatial extent, and association with other anomalies. Magnetic data was reviewed by the Hypack® Single Beam Editor (Figure 29), and the location, strength, duration, and type of anomaly was transcribed to a spreadsheet along with comments.

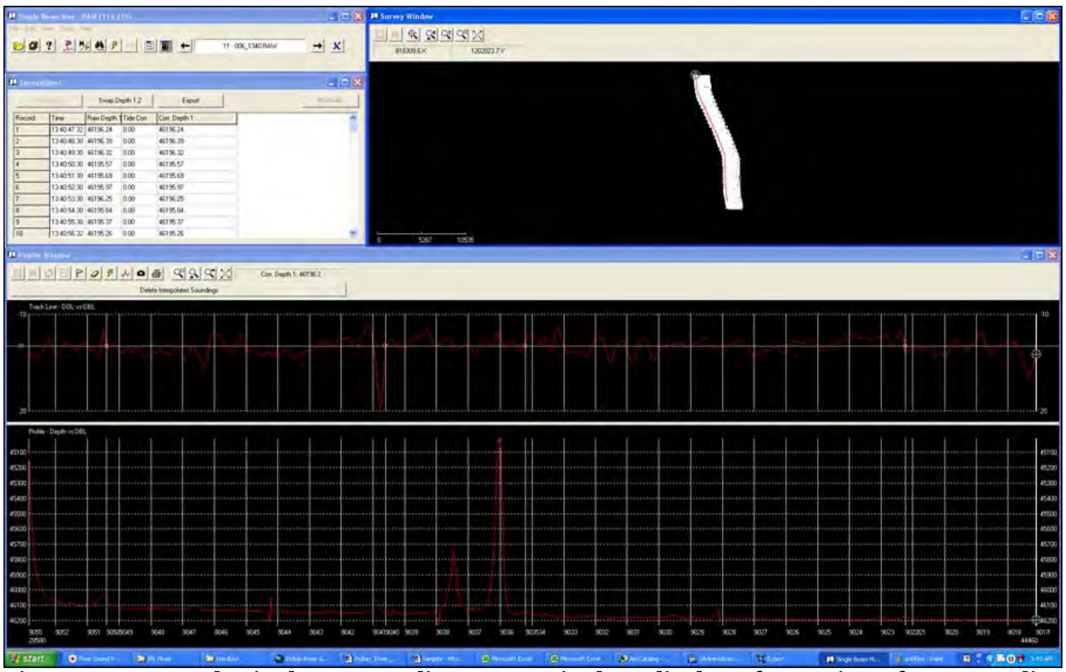


Figure 29. Hypack Single Beam Editor magnetic data display of a section of a survey line. Using these windows one can analyze anomaly position, strength, duration, and type. The peaks of these variations are the locations of target coordinates; their width is the duration.

3.5.3 Sidescan Sonar Data Collection and Processing

Post processing of sidescan sonar was accomplished using SonarWiz.MAP, a product that enables the user to view the sidescan data in digitizer waterfall format, pick targets, and enter target parameters including length, width, height, material, and other characterizations into a database of contacts. In addition, SonarWiz.MAP "mosaics" the sidescan data by associating each pixel (equivalent to about 10 centimeters) of the sidescan image with its geographic location determined from the DGPS position (layback rectified) and distance from the DGPS position (Figure 30). SonarWiz.MAP is the industry standard for mosaicing capability, and the results are exported as geo-referenced TIFFs for importing to the GIS database of the project. SonarWiz.MAP can generate target reports in PDF, Word, or Excel formats (Figure 31).

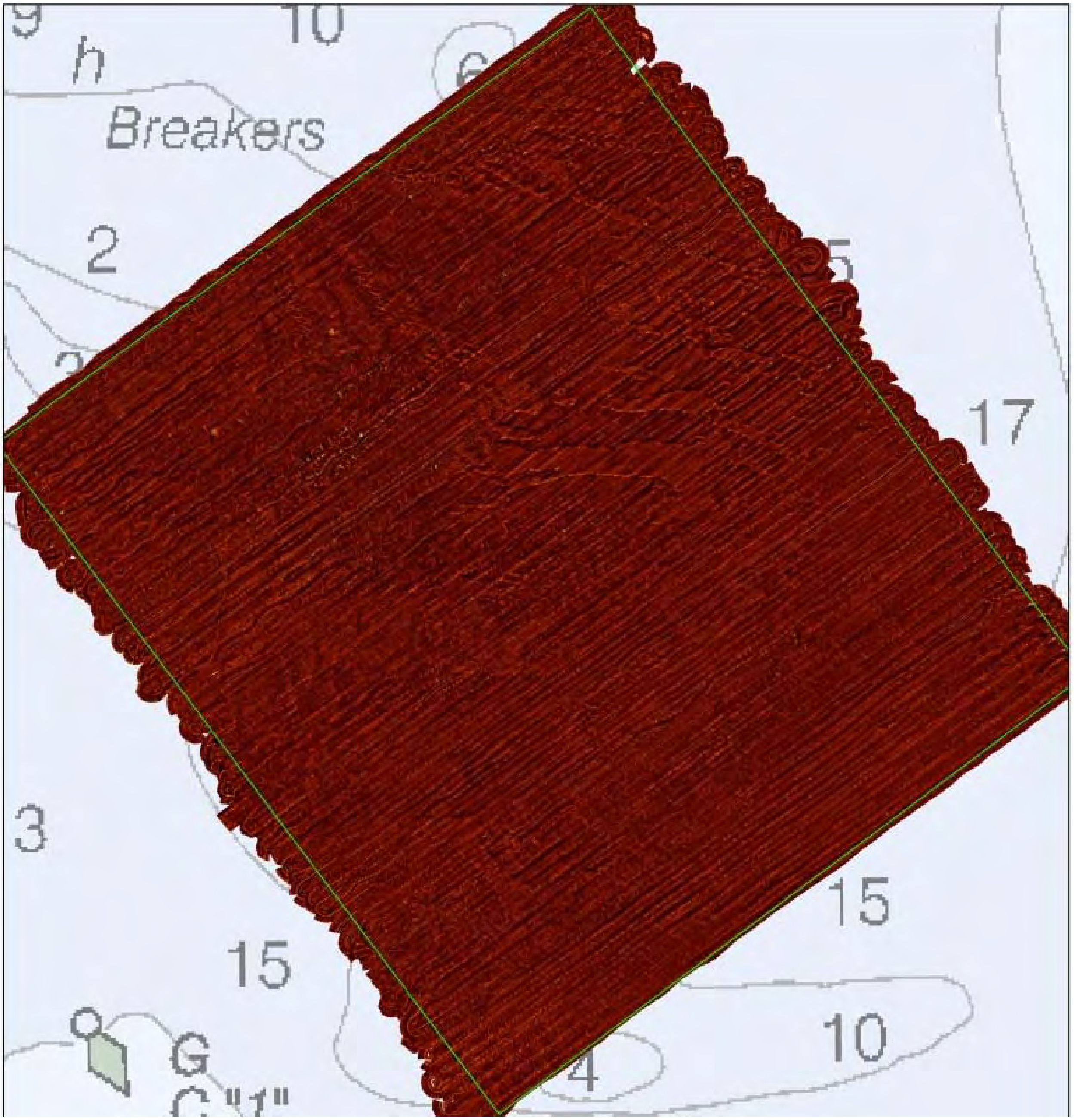


Figure 30. Sonar mosaic generated in SonarWiz.MAP showing 100% coverage of the Project Area.

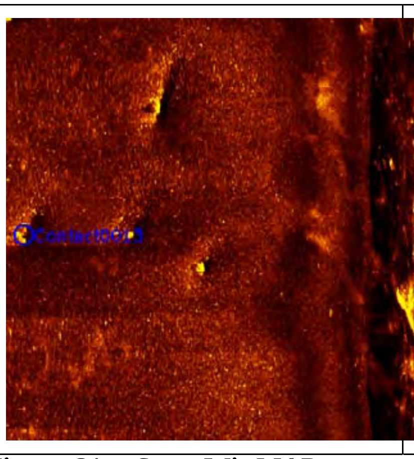
	SS-13	Dimensions
	• Sonar Time at Target: 02/05/2013 16:15:39 • Click Position (Projected Coordinates) (X) 2212888.24 (Y) 231916.08 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 11008 • Range to Target: 28.65 US Feet • Fish Height: 0.35 US Feet • Heading: 52.400 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	Target Height: = 0 US Feet Target Length: 0 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: posts or stumps??

Figure 31. SonarWiz.MAP sonar contact data automatically generated in tabular format. The target pictured here is SS-13, which lacks a magnetic signature and is likely a cluster of tree trunks or post.

3.5.4 Subbottom Profiler Data Processing and Analysis

Post processing of subbottom profiler data, like the sidescan data, was done with SonarWiz.MAP, which in this case enabled the analyst to view the subbottom data in a planar, trackline format. The analyst viewed the data in a digitizer window as a waterfall format, allowing the digitizing of subbottom features of interest, linear extent, depth, and type (Figure 32). SonarWiz.MAP batch processed waterfall images to *.JPG formats in order to generate figures (Figure 33). Sidescan mosaics and the contact databases were exported to the GIS database as *.SHP files. SonarWiz.MAP was also used to calculate the amount of sonar coverage and illuminate gaps to ensure full coverage of the Project Area.

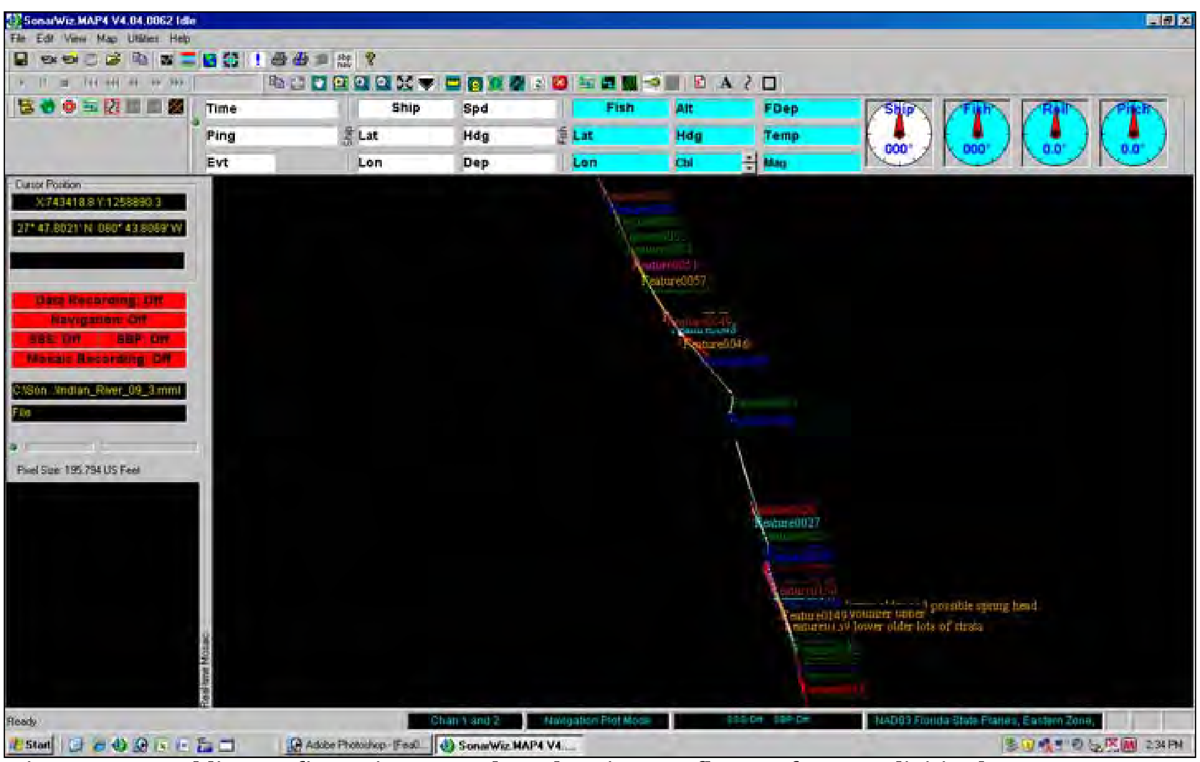


Figure 32. Trackline configuration example and various "reflector" features digitized.

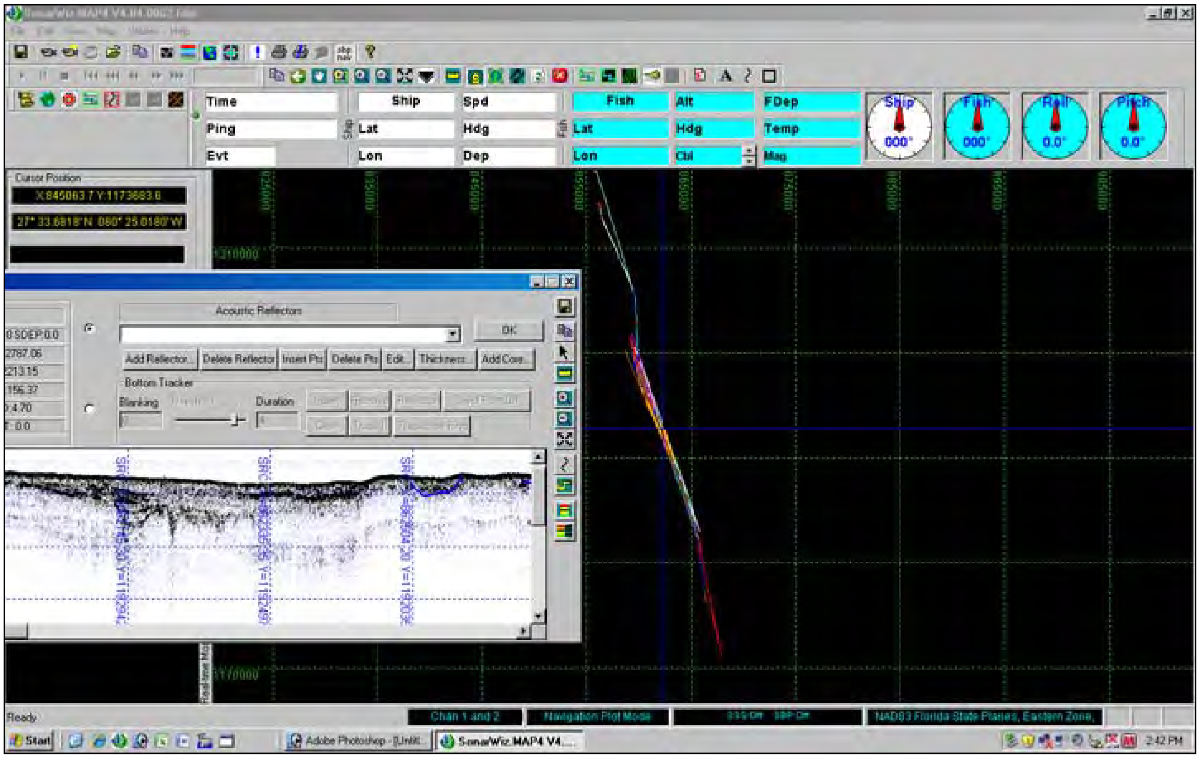


Figure 33. SonarWiz.MAP subbottom waterfall image example showing the seismic profile-digitizing window. The blue cross hairs in the background chart show the location of the cursor, which at the time of the image was directly over the peak of the positive relief feature shown.

3.5.5 Geographic Information Systems Analysis

A project GIS database was constructed using geo-referenced images and layers generated during the magnetometer, sidescan, and subbottom data analyses. Other layers can be added, such as orthophoto quads or Raster Navigation Charts (RNC). Several important things were accomplished by GIS compilation. First, the collected data were compared to one another and evaluated for accuracy and consistency of the positioning information. Second, magnetic, sidescan, and other remote sensing targets were compared for relationship (proximity analysis) (Figure 34).

3.6 Data Analysis Criteria, Theory, and Commentary

The remote sensing survey of the Edisto Beach Borrow survey area was performed to locate and identify the presence or absence of potentially significant submerged cultural resources, and if present, might be adversely affected by proposed dredging activities. However, the interpretation of remote sensing data obtained from both the magnetometer and sidescan sonar, as stated by Pearson et al. (1991), "relies on a combination of sound scientific knowledge and practical experience." The evaluation of remote sensing anomalies, with regard to a determination that the anomaly does or does not represent shipwreck remains, depends on a variety of factors. These include the detected characteristics of the individual anomalies (e.g., magnetic anomaly strength and duration, sidescan image configuration), associated with other sidescan or magnetic targets on the same or adjacent lines, and relationships to observable target sources such as channel buoys or pipeline crossings, etc.

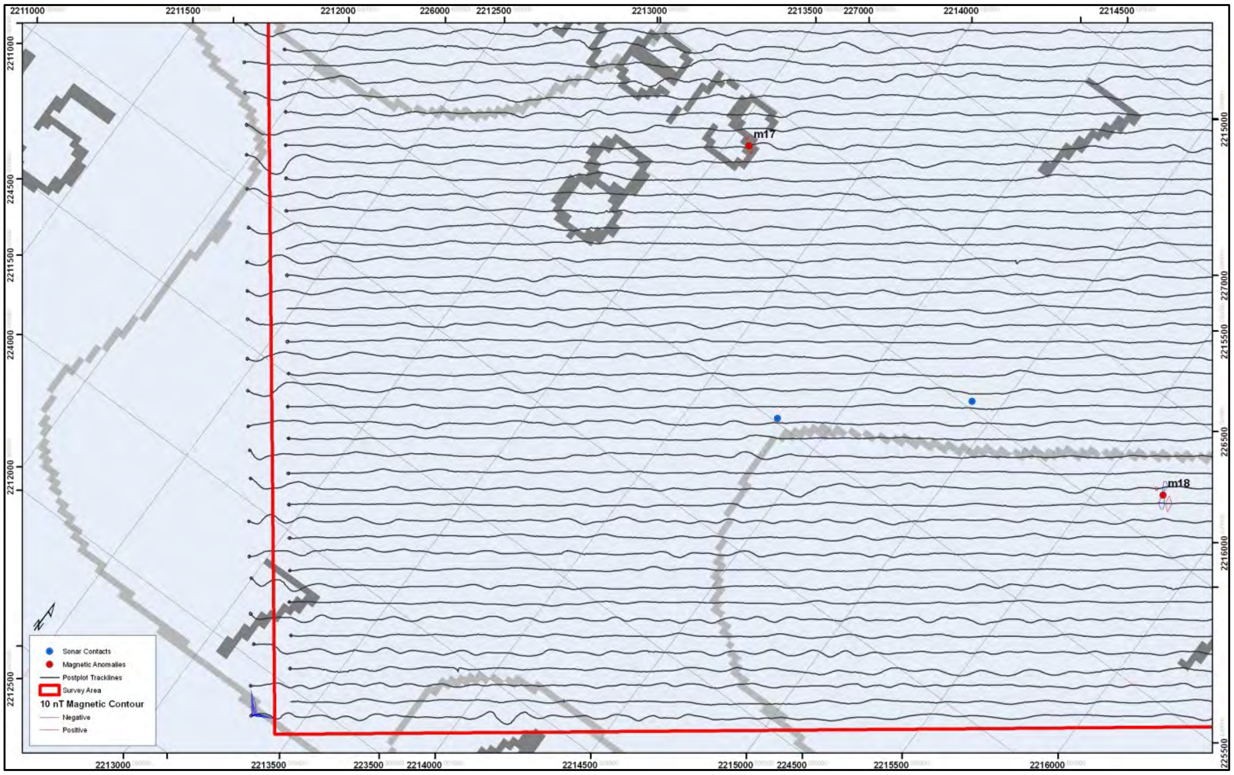


Figure 34. Magnetic contour map in GIS with the RNC chart as the background. Map presents layers of magnetic anomalies, sonar contacts, magnetic contours, and survey track lines.

3.6.1 Magnetometer

Interpretation of data collected by the magnetometer, the tool of choice by the underwater archaeologist for locating shipwrecks, is perhaps the most problematic. Magnetic anomalies are evaluated and prioritized based on magnetic amplitude or deflection of nanotesla intensity from the ambient background in concert with duration or spatial extent (distance in feet along a trackline of an anomaly influences the ambient background); they are also correlated with sidescan targets. Because the sonar record gives a visible indication of the target, identification or evaluation of potential significance is based on visible target shape, size, and presence of structure, as well as association with magnetic anomalies. Targets, such as isolated sections of pipe, can normally be immediately discarded as non-significant, while large areas of above-sediment wreckage are generally easy to identify.

The problems of differentiating between modern debris and shipwrecks, based on remote sensing data, have been discussed by a number of authors. This difficulty is particularly true in the case of magnetic data; therefore, it has received the most attention in the current body of literature dealing with the subject. Pearson and Saltus (1990:32) state, “even though a considerable body of magnetic signature data for shipwrecks is now available, it is impossible to positively associate any specific signature with a shipwreck or any other feature.” There is no doubt that the only positive way to verify a magnetic source object is through physical examination. With that said, however, the size and complexity of a magnetic signature does provide a usable key for distinguishing between modern debris and shipwreck remains (see also Garrison et al. 1989; Irion and Bond 1984; Pearson et al. 1993). Specifically, the magnetic signatures of most shipwrecks tend to be large in area and tend to display multiple magnetic peaks of differing amplitude.

In a study conducted for the Burea of Ocean and Energy Management for magnetic anomalies in the northern Gulf of Mexico, Garrison et al. (1989) indicate that a shipwreck signature will cover an area between 10,000 and 50,000 square meters. Using the Garrison et al. (1989) study, as well as years of "practical experience," in an effort to assess potential significance of remote sensing targets, the Pearson et al. (1991) study developed general characteristics of magnetometer signatures most likely to represent shipwrecks. The report states that "the amplitude of magnetic anomalies associated with shipwrecks varies considerably, but in general, the signature of large watercraft or portions of watercraft, range from moderate to high intensity (greater than 50 nanoteslas) when the sensor is at distances of 20 feet or so" (Pearson et al. 1991:70). Employing a table of magnetic data from various sources as baseline data, the report goes on to state that "data suggests that at a distance of 20 feet or fewer, watercraft of moderate size are likely to produce a magnetic anomaly [this would be a complex signature (i.e., a cluster of dipoles and/or monopoles)] greater than 80 or 90 feet across the smallest dimension..." (Pearson et al. 1991:70).

While establishing baseline amounts of amplitude and duration, reflective of the magnetic characteristics for a shipwreck site, the report "recognizes that a considerable amount of variability does occur" (Pearson et al. 1991:70). Generated in an effort to test the 50-nanotesla/80-foot criteria and to determine the amount of variability, Table 4 lists numerous shipwrecks as well as single and multiple-source objects located by magnetic survey and verified by divers. All shipwrecks meet and surpass the 50-nanotesla/80-foot criteria, while the majority of single-object readings fall below the criteria (with the exception of the pipeline, the two sections of pipe, and one of the seven rocket motors). However, the signature of the pipeline should appear as a linear feature on a magnetic contour map and not be confused with a single-source object. The strengths of the two sections of pipe represent refinement readings that sought to produce the highest reading possible and should perhaps be discounted from the sample. With respect to the rocket motors, they are single objects that, because of their association with the space program, must be considered potentially significant. While the shipwrecks and most single-source objects adhere to the 50-nanotesla/80-foot criteria, the multiple-source objects do not. If all targets listed on the table required prioritization of potential significance based on the 50-nanotesla/80-foot criteria, the two multiple-source object targets would be classified as potentially significant.

While the 50-nanotesla/80-foot criteria is a good general guide for most conditions, several recent studies have suggested that a 50-nanotesla/80-foot duration applied to remote sensing data as a baseline for all wreck sites are much too low. Allowing for a larger and more focused database on which to assess signature characteristics of specific vessel classes, the findings from these investigations argue for higher nanotesla and duration criteria for specific types of sites. Table 5 indicates the sizable magnetic deviation and duration of previously recorded and located steamboat wreck sites. However, there is one exception, each of the known steamboat wrecks investigated has a magnetic deviation of at least 500 nanoteslas and a duration of no fewer than 110 feet, usually in the greater than 200-foot range. As opposed to single objects, steamboat wrecks documented during previous investigations are generally much larger in magnetic strength (although not always), tend to have a longer duration, and typically have multi-component signatures. It should be noted, however, that each steamboat wreck signature differs markedly due to environmental conditions, amount of hull/machinery remaining, and the depth of water/overburden over the wreck site. Furthermore, it should be inferred that one of the biggest influences on a wreck site's magnetic signature is directly related to the distance from the magnetometer sensor to the wreck site. As stated in Pearson and Birchett:

> "For a typical iron object, the intensity of its magnetic signature (i.e., anomaly) is inversely proportional to the cube of the distance. One pound of iron, for example, would produce an anomaly of 100 nanoteslas at a distance of 2 feet. At a distance of 10 feet the same pound of iron would produce an anomaly of only 1 nanotesla. A 1,000-ton ship could produce a 700-nanotesla anomaly at 100 feet and a barely discernible 0.7-nanotesla anomaly at 1,000 feet" [1999:4-13].

Table 4. Compilation of Magnetic Data from Various Sources.

Vessel (Object)	Type and Size	Magnetic Deviation	Duration (ft.)	Reference
Shipwrecks				
Egmont Shoal wreck	19th century wooden-hulled copper clad sailing vessel	67	160	Krivor 2005
USS Narcissus	Civil War wooden tug	582	176	Krivor 2005
J.D. Hinde	129-ft. wooden sternwheeler	573	110	Gearhart and Hoyt 1990
Utina	267-ft. wooden freighter	690	150	James and Pearson 1991; Pearson and Simmons 1995
Mary Somers	iron-hulled sidewheeler	5,000	400	Pearson et al. 1993
Gen C.B. Comstock	177-ft. wooden hopper dredge	200	200	James et al. 1991
Mary	234-ft. iron-hulled sidewheeler	1,180	200	Hoyt 1990
El Nuevo Constante	126-ft. wooden collier	65	250	Pearson et al. 1991
James Stockton	55-ft. wooden schooner	80	130	Pearson et al. 1991
Homer	148-ft. wooden side-wheeler	810	200	Pearson and Saltus 1990
modern shrimp boat	segment 27 ¥ 5 ft.	350	90	Pearson et al. 1991
Confederate Obstructions	numerous vessels with machinery removed and filled with construction rubble	110	long duration	Irion and Bond 1984
Shrimp Boat	Modern	162	110	Watts 2000
Single Objects				
pipeline	18-in. diameter	1,570	200	Duff 1996
Pipe/mast/davit	18 in. by 26 ft.	475	104	Lydecker 2007
Pipe	3 in. by 10 ft.	55	352	Krivor 2005
anchor	6-ft. shaft	30	270	Pearson et al. 1991
iron anvil	150 lbs.	598	26	Pearson et al. 1991
engine block	modern gasoline	357	60	Rogers et al. 1990
steel drum	55 gallon	191	35	Rogers et al. 1990
pipe	8 ft. long ¥ 3 in. diameter	121	40	Rogers et al. 1990
railroad rail segment	4-ft. section	216	40	Rogers et al. 1990
7 Rocket Motors	8 ft. to 34 ft. in length	61 to 422	75 to 180	Watts 2000
Multiple Objects				
anchor/wire rope	8-ft. modern stockless/large coil	910	140	Rogers et al. 1990
cable and chain	5 ft.	30	50	Pearson et al. 1991
scattered ferrous metal	14 by 3 ft.	100	110	Pearson et al. 1991

Table 5. Magnetic Data from Steamboat Wreck Sites.

Vessel (Object)	Type and Size	Magnetic Deviation	Duration (ft.)	Reference
Shipwrecks				
Star of the West	172-ton ocean-going sidewheel	8,300	400	Krivor et al. 2002
3MO69 (unidentified)	Wooden sidewheeler	2,961	299	Buchner and Krivor 2001
Caney Creek Wreck	Sidewheeler	2,790	unknown	Hedrick 1998
Mary E. Keene	236 ft. sidewheeler	1,700	220	Robinson 1998
John Walsh	275 ft. sidewheeler	1,602	280	James et al. 2002
New Mattie	130 ft. wooden sternwheeler	1,491	200	Buchner and Krivor 2001
35th Parallel	Sidewheeler	1,414	320	Saltus 1993
Scotland	Sidewheeler	1,322	200	Kane et al. 1998
"Boiler" wreck (unidentified steamboat)	Sidewheeler/sternwheeler (?)	1,164	500	Saltus 1993
Hartford City	150 ton sidewheeler	856	400	Krivor et al. 2002
Mary Somers	Iron-hulled sidewheeler	5,000	325	Pearson et al. 1993
Homer	148 ft. wooden sidewheeler	810	200	Pearson and Saltus 1993
E.F. Dix/Eastport	Sidewheeler/ironclad	800	360	Pearson and Birchett 1995
Choctaw	223 ton sternwheel towboat	797	250	Krivor et al. 2002
J.D. Hinde	129 ft. wooden sternwheeler	573	110	Gearhart and Hoyt 1990
Oklahoma Wreck	Sidewheeler	497	300	M.C. Krivor personal comm.
Undine	Sternwheeler	200	300	James and Krivor 2000

An example of a steamboat wreck that produces a magnetic signature less than 500 nanoteslas involves the purported *Undine* site investigated by Panamerican in 1999 and 2000. During 1999, remote sensing operations located a magnetic anomaly with a magnetic deflection of 193 nanoteslas with a duration of 300 feet. During the 2000 field investigations, the anomaly was identified as the remnant of a charred steamboat approximately 38 to 40 feet below the river's surface and buried 8 feet below riverbed sediments. Historic records indicate the *Undine* was extensively salvaged after the scuttling incident; whereupon, everything of value including all iron plating, machinery, and cannon were removed from the wreck, but the hull remained in place (James and Krivor 2000:16-17). While only a small portion of the wreck site was uncovered (due to the extensive amount of overburden), it was evident that little of the hull is extant, only just to the turn of the bilge.

It should also be stated that two of the wreck sites with either small areas of deviation or low nanotesla deflections, the *J.D. Hinde* and the purported *Undine*, represent either partial hull remains (*J.D. Hinde*) or were heavily burned and salvaged (*Undine*). Historic records indicate the *J.D. Hinde* was also salvaged after the wrecking process. Retaining none of her steam machinery or wheels, half of the vessel was no longer present, most likely as a result of dredging, both salvage and dredging the obvious reason for its small magnetic duration (James and Pearson 1993:22). Salvage efforts often sought to remove any cargo as well as any machinery, cannon, anchors, or other goods of value. During the Civil War, the salvage of iron for reuse was often paramount. As stated by John B. Jones on August 11, 1863, "The iron was wanted more than anything else but men" (Black 1958:200). Therefore, it may be speculated that any wreck site that: (1) has been salvaged in the past; (2) has been exposed to excessive environmental processes (i.e., current); or (3) has been impacted by channelization efforts (i.e., dredging), will produce a lower nanotesla deflection (due to less ferrous metal on site) than a wreck not exposed to similar processes.

If the signatures of all the steamboat wrecks listed in Table 5 are averaged, a magnetic deviation averaging 1,576 nanoteslas with an average duration of 234 feet is obtained. While the sensor distance, environmental factors, and the amount of ferrous metal remaining on any given steamboat site must be taken into account, previously identified wreck sites have tended to produce sizable, greater than 200-nanotesla magnetic deviations, with a minimum duration of 110 feet. While the 110-foot duration represents the lowest duration of any of the known steamboat wreck sites, it must be stated that in such cases a portion of the wreck is no longer extant due to previous salvage and dredging/channelization efforts. However, until further surveys show that this short duration is an “anomaly” so to speak, it must be employed as the baseline duration. Similarly, with the exception of the *Undine* site, which as stated previously was heavily salvaged, all other surveyed steamboats have nanotesla deviations approaching 500 nanoteslas or above, but the 200-nanotesla reading must be employed as the baseline amplitude.

While the data indicates the validity of employing specific nanotesla strength and duration criteria when assessing magnetic anomalies, other factors must be taken into account. Pearson and Hudson (1990) have argued that the past and recent use of a water body must be an important consideration in the interpretation of remote sensing data; in many cases, this should supposedly be the most important criterion. Unless the remote sensing data, the historical record, or the specific environment (i.e., harbor entrance channel) provides compelling and overriding evidence, it is otherwise believed that the history of use should be a primary consideration in the interpretation. The constitution of “compelling evidence” is, to some extent, left to the discretion of the researcher; however, in settings where modern commercial traffic and historic use have been intensive, such as the current Project Area, the presence of a large quantity of modern debris must be anticipated. In harbor, bay, or riverine situations where traffic is heavy, this debris will be scattered along the channel Right Of Way (ROW), although it may be concentrated in areas where traffic would slow or halt, and it will appear on remote sensing survey records as discrete, small objects. This is, in fact, the case for many of the anomalies recorded during the current investigation.

In addition to anomaly strength and duration considerations, all anomalies were assessed for type [monopole (negative or positive influence), dipole (negative and positive influence), or complex] and association with other magnetic anomalies (i.e., clustering) and sidescan sonar targets. With regard to analysis of these anomalies, relative to potential significance, many will be found to represent a small, single-source object (a localized deviation), and are generally identified and labeled as non-significant, especially in an area of high use, such as adjacent to a navigation channel, similar to the current environment. As seen on contour maps, the contour lines for this type of anomaly can be seen to approach, or go to but not beyond, the adjacent survey trackline on which it is located. This visual interpretation is corroborated during the analysis of the electronic magnetometer strip-chart data of each survey trackline. An examination of a strip chart will show that the target was recorded only on a single transect, and that it was not recorded (i.e., did not influence the ambient magnetic background) on adjacent lines. This is especially true when an anomaly’s readings are large deviations but are recorded on only one line. This indicates the source for this target must be a small, discrete object, and the magnetometer sensor must have passed closely by or directly over the object in order to generate the large readings on this survey line, yet not be recorded or have had an influence on adjacent lines; especially relevant when employing a 50-foot transect interval. Because these anomalies represent single-source objects, they are not considered representative of a potentially significant submerged cultural resource and are not recommended for avoidance.

3.6.2 Sidescan Sonar

In contrast to magnetic data, sidescan interpretation is less problematic, as objects are reconstructed as they look to the eye. Targets, such as isolated sections of pipe, can normally be immediately discarded as non-significant, while large areas of above-sediment wreckage as well as some exposed paleofeatures are generally apparent. The chief factors considered in analyzing sidescan data, with regard to wreckage, include: linearity, height off bottom, size, associated magnetics, and environmental context. Since historic resources in the form of shipwrecks usually contain large amounts of ferrous compounds, complex sidescan targets with complex magnetic anomalies are of the greatest importance. The usual outcome of targets with no associated magnetics is items, such as rocks, trees, and other non-historic debris of limited interest to the archaeologist.

3.6.3 Clustering

Since an archaeological remote sensing survey involves the collection of several different types of data, each of which has the potential to locate significant cultural resources, attention must be given to groups of targets. These groupings, referred to as clustering, occur when a target exists that produces both a sidescan sonar return and a magnetic signature. In addition, a magnetic source that extends across several survey lines will produce an anomaly on each line, and since these anomalies are related, they will form a cluster. Previously discovered archaeological sites will also be considered as an aspect of clustering. Although criteria used to determine a cluster is somewhat subjective, anomalies, sidescan targets, and previously identified archaeological sites will generally be included in a cluster if they lie within 65 feet of one another.

3.6.4 Subbottom Profiler Analysis

Subbottom profilers generate low frequency acoustic waves that penetrate the seabed and reflect off boundaries or objects located in the subsurface. The data are then processed and reproduced as a cross section using two-way travel time to determine depth (the time taken for the pulse to travel from the source to the reflector and back to the receiver by a constant). The shapes, relationships, and extents of reflectors are used to infer bottom and subbottom geomorphological characteristics.

In general, high and low amplitude linear reflectors (light and dark lines) distinguish between sediment beds; parabolic reflectors indicate point-source objects with sound propagating out from them; and erosional or non-depositional contacts can be identified by discontinuities in extent, slope angle, and the shape of the reflector morphology. This latter fact is important when identifying buried and drowned channel systems and other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, and upland areas around drainage features).

In caution, there are five spurious signals that may cause confusion in the two-dimensional records that specialists recognize: direct arrival from the sound source; reflection multiples; water surface reflection; side echoes; and point-source reflections. Judicious analysis is required to identify these sound underwater imagery phenomena. Precise inference of a sediment bed or other anomaly from the subbottom profiler data would necessitate coring or excavation.

While it is challenging to know which reflectors are significant, the intent is to identify paleolandscape features likely to be conducive to human occupation and where preservation may be enhanced based on local geology and archaeology. In analysis, seismic returns indicating positive relief features as possible mounds and negative relief features as a probable channel or other fluvial feature with margins and sediment beds indicate higher potentials for prehistoric remains.

3.7 Method and Theory for Recognition of a Submerged Prehistoric Site

The methodology used for identifying submerged prehistoric sites entails developing criteria for the discovery of a "site" in any particular setting. The criteria are based on the geology and archaeology of the Project Area and models of site submergence. Models for the presence and preservation of submerged archaeological sites are discussed by several researchers, including Waters (1992) in his chapter on coastal processes, Kraft et al. (1983), and others. Much of this has to do with the identification of landforms identifiable with remote sensing that have the potential for archaeological site presence. For instance, two models used in this project were horizontal surfaces near channel features and positive relief features considered potentially to represent midden feature(s). Causeways, fishing weirs, or other prehistoric infrastructure features are difficult to identify.

Publications are more limited that are specific to recognizing sedimentary signatures of the deposits that make up sites that have been transgressed by rising sea levels and then remained submerged, perhaps buried, until exposure. One such study specifically focused on such information is Gagliano et al.'s (1982) *Sedimentary Studies of Prehistoric Archaeological Sites: Criteria for the identification of submerged archaeological Sites of the Northern Gulf of Mexico Continental Shelf*. This document is one of high value, but limited distribution. Gagliano's group chose 15 terrestrial sites in Louisiana and Texas as analogs from eight identifiable and mappable landforms with which archaeological sites are commonly and consistently associated on land, terrestrially. Their local geomorphic features included major natural levee, minor natural levee, Chenier and accretion ridges, barrier island, salt dome margin, estuarine margin, channel on Pleistocene terrace, and lake margins. They sampled sediments with excavations and box core sampling; recorded color, bedding, and contact descriptions; sorted the sediments to particle size; conducted point count and grain size analysis; and then geochemically analyzed the samples by levels. They showed that sites were recognized most frequently by shell content, fish bones, and charred wood. Some ceramic and lithic artifacts were identified, but they were rare and often small.

Another aspect to realize about submerged prehistoric sites is that virtually all examples of inundated sites are partially, or wholly, reworked in ways somewhat analogous to deflation (Masters and Flemming 1983; Fischer 1995). This is caused by fluidization of sediments at times of inundation and the removal of fine particles that are often re-deposited with material by subsidence of the inundation or wave action. Faught (2002–2004; 1996) has shown sites with late Pleistocene, early Holocene, and middle Holocene artifacts to be reworked by sea level rise and submergence, but that artifact arrays remain cohesive as surface and near surface remains.

Because of these factors, recognition that deposits are indeed cultural is not always immediately apparent to the diver, or at first glance of the collected materials. Artifacts are important, but not always part of the site, as Gagliano et al. (1982) has systematically determined. Expectations for midden deposits include dominance of unarticulated specimens of particular mollusk species, faunal bone, and manuports (i.e., geologic items out of place). On the other hand, discovery of any artifact would be important, especially in any sediment bed below a marine bed.

4.0 INVESTIGATIVE FINDINGS

Eighteen magnetic anomalies, thirty-one sidescan sonar targets, and two subbottom impedance contrast paleolandform feature areas were recorded during the current survey. Employing the previous discussions on target analysis, magnetic anomalies were assessed for potential significance based on magnetic deviation (above and/or below ambient background), duration (distance in feet, along a trackline, an anomaly influences the ambient background), type [monopole (negative or positive influence), dipole (negative and positive influence), or complex], and association with other magnetic anomalies (i.e., clustering) and/or sidescan sonar contacts. Sidescan sonar contacts, as visual images, were assessed for linearity, height off bottom, size, associated magnetics, backscatter characteristics, and visual surface associations (i.e., buoys, etc.). Subbottom features were assessed as to feature type, and association with other subbottom features and sidescan targets.

Out of all the anomalies, sonar targets, and subbottom impedance contrast features, no anomalies were considered to potentially represent significant historic cultural resources. Several sidescan sonar contacts and subbottom features were considered to represent vestiges of paleolandforms that have the possibility of containing prehistoric cultural resources sites. From review of the sidescan records, no apparent hardbottom features were identified.

4.1 Submerged Cultural Resources

4.1.1 Magnetometer Results

As listed in Table 6 and illustrated in Figure 35 (which corresponds to *Appendix B: Magnetic Anomalies Contour Maps*), a total of 18 magnetic anomalies with variations of approximately 10 nanoteslas or higher were recorded during the investigation within the survey area. Table 2 includes target location, type (i.e., monopole, dipole, complex), anomaly deviation in nanoteslas, duration in feet, and association with other targets (both magnetic and sidescan) from the current survey. The magnetic contour maps (Appendix B) are presented at a 10-nanotesla contour.

Based in part on the anomaly signature (i.e., linearity) and/or sidescan target association, the recorded anomalies have been identified as mainly single point source anomalies, with only one unknown, M18. Many of the single-source anomaly readings have large deviations (yet were recorded on only one line); this indicates the source for these targets must be small, discrete objects. This is further evidenced by the very shallow nature of the survey area. The magnetometer sensor must have passed closely by or directly over the object to generate the large readings on a survey line, but not be recorded or have had an influence on an adjacent line. The single-source anomaly type is not considered representative of a potentially significant submerged cultural resource.

The one unknown anomaly is M18. The unknown designation means there is no readily available explanation as to its source; it has no associated acoustic image. Its signal was recorded on two lines, but more on one line than the other; indicating it sits between the two lines. With only a 30-nanotesla total deviation and of relatively short duration, this anomaly is not considered to meet criteria for a potentially significant anomaly, as discussed in Section 2.0.

4.1.2 Sidescan Sonar Results

Listed in Tables 7 and 8, and illustrated in Figure 36, thirty-one sidescan sonar contacts were recorded during the analysis of the data. Their locations are shown on the magnetic contour maps in Appendix B, these "contacts" included any object or anomalous bottom return that was not uniform sand. Of the 31 sidescan sonar contacts, none represent potentially submerged cultural resources of a historic nature (i.e., shipwrecks). They represent small isolated debris (i.e., crab pots, etc.) that do not possess characteristics indicative of vessel wreckage, and none are associated with magnetic anomalies, adding further evidence to this statement. However, and as discussed below, several are indicators of paleolandscape settings and may have prehistoric site potentials.

Table 6. Magnetic Anomalies.

Anomaly	Strength (+) nT	Strength (-) nT	Duration (ft)	Type	E	N	Associations/ Comments	Appendix B Map Number
M01	10	60	70	D	2214543	233208	SPS	2
M02	0	30	37	M	2213597	232989	SPS	2
M03	0	10	15	M	2214183	233070	SPS	2
M04	0	10	15	M	2213861	232905	SPS	2
M05	0	20	45	M	2213068	231972	SPS	2
M06	20	0	35	M	2213168	232030	SPS	2
M07	20	20	60	D	2211857	230811	SPS	1
M08	0	10	15	M	2212315	232071	SPS	2
M09	0	20	35	M	2211006	230399	SPS	1
M10	0	50	175	CM	2210683	230176	SPS	1
M11	20	20	70	D	2210373	229925	SPS	1
M12	0	20	35	M	2209440	229587	SPS	1
M13	0	30	25	M	2215023	232112	SPS	2
M14	0	10	10	M	2211260	227527	SPS	3
M15	0	20	20	M	2213796	228167	SPS	3
M16	30	10	70	D	2214924	228680	SPS	4
M17	20	0	25	M	2213575	226322	SPS	5
M18	20	10	75	D	2215729	226179	Unknown	5

M= monopole, D= dipole, C= complex; SPS = Single Point Source
Coordinates in NAD83 South Carolina State Plane U.S. Survey Feet.

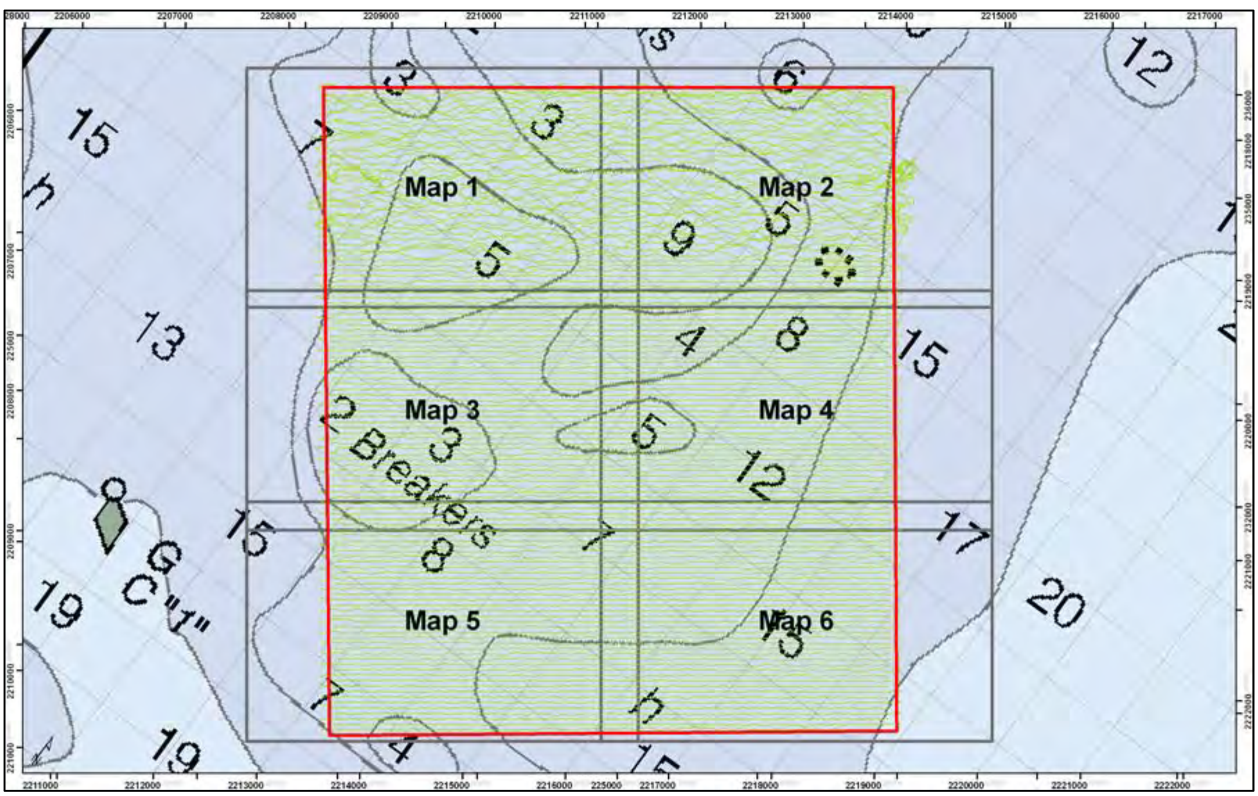


Figure 35. Map Key for Appendix B.

Table 7. Sidescan Sonar Targets within the Survey Area.

No.	Description	L (ft)	W (ft)	E	N	Association	Map No.
C-01	sediment clumps	30	20	2213206	232856		2
C-02	object in bottom, tree stump or log?	33	4	2213748	232939		2
C-03	sediment clumps measure top one	19	14	2213129	232330		2
C-04	object	10	2	2212874	231979		2
C-05	object	6	3	2212890	231889		2
C-06	object in bottom	13	7	2212925	231990		2
C-07	stump or roots or both, possible shell scatter	15	4	2213319	232095		2
C-08	object	9	6	2213610	232196		2
C-09	posts or stumps?	NA		2212907	231877	C-10, C-11, C-12	2
C-10	posts or stumps??	NA		2212903	231898	C-09, C-11, C-12	2
C-11	posts or stumps??	NA		2212931	231911	C-09, C-10, C-12	2
C-12	posts or stumps??	NA		2212888	231916	C-09, C-10, C-11	2
C-13	objects on bottom	41	8	2213948	232667		2
C-14	measure second from right	15	5	2213374	232085		2
C-15	measure largest object	10	6	2213482	232172		2
C-16	looks like wood maybe	22	11	2213537	232231		2
C-17	stumps on river margin??	12	2	2213811	232306		2
C-18	crab pot	4	4	2214250	232107		5
C-19	object on bottom	22	9	2213379	232074		2
C-20	texture difference in parallel - matting??	28	31	2213251	232149		2
C-21	cable fragment??	24		2213194	229815		2
C-22	crab pot	4	4	2215964	231228		4
C-23	object on bottom wood??	6	6	2213211	232165		2
C-24	object	6	1	2214311	225515		2
C-25	crab pot	3	3	2215946	228491		4
C-26	crab pot	3	3	2215948	228486		4
C-27	exposed sand wave? bedrock?	82	22	2213158	228191		3
C-28	vague object(s)	7	4	2216355	230356		4
C-29	crab pot	3	4	2216157	227625		6
C-30	large fish?	6		2214895	226029		5

Table 8. Sidescan Sonar Target Images.

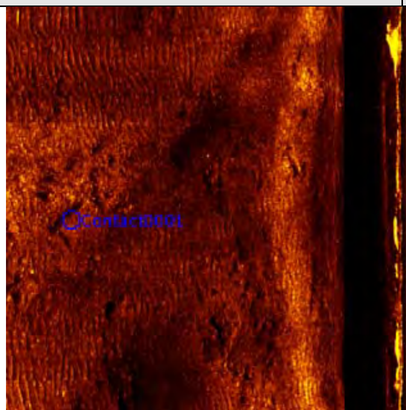
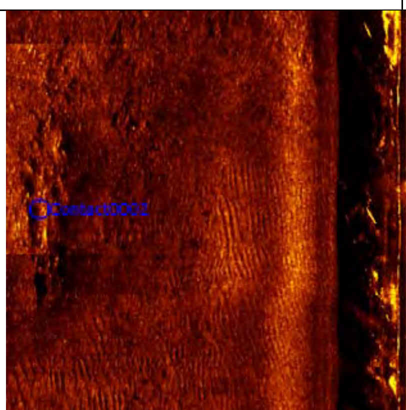
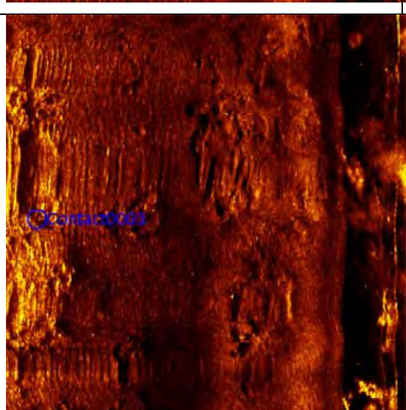
Contact Image	Contact Info	User Entered Info
	**SS-01** • Sonar Time at Target: 02/05/2013 13:30:57 • Click Position (Projected Coordinates) (X) 2213206.31 (Y) 232855.93 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB047-to-05FEB066.csf • Ping Number: 14151 • Range to Target: 25.08 US Feet • Fish Height: 0.29 US Feet • Heading: 52.200 degrees • Event Number: 0 • Line Name: 05FEB047-to-05FEB066	**Dimensions** Target Height: = 0 US Feet Target Length: 30 US Feet Target Shadow: 0 US Feet Target Width: 20 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: sediment clumps
	**SS-02** • Sonar Time at Target: 02/05/2013 14:35:52 • Click Position (Projected Coordinates) (X) 2213748.29 (Y) 232938.74 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB125-to-05FEB144.csf • Ping Number: 15809 • Range to Target: 27.42 US Feet • Fish Height: 0.12 US Feet • Heading: 45.400 degrees • Event Number: 0 • Line Name: 05FEB125-to-05FEB144	**Dimensions** Target Height: = 0 US Feet Target Length: 33 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Object in bottom .. tree stump or log?
	**SS-03** • Sonar Time at Target: 02/05/2013 15:06:12 • Click Position (Projected Coordinates) (X) 2213128.86 (Y) 232330.31 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB165-to-05FEB183.csf • Ping Number: 12768 • Range to Target: 27.66 US Feet • Fish Height: 0.29 US Feet • Heading: 47.200 degrees • Event Number: 0 • Line Name: 05FEB165-to-05FEB183	**Dimensions** Target Height: = 0 US Feet Target Length: 19 US Feet Target Shadow: 0 US Feet Target Width: 14 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: sediment clumps measure top one

Table 8. (continued)

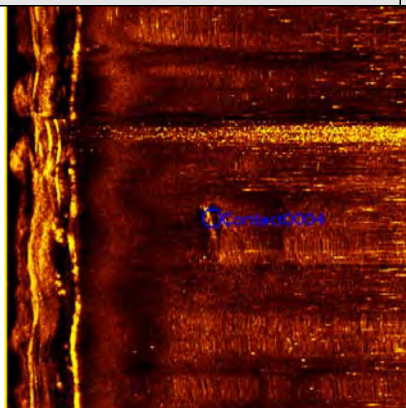
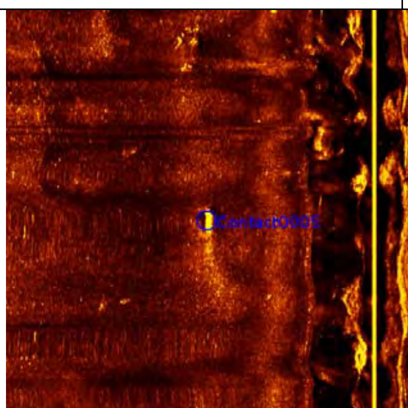
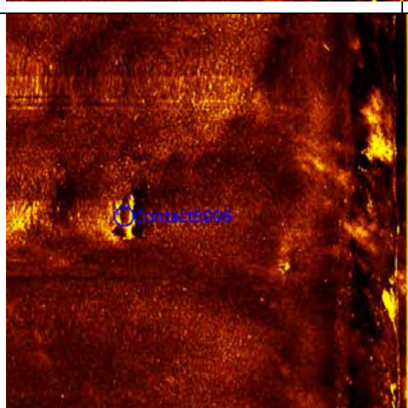
Contact Image	Contact Info	User Entered Info
	**SS-04** • Sonar Time at Target: 02/05/2013 15:17:42 • Click Position (Projected Coordinates) (X) 2212874.48 (Y) 231978.79 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB186-to-05FEB204.csf • Ping Number: 5777 • Range to Target: 15.47 US Feet • Fish Height: 0.29 US Feet • Heading: 260.800 degrees • Event Number: 0 • Line Name: 05FEB186-to-05FEB204	**Dimensions** Target Height: = 0 US Feet Target Length: 10 US Feet Target Shadow: 0 US Feet Target Width: 2 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: object
	**SS-05** • Sonar Time at Target: 02/05/2013 15:17:43 • Click Position (Projected Coordinates) (X) 2212889.80 (Y) 231888.55 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB186-to-05FEB204.csf • Ping Number: 5784 • Range to Target: 12.36 US Feet • Fish Height: 0.29 US Feet • Heading: 259.900 degrees • Event Number: 0 • Line Name: 05FEB186-to-05FEB204	**Dimensions** Target Height: = 0 US Feet Target Length: 6 US Feet Target Shadow: 0 US Feet Target Width: 3 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Object
	**SS-06** • Sonar Time at Target: 02/05/2013 15:44:10 • Click Position (Projected Coordinates) (X) 2212924.53 (Y) 231989.83 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB213-to-05FEB231.csf • Ping Number: 11907 • Range to Target: 21.15 US Feet • Fish Height: 0.12 US Feet • Heading: 61.600 degrees • Event Number: 0 • Line Name: 05FEB213-to-05FEB231	**Dimensions** Target Height: = 0 US Feet Target Length: 13 US Feet Target Shadow: 0 US Feet Target Width: 7 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: object in bottom

Table 8. (continued)

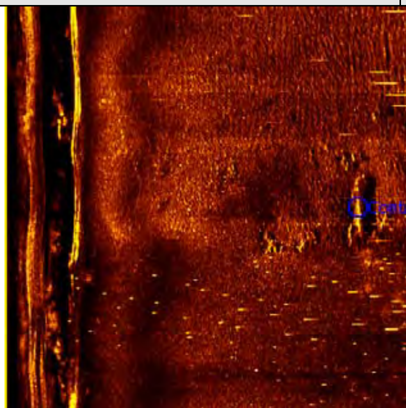
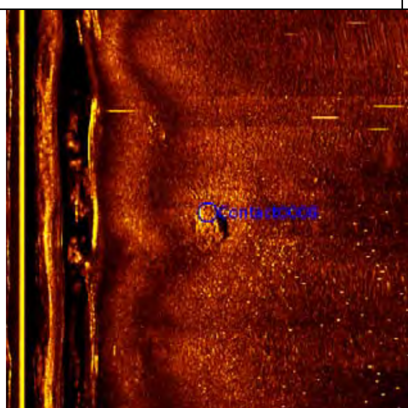
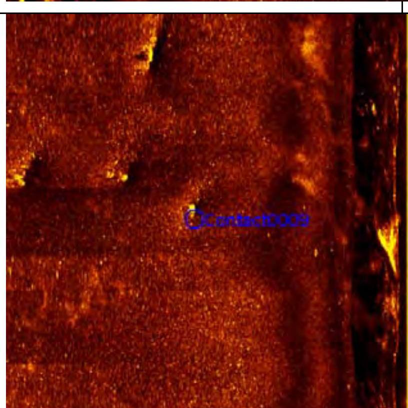
Contact Image	Contact Info	User Entered Info
	**SS-07** • Sonar Time at Target: 02/05/2013 15:44:58 • Click Position (Projected Coordinates) (X) 2213318.79 (Y) 232094.90 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB213-to-05FEB231.csf • Ping Number: 12837 • Range to Target: 26.31 US Feet • Fish Height: 0.12 US Feet • Heading: 35.000 degrees • Event Number: 0 • Line Name: 05FEB213-to-05FEB231	**Dimensions** Target Height: = 0 US Feet Target Length: 15 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: stump or roots or both possible shell scatter
	**SS-08** • Sonar Time at Target: 02/05/2013 16:47:16 • Click Position (Projected Coordinates) (X) 2213610.34 (Y) 232196.29 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB233-to-05FEB269.csf • Ping Number: 14523 • Range to Target: 13.77 US Feet • Fish Height: 0.76 US Feet • Heading: 43.200 degrees • Event Number: 0 • Line Name: 05FEB233-to-05FEB269	**Dimensions** Target Height: = 0 US Feet Target Length: 9 US Feet Target Shadow: 0 US Feet Target Width: 6 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: object
	**SS-09** • Sonar Time at Target: 02/05/2013 16:15:38 • Click Position (Projected Coordinates) (X) 2212906.93 (Y) 231877.37 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 10984 • Range to Target: 15.94 US Feet • Fish Height: 0.35 US Feet • Heading: 50.700 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 0 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: posts or stumps?? buried structure

Table 8. (continued)

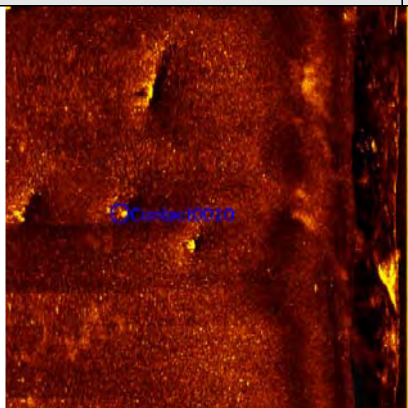
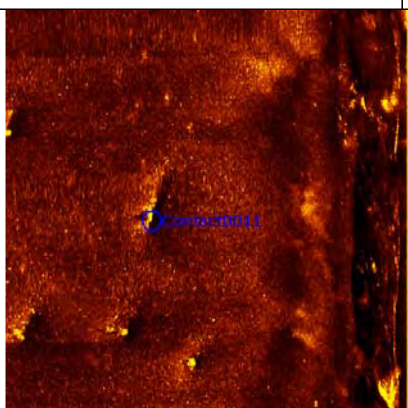
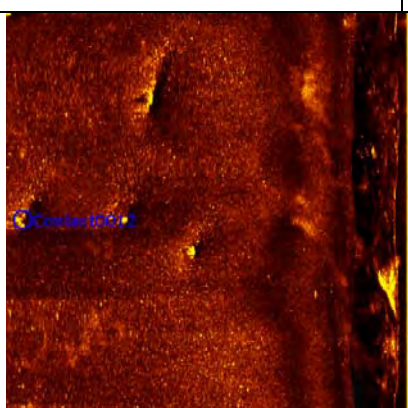
Contact Image	Contact Info	User Entered Info
	**SS-10** • Sonar Time at Target: 02/05/2013 16:15:39 • Click Position (Projected Coordinates) (X) 2212903.37 (Y) 231897.91 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 11008 • Range to Target: 21.45 US Feet • Fish Height: 0.35 US Feet • Heading: 52.400 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 0 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: posts or stumps??
	**SS-11** • Sonar Time at Target: 02/05/2013 16:15:42 • Click Position (Projected Coordinates) (X) 2212931.18 (Y) 231910.53 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 11075 • Range to Target: 19.10 US Feet • Fish Height: 0.35 US Feet • Heading: 49.700 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 0 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: posts or stumps??
	**SS-12** • Sonar Time at Target: 02/05/2013 16:15:39 • Click Position (Projected Coordinates) (X) 2212888.24 (Y) 231916.08 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 11008 • Range to Target: 28.65 US Feet • Fish Height: 0.35 US Feet • Heading: 52.400 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 0 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: posts or stumps??

Table 8. (continued)

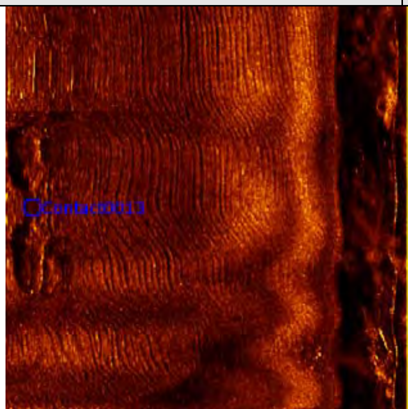
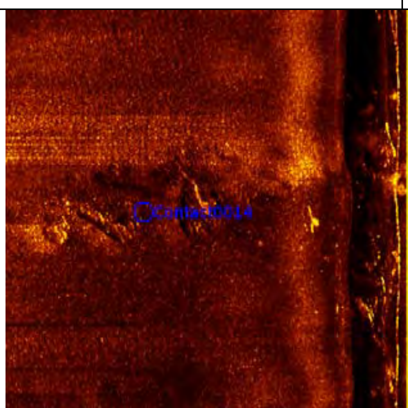
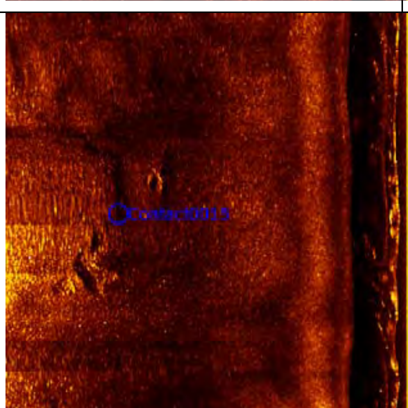
Contact Image	Contact Info	User Entered Info
	**SS-13** • Sonar Time at Target: 02/05/2013 16:18:11 • Click Position (Projected Coordinates) (X) 2213947.91 (Y) 232666.89 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 14103 • Range to Target: 27.95 US Feet • Fish Height: 0.35 US Feet • Heading: 61.300 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 41 US Feet Target Shadow: 0 US Feet Target Width: 8 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: objects on bottom
	**SS-14** • Sonar Time at Target: 02/05/2013 17:19:02 • Click Position (Projected Coordinates) (X) 2213374.41 (Y) 232085.50 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB271-to-05FEB287.csf • Ping Number: 12585 • Range to Target: 19.69 US Feet • Fish Height: 0.47 US Feet • Heading: 51.800 degrees • Event Number: 0 • Line Name: 05FEB271-to-05FEB287	**Dimensions** Target Height: = 0 US Feet Target Length: 15 US Feet Target Shadow: 0 US Feet Target Width: 5 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: objects on bottom
	**SS-15** • Sonar Time at Target: 02/05/2013 17:19:17 • Click Position (Projected Coordinates) (X) 2213482.15 (Y) 232172.32 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB271-to-05FEB287.csf • Ping Number: 12901 • Range to Target: 21.56 US Feet • Fish Height: 0.47 US Feet • Heading: 57.100 degrees • Event Number: 0 • Line Name: 05FEB271-to-05FEB287	**Dimensions** Target Height: = 0 US Feet Target Length: 10 US Feet Target Shadow: 0 US Feet Target Width: 6 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: objects on bottom

Table 8. (continued)

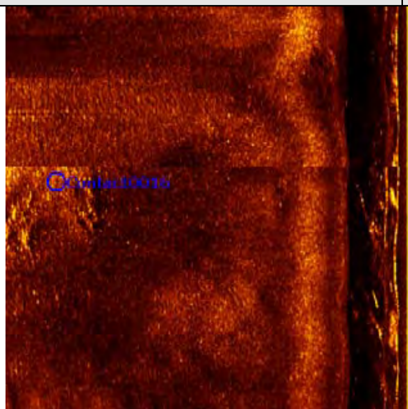
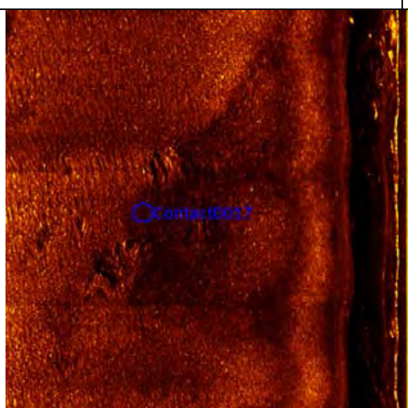
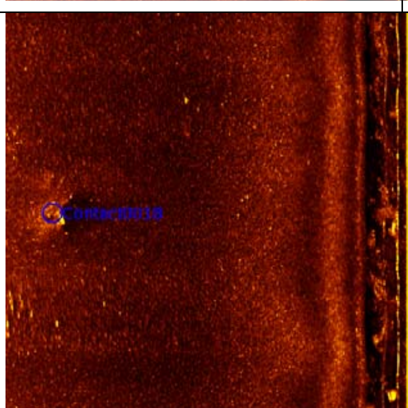
Contact Image	Contact Info	User Entered Info
	**SS-16** • Sonar Time at Target: 02/05/2013 17:19:27 • Click Position (Projected Coordinates) (X) 2213536.97 (Y) 232231.00 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB271-to-05FEB287.csf • Ping Number: 13114 • Range to Target: 26.19 US Feet • Fish Height: 0.47 US Feet • Heading: 56.100 degrees • Event Number: 0 • Line Name: 05FEB271-to-05FEB287	**Dimensions** Target Height: = 0 US Feet Target Length: 22 US Feet Target Shadow: 0 US Feet Target Width: 11 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: looks like wood maybe
	**SS-17** • Sonar Time at Target: 02/05/2013 17:50:30 • Click Position (Projected Coordinates) (X) 2213811.35 (Y) 232306.40 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB289-to-05FEB307.csf • Ping Number: 14656 • Range to Target: 19.75 US Feet • Fish Height: 0.35 US Feet • Heading: 58.800 degrees • Event Number: 0 • Line Name: 05FEB289-to-05FEB307	**Dimensions** Target Height: = 0 US Feet Target Length: 12 US Feet Target Shadow: 0 US Feet Target Width: 12 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: stumps on river margin??
	**SS-18** • Sonar Time at Target: 02/05/2013 20:16:28 • Click Position (Projected Coordinates) (X) 2214250.00 (Y) 232106.87 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB446-to-05FEB464.csf • Ping Number: 14547 • Range to Target: 26.43 US Feet • Fish Height: 0.35 US Feet • Heading: 50.600 degrees • Event Number: 0 • Line Name: 05FEB446-to-05FEB464	**Dimensions** Target Height: = 0 US Feet Target Length: 4 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Crab Pot

Table 8. (continued)

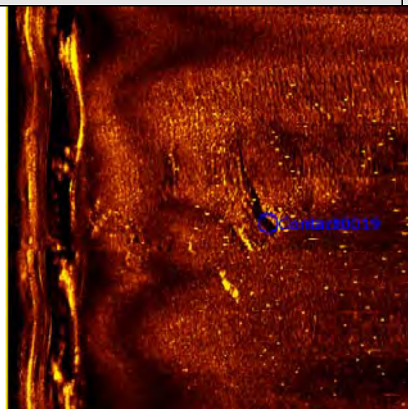
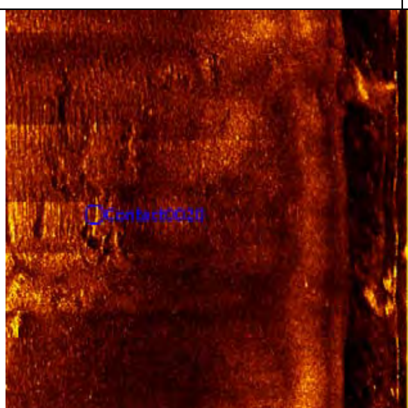
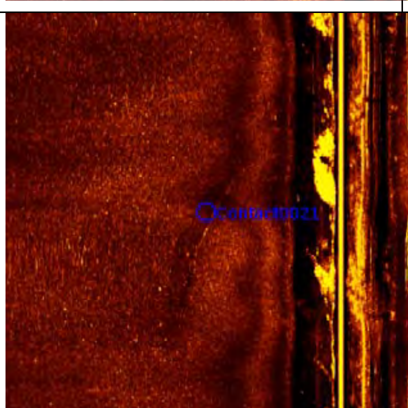
Contact Image	Contact Info	User Entered Info
	**SS-19** • Sonar Time at Target: 02/05/2013 16:16:34 • Click Position (Projected Coordinates) (X) 2213379.06 (Y) 232074.21 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 12138 • Range to Target: 19.51 US Feet • Fish Height: 0.35 US Feet • Heading: 51.900 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 22 US Feet Target Shadow: 0 US Feet Target Width: 9 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Object on bottom
	**SS-20** • Sonar Time at Target: 02/05/2013 16:16:27 • Click Position (Projected Coordinates) (X) 2213250.53 (Y) 232149.44 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB234-to-05FEB250.csf • Ping Number: 11992 • Range to Target: 23.32 US Feet • Fish Height: 0.35 US Feet • Heading: 65.700 degrees • Event Number: 0 • Line Name: 05FEB234-to-05FEB250	**Dimensions** Target Height: = 0 US Feet Target Length: 28 US Feet Target Shadow: 0 US Feet Target Width: 31 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: texture difference in parallel - matting??
	**SS-21** • Sonar Time at Target: 02/06/2013 17:24:01 • Click Position (Projected Coordinates) (X) 2213194.12 (Y) 229815.08 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto2\06FEB417-to-06FEB434.csf • Ping Number: 9006 • Range to Target: 9.90 US Feet • Fish Height: 0.41 US Feet • Heading: 52.600 degrees • Event Number: 0 • Line Name: 06FEB417-to-06FEB434	**Dimensions** Target Height: = 0 US Feet Target Length: 24 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: teeny piece of cable??

Table 8. (continued)

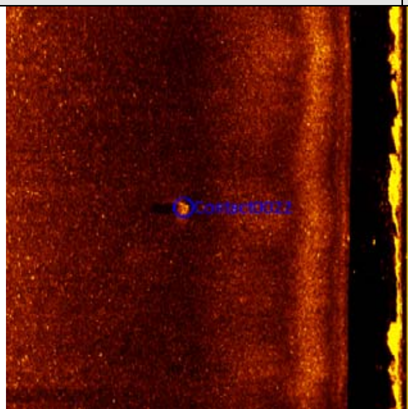
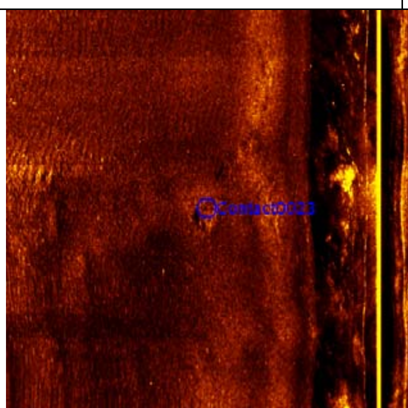
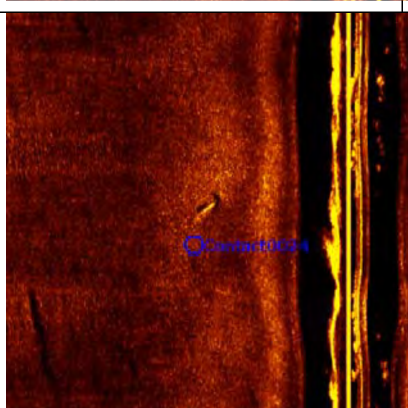
Contact Image	Contact Info	User Entered Info
	**SS-22** • Sonar Time at Target: 02/06/2013 20:03:49 • Click Position (Projected Coordinates) (X) 2215964.02 (Y) 231228.08 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto2\06FEB577-to-06FEB595.csf • Ping Number: 16972 • Range to Target: 16.76 US Feet • Fish Height: 0.00 US Feet • Heading: 47.700 degrees • Event Number: 0 • Line Name: 06FEB577-to-06FEB595	**Dimensions** Target Height: = 0 US Feet Target Length: 4 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: crab pot
	**SS-23** • Sonar Time at Target: 02/05/2013 15:44:57 • Click Position (Projected Coordinates) (X) 2213210.93 (Y) 232164.99 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\05FEB213-to-05FEB231.csf • Ping Number: 12800 • Range to Target: 12.71 US Feet • Fish Height: 0.12 US Feet • Heading: 35.600 degrees • Event Number: 0 • Line Name: 05FEB213-to-05FEB231	**Dimensions** Target Height: = 0 US Feet Target Length:6 US Feet Target Shadow: 0 US Feet Target Width:6 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: object on bottom, wood??
	**SS-24** • Sonar Time at Target: 02/14/2013 17:41:47 • Click Position (Projected Coordinates) (X) 2214311.31 (Y) 225515.04 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\14FEB213-to-14FEB229.csf • Ping Number: 10908 • Range to Target: 11.48 US Feet • Fish Height: 0.00 US Feet • Heading: 234.700 degrees • Event Number: 0 • Line Name: 14FEB213-to-14FEB229	**Dimensions** Target Height: = 0 US Feet Target Length: 6 US Feet Target Shadow: 0 US Feet Target Width: 1 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: object

Table 8. (continued)

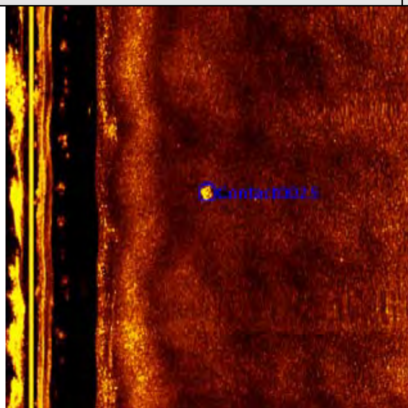
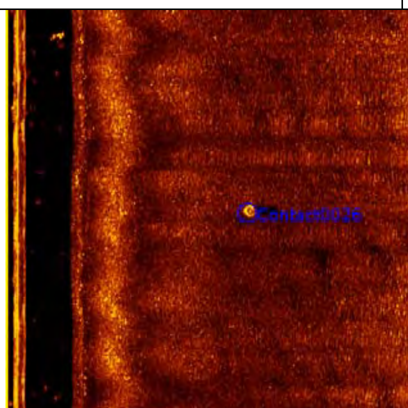
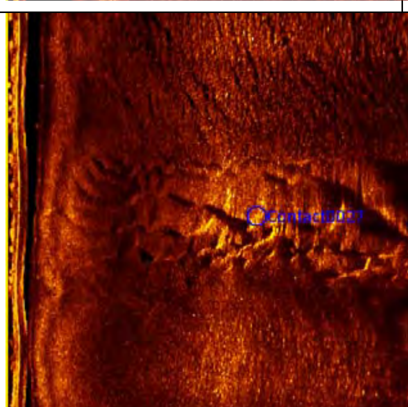
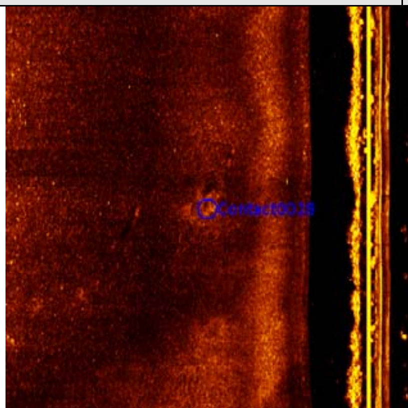
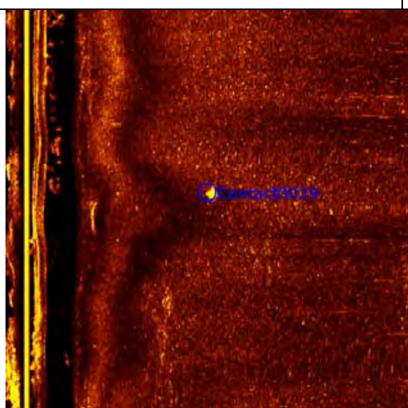
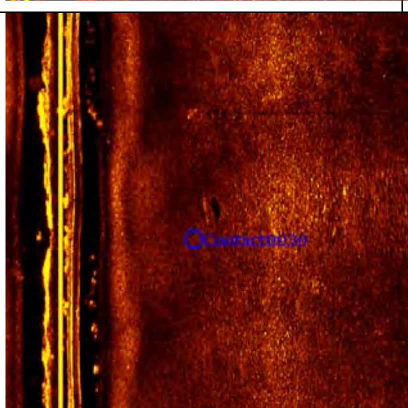
Contact Image	Contact Info	User Entered Info
	**SS-25** • Sonar Time at Target: 02/07/2013 04:38:32 • Click Position (Projected Coordinates) (X) 2215945.56 (Y) 228491.46 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto3\06FE1216-to-06FE1234.csf • Ping Number: 4256 • Range to Target: 13.07 US Feet • Fish Height: 0.00 US Feet • Heading: 230.900 degrees • Event Number: 0 • Line Name: 06FE1216-to-06FE1234	**Dimensions** Target Height: = 0 US Feet Target Length: 3 US Feet Target Shadow: 0 US Feet Target Width: 3 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: crab pot
	**SS-26** • Sonar Time at Target: 02/07/2013 04:30:13 • Click Position (Projected Coordinates) (X) 2215948.11 (Y) 228486.05 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto3\06FE1196-to-06FE1215.csf • Ping Number: 13676 • Range to Target: 17.99 US Feet • Fish Height: 0.00 US Feet • Heading: 57.900 degrees • Event Number: 0 • Line Name: 06FE1196-to-06FE1215	**Dimensions** Target Height: = 0 US Feet Target Length: 3 US Feet Target Shadow: 0 US Feet Target Width: 3 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Crab pot
	**SS-27** • Sonar Time at Target: 02/06/2013 22:44:20 • Click Position (Projected Coordinates) (X) 2213157.92 (Y) 228191.12 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto3\06FEB776-to-06FEB794.csf • Ping Number: 7036 • Range to Target: 18.63 US Feet • Fish Height: 0.00 US Feet • Heading: 55.000 degrees • Event Number: 0 • Line Name: 06FEB776-to-06FEB794	**Dimensions** Target Height: = 0 US Feet Target Length: 82 US Feet Target Shadow: 0 US Feet Target Width: 22 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Exposed sand wave? Bedrock?

Table 8. (concluded)

Contact Image	Contact Info	User Entered Info
	**SS-28** • Sonar Time at Target: 02/06/2013 23:56:29 • Click Position (Projected Coordinates) (X) 2216354.84 (Y) 230356.08 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto3\06FEB854-to-06FEB872.csf • Ping Number: 16588 • Range to Target: 11.95 US Feet • Fish Height: 0.00 US Feet • Heading: 52.600 degrees • Event Number: 0 • Line Name: 06FEB854-to-06FEB872	**Dimensions** Target Height: = 0 US Feet Target Length: 7 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: vague object(s)
	**SS-29** • Sonar Time at Target: 02/14/2013 15:39:23 • Click Position (Projected Coordinates) (X) 2216157.30 (Y) 227624.50 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\14FEB063-to-14FEB081.csf • Ping Number: 5651 • Range to Target: 13.42 US Feet • Fish Height: 0.00 US Feet • Heading: 250.900 degrees • Event Number: 0 • Line Name: 14FEB063-to-14FEB081	**Dimensions** Target Height: = 0 US Feet Target Length: 3 US Feet Target Shadow: 0 US Feet Target Width: 4 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Crab pot
	**SS-30** • Sonar Time at Target: 02/14/2013 17:40:26 • Click Position (Projected Coordinates) (X) 2214894.54 (Y) 226029.01 • Map Proj: SC83F • Acoustic Source File: C:\SonarWiz-Projects\Edisto\14FEB213-to-14FEB229.csf • Ping Number: 9194 • Range to Target: 9.91 US Feet • Fish Height: 0.00 US Feet • Heading: 237.000 degrees • Event Number: 0 • Line Name: 14FEB213-to-14FEB229	**Dimensions** Target Height: = 0 US Feet Target Length: 6 US Feet Target Shadow: 0 US Feet Target Width: 0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: large fish?

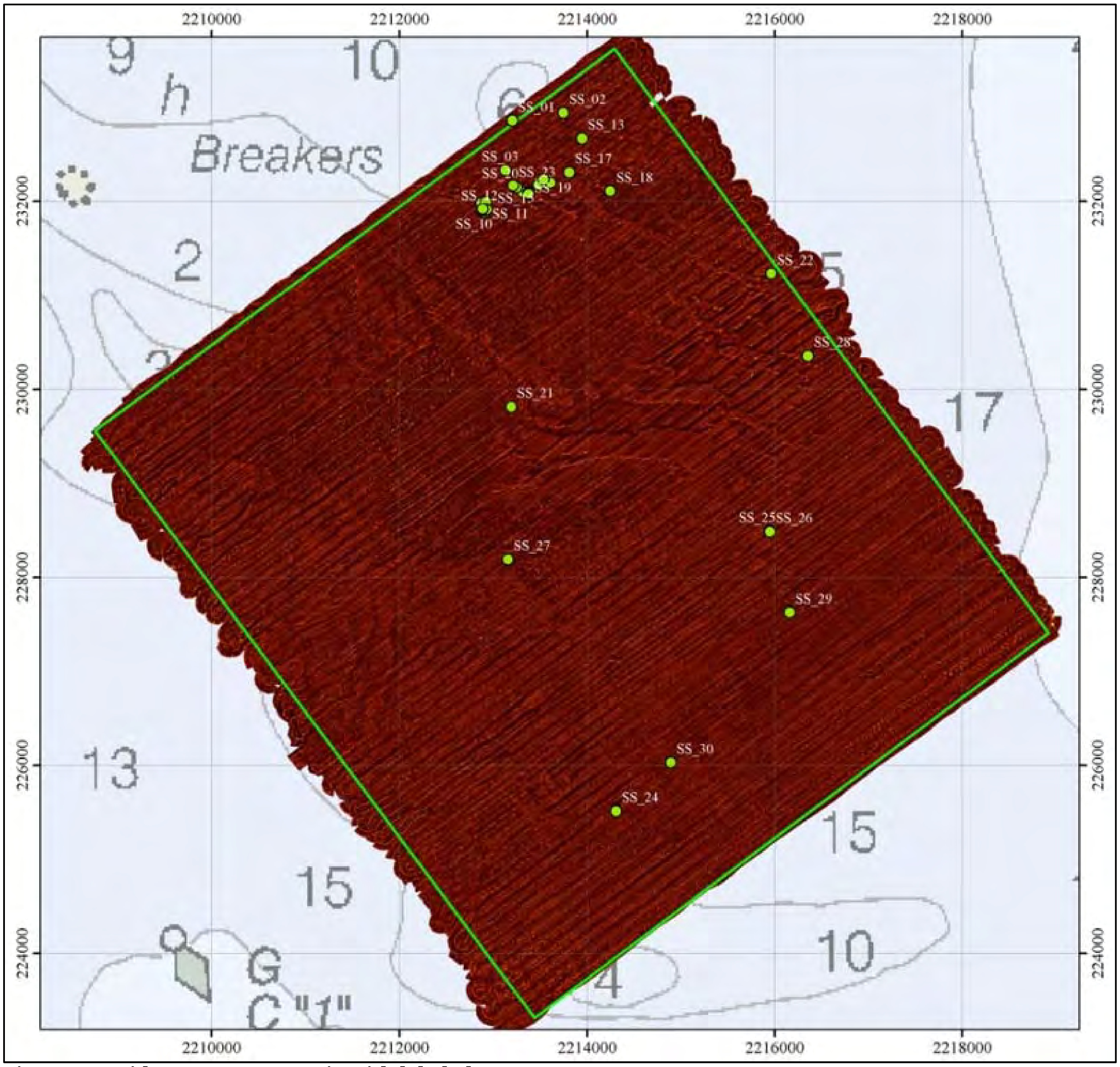


Figure 36. Sidescan sonar mosaic with labeled contacts.

4.1.3 Sidescan Sonar and Subbottom Profiler Results With Respect to Submerged Prehistoric Potentials

4.1.3.1 Sidescan Sonar Results

In addition to analyzing the acoustic images for evidence of historic shipwrecks, or other objects sitting on or in the marine sediments, the record was scrutinized for evidence of former landscape features or other evidence of pre-inundation paleolandscape settings where human activities might have taken place. Figure 36 above shows the locations of contacts recorded during the analysis of the sidescan data on a mosaiced geo-referenced image, including a cluster of 20 in the northeastern quadrant that record portions of a blocky, rugged area of apparently disintegrating topography, an example of which is shown in Figure 37.

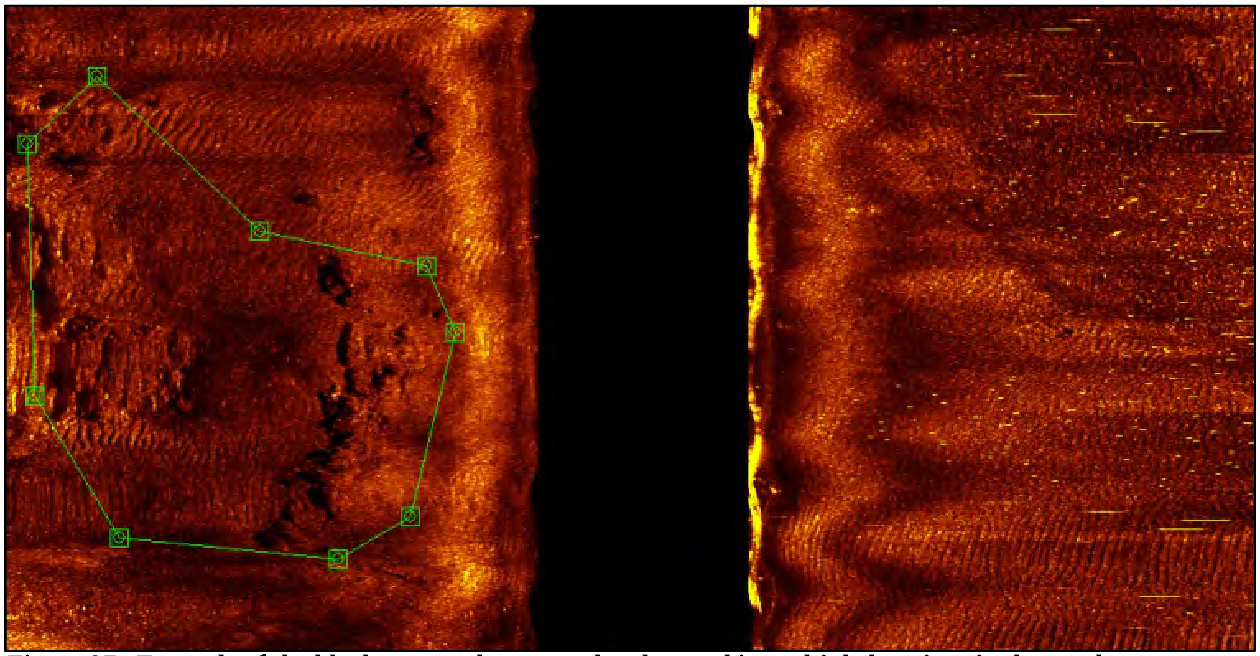


Figure 37. Example of the blocky, rugged topography observed in multiple locations in the northern corner.

These contacts (see SS-01 to SS-20 with the exception of crab pots, etc.) include blocky textures, stumps, and other evidence for wood or reworked paleolandscape (see Table 8). This area is highly potential for prehistoric archaeological sites from times when this area would have been tidal marsh or even coastal environment, before inundation.

SS-05 and SS-09 to SS-12, in particular, represent five posts or stumps that protrude from the bottom. These objects are apparently vertical, but their depth and overall lengths are unknown, as is their age and formation. It is considered possible that these could represent a pile dwelling or other infrastructure construction *sensu* Crook (2007) preserved in the sediments and therefore the feature, and the surrounding paleolandscape, should be avoided or investigated in more detail.

Based on the subbottom profiler record, the exposed possible surface may continue into the sediment bank to the west, away from the exposure. Because this may be an area that could potentially contain pre-Contact era cultural resource sites, it should be avoided by a distance of 1,500 feet around an arbitrary point at E2213373, N232446.

Another apparent feature that covers much of the study area is bounded units of change in the surface expression of the bottom. These were assumed to be textural changes more than changes in relief of unknown significance to reconstructing the paleolandscapes of the study area. Several of these features and their orientation are shown in Figure 38 by white arrows. In general, less distinct bottom returns characterized the western half of the study area and more distinct bottom returns were observed in the eastern, particularly the northeastern portions of the study area.

Farther south, sand waves transition to featureless, less reflective areas. It was also noted that different sand wave configurations included changes in wave height and size, as well as the apparent angularity, which probably indicates that these areas are controlled by different local tidal flow regimes.

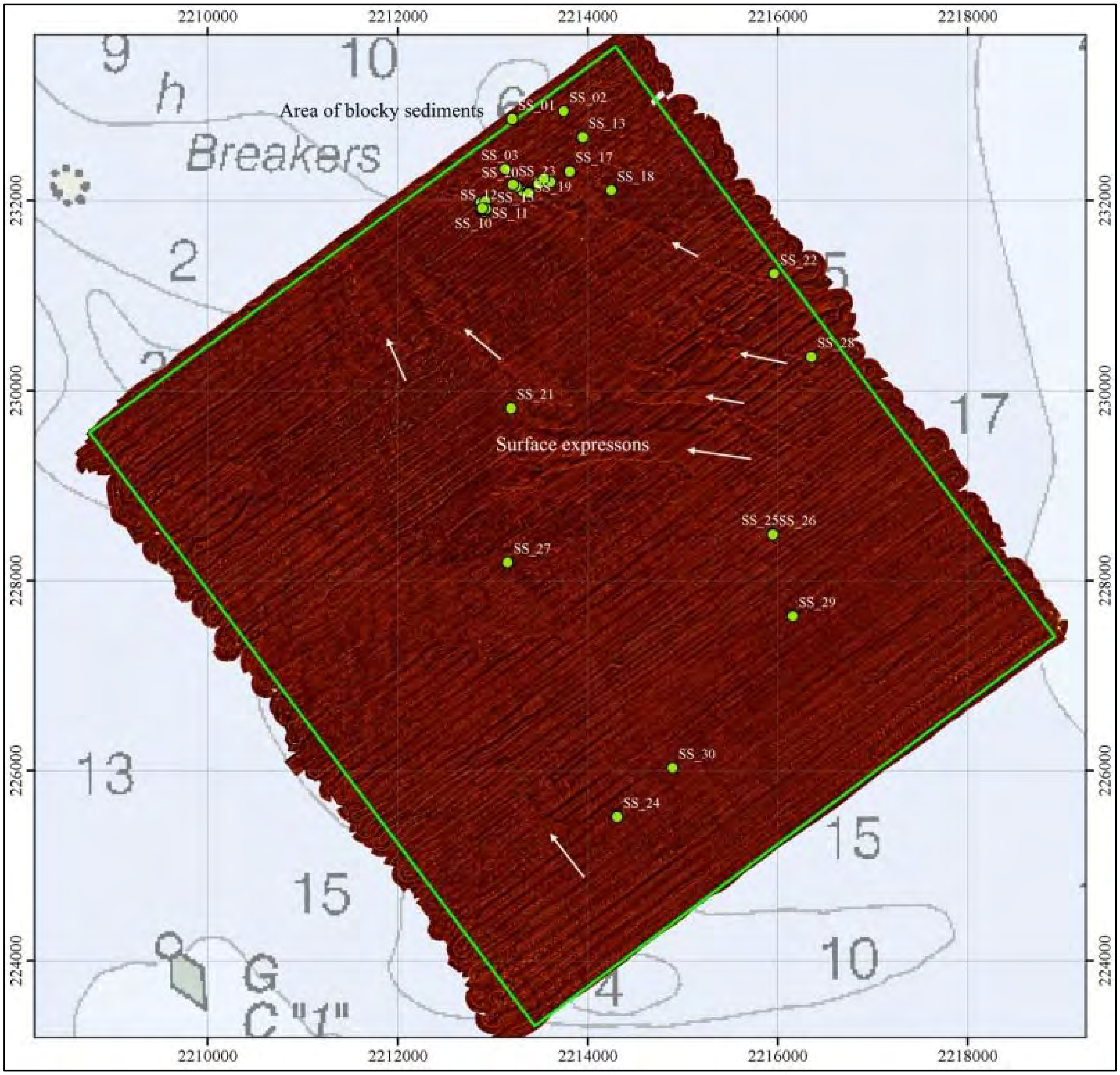


Figure 38. Mosaic with arrows marking changes in the surface expression of the bottom.

4.1.3.2 Subbottom Profiler Results

With respect to subbottom profiler data for the survey, Figure 39 shows the trackline record ghosted and the extent of features mapped in SonarWiz.MAp during the analysis of the data. The bolded tracklines are the example profiles presented in Figure 40.

In general, there were areas of higher relief, i.e., shallower portions that were less reflective overall, with a zone of 6 to 7 feet of somewhat darker reflection, with an abrupt transition to less reflectivity at approximately 18 feet depth, as if there were a horizon or horizontal transition. Lower swale areas exhibited increased reflectivity; possibly indicating finer, possibly organic material; although without coring or other sampling, these remain explanations for the data in need of testing.

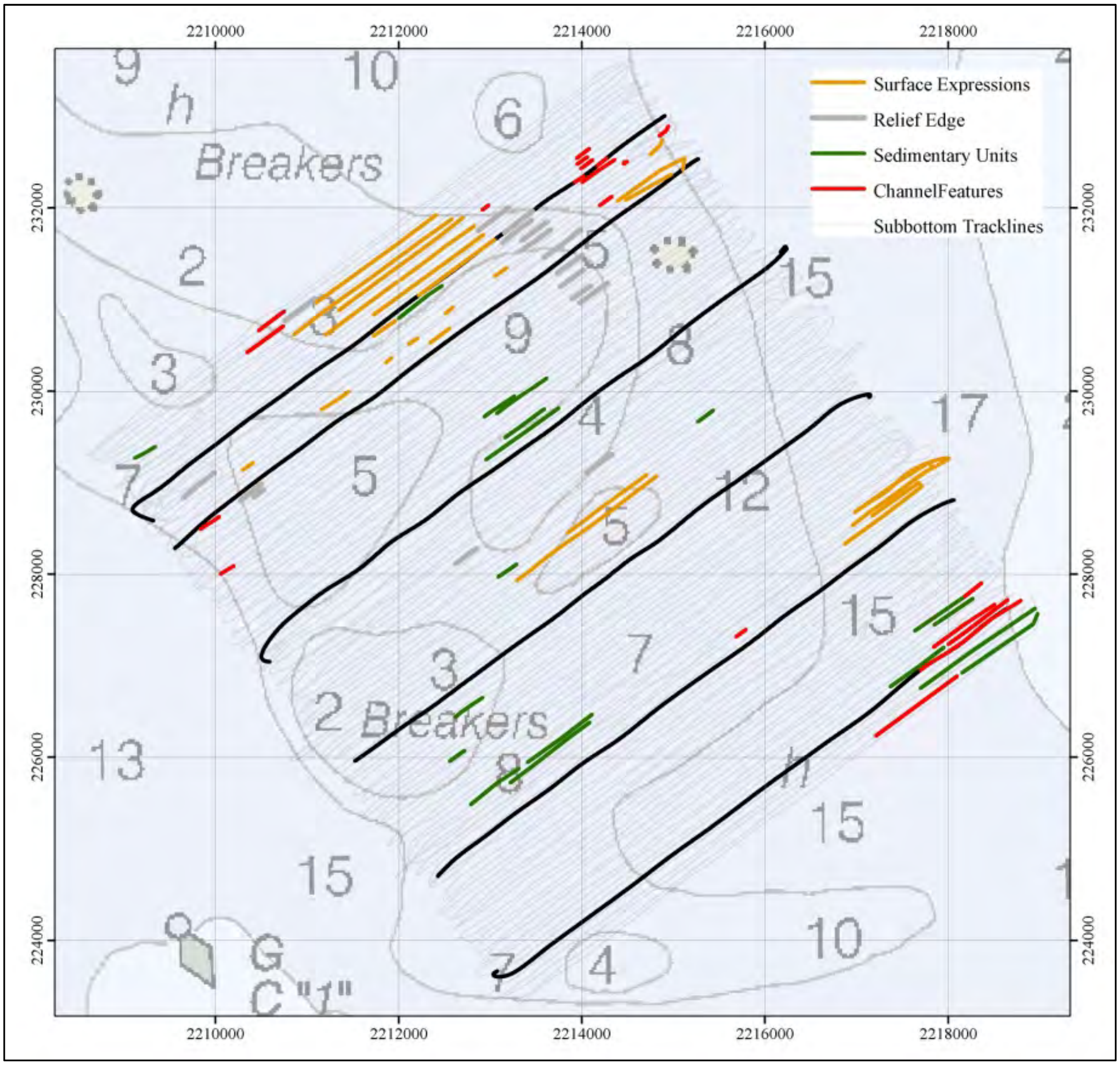


Figure 39. Subbottom trackline record ghosted, bolded tracklines shown in the profile composite in Figure 40. Features were mapped in SonarWiz.MAp during the analysis of the data.

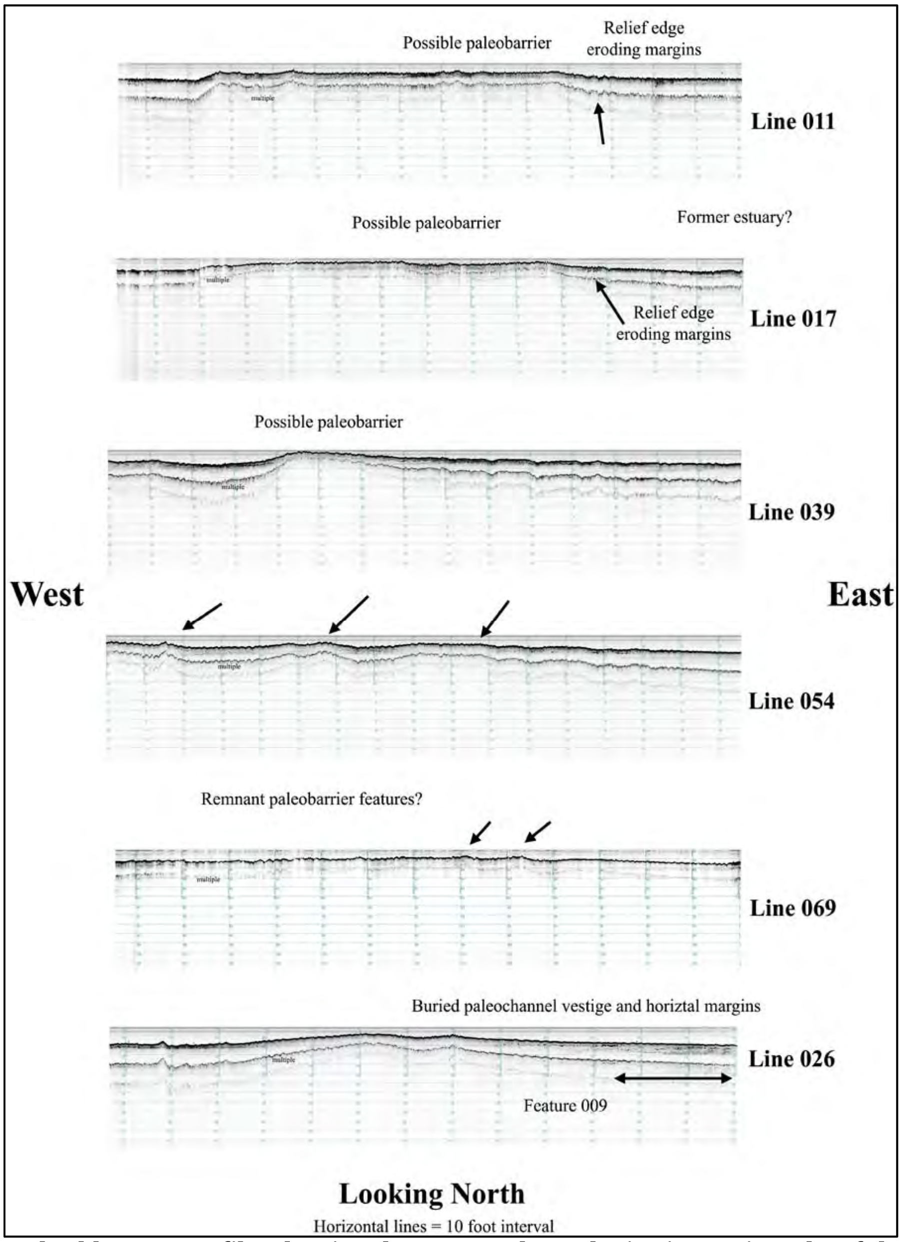


Figure 40. Selected subbottom profiles showing the topography and seismic stratigraphy of the study area.

Features mapped included possible paleochannels (areas of increased reflectivity and apparent stratification) as well areas of horizontal facies (strata). Both of these can be useful paleoenvironmental records for the geologist, but not necessarily indicative of potential archaeological site locations for the culture resources manager. On the other hand, horizontal surfaces or horizons of sediments on the margins of paleochannels are highly potential for archaeological sites, depending on the age of the horizontal strata being latest Pleistocene or Holocene (i.e. recent).

Based on the subbottom record, there is one such situation that was crossed over several trackline passes in the southeastern corner of the study area, an example of which is shown in Figure 41. Because the age of this feature is unknown, we recommend that it be avoided by a radius of 1,500 feet around an arbitrary center point at E2218203, N227338, or studied in more detail.

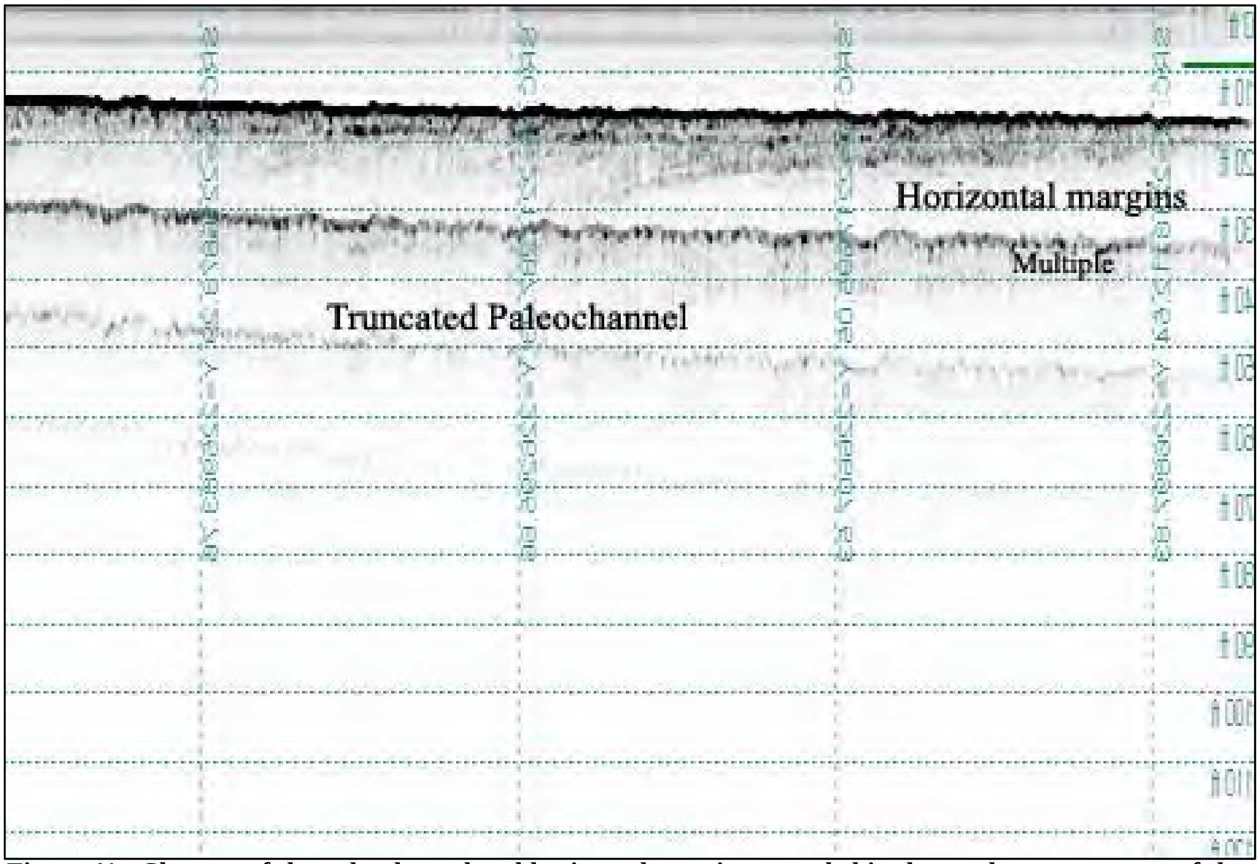


Figure 41. Close up of the paleochannel and horizontal margins recorded in the southeastern corner of the study area.

Since the sidescan sonar record indicated potential exposed and shallowly buried paleolandscapes in the northeastern portion of the study area, additional effort was placed there to understand the sidescan configurations and investigate the possibility of additional understanding of the remote sensing record with regard to submerged prehistoric sites. Figure 39 shows that this resulted in mapping a change of elevation that may be the transition from paleobarrier to paleosubmerged conditions, where both are now submerged. Some small areas of increased reflectivity were mapped to the east of the change in slope in the lower, deeper portion as vestiges of small paleochannels, as well as the aforementioned zone of increased reflection to the west in the shallower, higher relief, paleobarrier. These can be seen with close inspection of Figure 40, Lines 011 and 017.

4.1.4 Summary

In general, the entire Edisto Beach study area has the possibility, albeit slight, to contain eroded prehistoric archaeological sites, particularly Middle Archaic sites because the area was an exposed paleocoastal or paleoestuarine configuration at times when people may have been in the area. However, determining the specific location of any particular locus of activity is beyond the capabilities of the state of the art and industry standard remote sensing regime used in this report. Other strategies of cultural resources management could be utilized in this large area such as determining the age of the features or monitoring the dredge spoil on the dredge or once it is deposited on the beach.

On the other hand, there are two areas of potential paleolandscape settings that should be avoided or studied in greater detail. One area includes an exposed paleolandscape with multiple logs (or stumps) that has one feature of possible upright posts indicating a possible shallowly buried structure (Crook 2007) in the northeastern quadrant of the study area, as indicated by the sidescan sonar data. Subbottom profiler data indicate that the exposed and shallowly buried landscape sediments may continue into the inferred paleobarrier sediments to the west, away from the exposed portions. Because this may contain potentially eligible pre-Contact cultural resources, it should be avoided by a distance of 1,500 feet around an arbitrary point at E2213373, N232446 (Figure 42).

The second area, based on the subbottom record, is a buried paleochannel feature with horizontal margins within the study area at the far southeastern corner. Because the age of this feature is unknown, we recommend that it should be avoided by a radius of 1,500 feet around an arbitrary center point at E2218203, N227338, or studied in more detail (see Figure 42).

4.2 Hardbottom Resources

Review of existing data sources for the Edisto borrow area survey included the South Carolina Department of Natural Resources, NOAA Digital Coast, and the U.S. Navy (Atlantic GIS data set). All data sources consisted of the same Southeast Area Monitoring and Assessment Program (SEAMAP) coverage, which was supplemented by U.S. Navy-Atlantic GIS artificial reef and shipwreck location data.

The SEAMAP project began in 1985 and was finalized in 2001 with the goal of classifying the coastal ocean bottom along the Southeastern U.S. (North Carolina to Florida) out to a 200-meter depth. The SEAMAP data were structured into one-minute latitude by one-minute longitude grid cells, where each cell was ultimately determined to represent hardbottom, possible hardbottom, or not hardbottom habitat. Over 65,000 data records (scientific diver observations, video and still camera, dredge data, and sidescan data) were analyzed and integrated to develop the SEAMAP bottom mapping classifications (Van Dolah et al. 1994:46). Based on review of this information, there are no known documented hardbottom occurrences within the proximity of the survey area. All sidescan records were reviewed by our remote sensing analyst who is experienced in identifying hardbottom signatures. Based on the background research, sidescan survey performed, and interpretation of the survey records, no hardbottom habitat is likely to occur within the defined survey area. National Marine Fisheries Service (NMFS) review and concurrence on these findings is required for compliance with the Magnuson-Stevens Fisheries Conservation and Management Act. Since no hardbottom signatures were identified from sidescan records, the USACE has determined that implementation of Phase 2 of the SOW (towed video and habitat characterization) is not required.

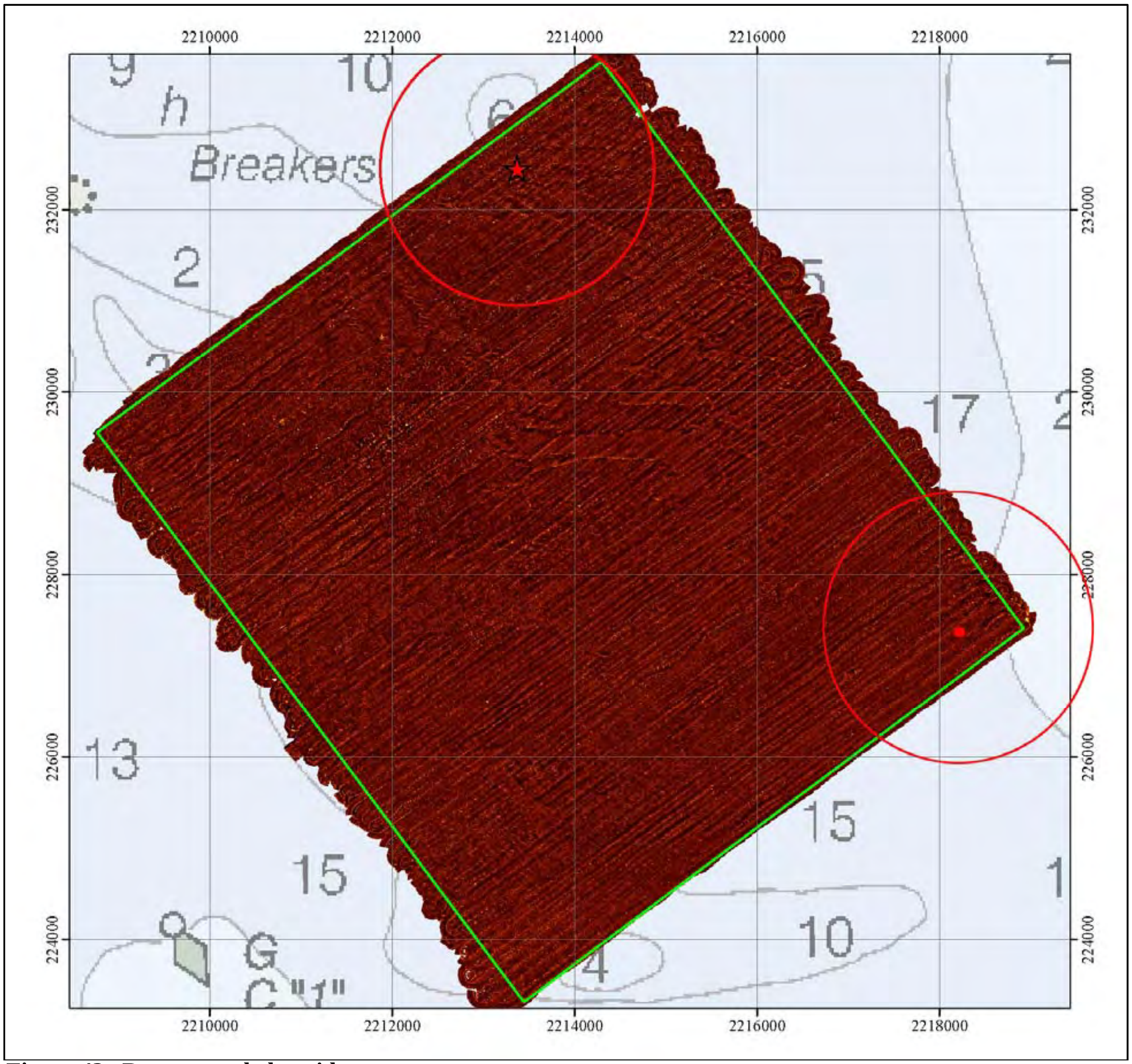


Figure 42. Recommended avoidance zones.

5.0 CONCLUSIONS

5.1 Cultural Resources

Eighteen magnetic anomalies, thirty-one sidescan sonar targets, and two subbottom impedance contrast features in the form of paleolandform areas were recorded during the current survey. Out of all the anomalies, sonar targets, and subbottom impedance contrast features, no anomalies were considered to potentially represent significant historic cultural resources. Several sidescan sonar contacts and subbottom features were considered to represent vestiges of paleolandforms that have the possibility of containing prehistoric cultural resources sites. Illustrated in Figure 43, the two areas of potential paleolandscape settings that should be avoided include an area of exposed paleolandscape with multiple logs (or stumps) that has one feature of possible upright posts indicating a possible structure. Because this may contain potentially eligible pre-Contact cultural resources, it should be avoided by a distance of 1,500 feet around an arbitrary point at

E2213373, N232446 (see Figure 43). The second area, based on the subbottom record, is a buried paleochannel feature with horizontal margins within the study area at the far southeastern corner. Because the age of this feature is unknown, it is recommended that it should be avoided by a radius of 1,500 feet around an arbitrary center point at E2218203, N227338, or studied in more detail (see Figure 43).

A letter of concurrence from the SCIAA (Mr. James Spirek) is provided in Appendix C. The agency did, however, request that any inadvertent discovery of potential archaeological materials, i.e., wood structure, prehistoric lithics, ceramics, etc. during dredging operations cease from that area until inspections may reveal the source of this material. Further, the agency had no objections from a submerged cultural resources viewpoint for dredging to occur within the proposed borrow area.

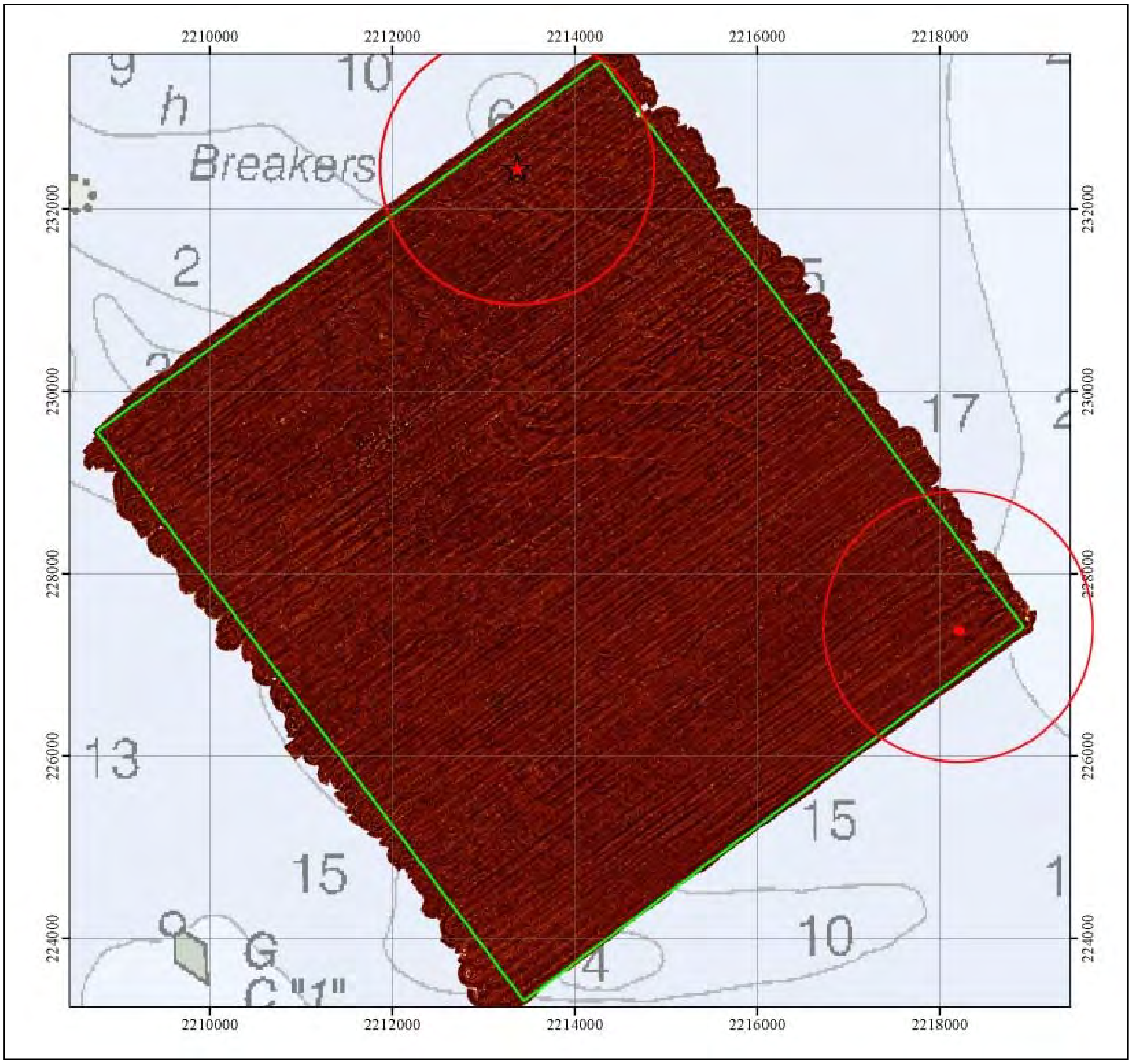


Figure 43. Two recommended avoidance zones.

5.2 Hardbottom Resources

Based on review of available marine resource GIS data sources and review of the collected sidescan records, there is not likely to be any hardbottom habitat within the borrow site survey area. No further investigation is deemed necessary. Review and concurrence with the NMFS (Pace Wilber) is required to conclude consultation on this Essential Fish Habitat resource type.

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APPENDIX A

SCOPE OF WORK HARDBOTTOM AND CULTURAL RESOURCE SURVEYS
EDISTO BEACH OFFSHORE BORROW SITE,
EDISTO BEACH, SOUTH CAROLINA

SCOPE OF WORK
HARDBOTTOM AND CULTURAL RESOURCE SURVEYS OF THE EDISTO BEACH OFFSHORE BORROW SITE, EDISTO BEACH, SOUTH CAROLINA

11 December 2012

1. **Background.** The U.S. Army Corps of Engineers, Charleston District requires magnetometer, sub-bottom profiling, and side-scan sonar survey over a 1.25 x 1.13 nautical mile area located offshore of Edisto Beach, Colleton County, South Carolina. The purpose of this work is to discover magnetic and/or sonar anomalies that might represent cultural resources or other objects that would impact the use of the proposed area as a source of borrow material for hurricane and storm damage reduction along Edisto Beach. In addition, the contractor will identify and map areas of hard bottom habitat as identified from side-scan sonar analysis. The data collected from this work is required in order to establish baseline conditions and subsequently refine the proposed study improvements areas and to avoid impacts to significant cultural and environmental resources from dredging activities. This Description of Services reflects the provisions of Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800, *Protection of Historic Properties)* and the Abandoned Shipwreck Act of 1987 (*Abandoned Shipwreck Act Guidelines*, National Park Service, *Federal Register*, Vol. 55, No. 3, December 4, 1990, pages 50116-50145). All work shall be conducted in accordance with this Description of Services, the contract Scope of Work, and the instructions of the Charleston District Contracting Officer or his/her authorized representative.

2. **Project Site Description.** The survey areas are located offshore of Edisto Beach, SC and are shown in Figure 1 together with NAD-83 SC State Plane coordinates. The approximate acreage for the survey area is approximately 1.41 NM^2.

3. **Description of Supplies/Services.** This work will be accomplished in a phased approach in order to (1) acquire survey data of the project area and interpret the data for potential hardbottom and cultural resources, and (2) ground truth selected sites to confirm the presence or absence of hardbottom resources using benthic grab sample techniques.

   Phase 1. The survey team shall conduct a remote sensing survey of the study area (see Appendix A). Prior to commencement of survey work, the survey team shall provide the Corps with the proposed survey plan for their review and approval. Additionally, prior to initiating any fieldwork, the survey team shall conduct sufficient background research to develop a current historic overview, review previous archaeological investigations, and document vessel losses and known shipwrecks in the vicinity of the project areas. The background research shall include, but is not limited to, research of the state archaeological site files at the South Carolina Institute of Archaeology and Anthropology. This information shall be used to model the potential database so that discovered magnetic and sonar signatures can be more thoughtfully inventoried and analyzed. A list and description of all relevant vessel losses for the project area shall be included in the report. The survey team shall also conduct sufficient background documentation to summarize previous work conducted in the area as well as avoid duplication of survey collection efforts.

   Side Scan Sonar - The survey vessel will be equipped with a side-scan sonar with 500-700 kHz capability to achieve detailed geo-referenced morphologic mosaic maps. The instrument will be interfaced with a Differential Global Positioning System (DGPS) with less than 1m accuracy. HYPACK (or technical equivalent) navigation software should be used to develop the survey transects and maintain vessel track during data collection. To assist in data analysis a complete record of hydrographic data should be recorded in HYPACK. The survey team shall be experienced in the post processing and interpretation of side-scan sonar for hardbottom resources and shall provide shape files of areas identified as potential hardbottom resources. Side-scan sonar data should be collected along parallel transects spaced at appropriate intervals to ensure at least 25% percent overlapping coverage of adjacent survey lines. The side-scan sonar towfish will be maintained at a height above the bottom that provides for the most accurate data collection (generally 10 to 30 feet). The side-scan sonar will be run concurrently with the magnetometer (discussed below).

Sub-Bottom Profiling - The survey team shall utilize a CHIRP dual frequency sub-bottom profiler and not more than 8-second registration interval to establish the depth and nature of the potential hardbottom or cultural resource at individually potentially significant magnetic anomalies. All data collection should meet, or exceed the recommended specifications in USACE Engineering Manual (EM) 1110-2-1003. All acoustic data shall be backed up on external hard-drives at the end of each day.

Magnetometer - The survey team shall utilize a digital cesium vapor magnetometer with 0.1-nT sensitivity and 0.5-second registration interval. The magnetometer shall be towed at a speed of 5 - 7 knots. The magnetometer sensor shall employ a depressor or other device capable of maintaining a tow height of not more than 6-meters above the sea floor. Survey lanes for the magnetometer shall be placed at not greater than 20-meter intervals. The magnetic data shall be contoured to produce a magnetic contour map of the project area. The magnetometer will be run concurrently with the side-scan sonar (discussed above).

General Requirements - All survey instrumentation shall be electronically interfaced with an electronic navigation-positioning system offering repositioning accuracy of not more than 1 meter. Positioning must be by corrected DGPS. All hard-copy analog and image records shall be annotated at not more than 30 meter intervals with real time, absolute (e.g. lat./long.) and relative position (transect number and distance), and event numbers.

At the completion of Phase 1, the survey team will produce a graphically illustrated letter report with preliminary findings of the side-scan survey, including a side-scan mosaic of recorded signatures and a magnetic contour map. Any potentially significant biological or cultural resources will be reported. Recommendations for further study, as defined for Phase 2 shall be provided.

Hardbottom Analysis - The survey team will review acoustic records (side-scan sonar and depth) to identify and define areas that are "hardbottom" or habitat for marine animals. Hardbottom areas will be defined as areas of any size that demonstrate low, medium and high protrusions (aka "targets"). Low protrusions will be defined as areas less than 0.5-meters above the bottom, "moderate" protrusions - the majority of the area 1 to 2-meters above the bottom, and "high" protrusions - over 2 meters above the bottom. Acoustic data will be graphically illustrated and will include SC State Plane NAD 83 coordinates for the boundaries. Results of this mapping effort will be used to select and recommend sites for the Phase 2 ground-truthing video survey. As part of the draft and final report, the survey team will produce a geo-referenced mosaic of the side-scan sonar survey. In addition, raster data shall depict information used to define potential hardbottom areas within the project area. The remote sensing data also shall be developed into polygon shapefiles compatible with ESRI ArcView/ArcInfo Version 10.0. Detailed recommendations will be included as part of the draft and final report. The potential significance of targets will be defined clearly. Any recommendations for additional investigations will be discussed in detail.

Cultural Resources Analysis. The survey team's report shall completely describe each target's magnetic and/or sonar characteristics including intensity, duration, estimated mass, height, length, water depth, position relative to the bottom, and absolute position. When possible, the analysis and description will relate the discovered sites to any potential features or sites derived from project archival documentation. All magnetic and side-scan sonar data shall be summarized in a table that also indicates recommendations for each discovered target. All targets shall be delivered in point shapefiles identifying potential sites within the project area. The shapefiles shall be in a format compatible with ESRI ArcView/ArcInfo Version 10.0.

Recommendations. The survey team shall prepare or update state site forms for all sites identified within the project area and provide recommendations for each potentially significant site's National Register of Historic Places eligibility. The survey team shall prepare detailed recommendations for any future investigations of discovered cultural resource targets or sites. It must be clear why certain targets are included or excluded from recommendations for further investigation. It should also be clear what types of information should be sought at each site and what methods might be employed to retrieve that information. If sampling is recommended, the reasons for recommending a particular sampling strategy should be made clear in the report. The final report shall include the assigned state archaeological site numbers of significant cultural resources located during the survey.

Phase 2. The survey team shall utilize a towed video camera to ground truth and confirm the presence and/or absence of hardbottom and/or cultural/historic resources within the areas previously identified in Phase 1 as potential hardbottom from the side-scan sonar interpretation. Videography with DGPS annotation shall be used at a select number of interpreted potential hardbottom sites to confirm the presence or absence of hardbottom features associated with interpreted side-scan sonar signature returns. If the towed video camera is unable to produce adequate results to determine hard bottom resources, then the survey team will use diving operations to obtain better quality video. A Phase 2 survey plan shall be submitted to the Corps for approval prior to commencement of work. The plan shall discuss the rationale for selection of ground truth sites as well as transect locations within each site. Positioning shall be performed with an accuracy of ± 1-meter, or other system of equivalent accuracy. The distribution of sites shall consider factors such as: (1) the diversity of bottom type (i.e. differences in backscatter return) and (2) diversity of interpreted relief. The videography transect lines shall traverse benthic habitat transitional points identified by side-scan sonar backscatter differences. Real time coordinates shall be clearly visible in the video to determine location along the video transect. Additionally, benthic grab samples (N=2/site; Total = 10), correlated with select transect locations, shall be obtained to assess the sediment characteristics for each site. The sediment samples will be described using visual classifications and the Unified Soil Classification System. Adjustments to locations may be made based on information gathered in the field and with approval from the Corps. All coordinates shall be in South Carolina State Plane coordinates based on 1983 North American Datum coordinate system. For budget purposes the survey team will assume that up to ten sites will require video confirmation.

Additional Phase 2 ground truth sites are a separately priced optional bid item (priced by day, but not to exceed 3 days) to be exercised by the Contracting Officer if necessary to adequately ground truth the diversity of side-scan signature returns in the project area. The video observations will be used to provide a rational for back-scatter differences previously identified through side-scan imagery which suggested potential hardbottom.

The correlation of ground truth data to specific side-scan sonar signature returns shall be used to interpolate and refine bottom mapping results within the rest of the project area. All confirmed hardbottom areas from ground truth efforts, as well as interpolated sites, shall be characterized as being of low, moderate, and/or high relief, as described above.

4. **Required Deliverables**. The survey team is required to deliver side-scan mosaic, Interim letter report and mosaic and list of targets, Raster data sets, shapefiles, metadata records, survey plan, videography records, weekly status reports, and a Draft and Final Report.

Side-scan Mosaic Raster Data Sets. The survey team shall deliver Georeferenced Mosaics of the Raster Data sets from the Side-scan Survey. The Raster Data sets shall depict the backscatter information used to map the potential hardbottom areas in the project area and shall be in a format compatible with ESRI ArcView/ArcInfo Version 10.0.

Magnetic Contour Map. The survey team shall deliver magnetic contour maps of potential cultural/historic resource anomalies.

ESRI File Geodatabase. The survey team shall deliver all data collected in a File Geodatabase that is compliant with SDSFIE. Guidance on format of SDSFIE compliance is http://www.sdsfie.org and https://tsc.wes.army.mil/products/tssds-tsfms/tssds/projects/sds/default.asp. The Geodatabase shall contain files defining the areas of confirmed hard bottom features, associated relief classification within the project area based on ground truth efforts, all metadata records as well as areas of interpolated hardbottom areas that were mapped based on similar backscatter characteristics to ground truthed areas. The Geodatabase shall be named "Edisto_Beach_Borrow_HB_CS_Phase_1_2012".

Metadata Record. An FGDC compliant metadata record for each spatial data deliverable shall be created using ESRI ArcView/ArcInfo ArcCatalog version 10.0 or better. Appropriate information shall be entered in all required fields. The survey team shall attach the appropriate metadata record to each spatial data file using ArcCatalog so that no importing or formatting of the metadata record is required by the Government.

Videography Data. All videography ground truth data shall be provided on a DVD and shall be organized and labeled by site location.

Reports. The following reports must be submitted: (1) Work Plan and Quality Assurance Project Plan, (2) Field appraisal reports in accordance with fieldwork progress, (3) Site Specific Safety and Health Plan – Accident Prevention Plan), (4) Interim letter report, including mosaic and list of targets, and (5) Draft Report and Final reports.

Draft and Final Report. A written report summarizing all data collection activities shall be submitted as a Portable Document File (PDF) and in bound hardcopy. The survey report shall include a technical approach, results (including side-scan mosaic and screen captures), and recommendations sections, as well as the following items:

- Written description of workflow to complete task order
- Dates and times of each data collection activity
- Atmospheric Conditions for each day of data collection activity
- All Horizontal and Vertical Control used including monument name, establishing agency, date established, description, and published horizontal and vertical values
- Temporary Bench Mark (TBM) descriptions with vertical values
- Copy of all field notes
- Complete and detailed list of all survey equipment used
- Rational for identification and mapping of select hardbottom features shall be provided based on a combination of videography ground truth data and side-scan sonar interpretive expertise
- Qualitative characterization of the general biological communities associated with any hard ground or other benthic resources identified.

Reports. The survey team shall prepare an initial field appraisal of data deemed relevant for the proposed study area. This appraisal shall be in the form of a management summary or letter report. This appraisal shall be developed as fieldwork progresses so that it is available as soon as possible after completion of the fieldwork. The survey team shall also prepare a draft and final research report of the investigations. The report shall discuss all aspects of the investigation and shall identify the methods used in the survey. The report shall contain this Description of Services as an appendix. The survey team shall assure that the report meets the standards of the South Carolina State Historic Preservation Office.

For marine cultural resource targets identified as potentially significant, ground truthing of these sites may be required if they are deemed to be potentially impacted from future dredging activities. For purposes of this initial study, no dive confirmation is proposed. In the event ground truthing is needed, a modification to this task order would be required.

5. **Report Format.** The report shall adhere to the standards of the SC SHPO and the contract scope of work. Draft and Final reports shall contain at least the following sections/chapters:

a. *Cover and title page*. The cover and title page shall indicate the title of the project report, the authors, the contract number, the sponsoring agencies, and date. The title page must also have the signature of the Principal Investigator or other individual responsible for actual completion of the project.

b. *Abstract*. The abstract shall be a brief summary of where and why the survey took place, study results, and recommendations for further work. Abstracts are generally ½ page or less in length.

c. *Acknowledgements*. This section should mention all individuals or organizations that contributed to successful project fulfillment.

d. *Table of Contents, List of Figures and Tables*. It is important that the contents accurately reflect page numbers in both the Draft and Final reports.

e. *Introduction or Project Background*. This section should explain why the survey is necessary and should refer to the legal requirements.

f. *Prehistoric and Historic Overviews*. The historic overview should develop the context within which any anomalies and shipwrecks will be evaluated. Past USACE reports will be used extensively for this section.

g. *Documentation of Vessel Losses*. A listing of past vessel losses is required. The report shall include a table of vessel losses that includes vessel name, type of vessel, date and place of loss, and disposition (salvaged, burned, unknown, etc.).

h. *Past Investigations*. Knowledge of the local history, vessel losses, and past investigations shall be used as a guide to developing criteria for lane interval and evaluation of targets.

i. *Field and Analytical Methods*. This section shall include a description of the equipment that was used in the field survey and how it was operated. This section should note restrictions, shortcomings, or problems of the research and how they have been overcome or controlled.

j. *Analysis and Results*. This section should include a full verbal description of each anomaly. In addition, a table or tables shall be included that summarizes magnetic and sonar target characteristics. The narrative description should make clear what factors were considered in the evaluation of anomaly characteristics and how those factors bear in selecting or eliminating an anomaly for inclusion in recommendations for further sampling. The table shall identify each anomaly or target by at least number, location, amplitude, shape (monopole, dipole), depth, position relative to the bottom, and recommendation.

k. *Recommendations.* The survey team shall prepare as appropriate, recommendations for further work, or for no further work. It is important that all recommendations be justified. That is, individual anomalies that are suggestive of shipwrecks shall be so noted and described. For large numbers of suspicious anomalies or anomalies that cannot be eliminated by other means, dive sampling may be appropriate.

l. *References.* The report shall contain references for work cited in the report. The references shall follow the style of the journal *Historical Archaeology.*

m. *Description of Services.* This Description of Services shall be included as an appendix to the report.

6. **Daily Field Operations.** A pre-departure safety meeting will be held dockside to review potential safety hazards and protocols each day field surveys are undertaken. Vessels will be inspected to ensure all safety equipment is present and functional. Staff will maintain field logbooks daily to record dates, times, and other information pertinent to survey efforts to serve as a basis for written reports. A Daily Quality Control Report will be generated each day by field personnel describing the work performed and deviations from submitted work plans. A weekly status report will be generated by field personnel and forwarded electronically from the field station to the Contracting Officer's Representative (COR) and the Technical Point of Contact (POC).

7. **Quality Assurance Project Plan.** A QA/QC Plan shall be prepared as part of the Phase 1 Work plan. The purpose of this plan is to identify normal operating procedures used to insure the quality of the data collected, analyzed and reported upon in the draft and final reports for Phase 1 activities.

Quality control measures will include daily QA of survey instrumentation as defined in EM 1110-2-1003, as well as real time log keeping, and daily backup of all remote sensing data. During data collection all incoming data will be monitored to insure that acoustic and magnetic records are of the best quality. Data collection will be suspended if noise created by the electronic background (RF), and, or weather or sea conditions significantly reduce the quality of remote sensing records.

Interpretation of acoustic and magnetic records will be based upon professional experience of the marine archeologist. The Phase 1(a) report will include mapped records to support draft and final report findings and recommendations. As part of normal QA/QC procedures, reports will be technically edited to ensure all data cited is accurately presented and referenced.

8. **Compliance**. Surveying and Mapping shall be in strict compliance with EM-1110-1-1002 Survey Markers and Monumentation, EM-1110-1-1003 NAVSTAR Global Positioning System Surveying, EM-1110-1-1005 Topographic Surveying, EM-1110-2-1003 Hydrographic Surveying and change 1 April 1, 2004, EM 1110-2-6056 Standards and Procedures for Referencing Project Elevation Grades to Nationwide Vertical Datums (Draft, Finalized Sept 30, 2010), EM-1110-1-2909 Geospatial Data and System.

9. **Survey Control**. All horizontal and vertical control used for this survey shall be from South Carolina or a Federal Agency Network and be of third order accuracy or better. All control loops must be tied to at least two or more control points. The survey team shall furnish a list of all points used to the Government. All work shall be relative to State Plane NAD 1983 (2007) SC-3900 South Carolina International Feet in the horizontal plane and NAVD 88 feet in the vertical plane. The Government will provide control information for previously established Control Points along the length of the project area.

10. **Weekly Status Report**. The survey team is required to submit a Weekly Status Report each week, beginning on the Task Order Award Date, until all deliverables are received and accepted by the Government. The Weekly Status Report shall be delivered via e-mail no later than 8:00 AM each Monday

and shall document the survey team's progress from the previous Monday through the previous Sunday. The status report shall itemize each scope item with percent of work complete and an estimated date of completion. The report shall also include the number and type of field crews working, a description of any problems and/or delays encountered, and any photographs of the site and/or significant site features and/or specialized data collection activities. A weekly status report will be generated by field personnel and forwarded electronically from the field station to the COR and Technical POC.

11. **Requirements for Report Submission.** The data obtained shall be presented in graphical, tabular, and written text as appropriate. The draft and final reports shall undergo internal technical review and quality assurance review by persons with appropriate technical qualifications to ensure that the report meets the project requirements specified in the technical work plan and the QA goals.

The draft and final reports shall consist of 8 1/2" by 11" pages with drawings folded, if necessary to this size. The report margins shall be suitable for use in a durable 3-ring binder. A decimal numbering system shall be used with each section having a unique decimal designation. Reports that require extensive editing, have extensive errors, or are not in the required formats shall be rejected and re-submittal shall be required. Any maps, drawings, figures, sketches, databases, spreadsheets, or text files prepared for this report shall be provided in both hard copy and digital form.

The digital copies of reports and other text documents shall be provided in Microsoft Word 2000. Spreadsheet files and data files shall be provided in Microsoft Excel 2000 format. All text, spreadsheet, and database files shall be delivered compact disk read-only memory (CD-ROM) with ISO-9660 format.

A copy of the report must also be provided as an Adobe Acrobat .pdf file. Geographic data shall be provided in feet and projected into the NAD 83 South Carolina State Plane coordinate system. All digital files, final hard-copy products, source data acquired for this project, and related materials shall become the property of the US Army Corps of Engineers, Charleston District and shall not be issued, distributed, or published by the survey team without prior approval.

Three hard copies of the draft and final reports and five electronic copies of the draft and final reports shall be submitted to the Charleston District.

Field Logbook. Personnel conducting the survey and collecting required data shall record all necessary documentation in appropriate field logbooks. All entries shall be dated and time of entry recorded. For sediment grab samples, water depth, sample location, sample penetration, and descriptive characteristics of collected sediments should also be documented. Field records are a basis for later written reports and therefore should be complete and factual.

Daily Quality Control Report. A daily quality control report (DQCR) shall be prepared for each day activities are conducted. The DQCR shall contain at a minimum the following information:

(1) Work Performed. Relevant information regarding the surveys performed and associated data collection efforts (i.e. videography, grab samples, etc.) shall be included. (2) Departures from Submitted Plans. Any departure from the previously approved plans or corrective actions required should be identified in the DQCR. Verbal or written changes to the plan should be documented.

12. **Safety.** The U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, is available on line at:

http://www.usace.army.mil/net/usace-docs/eng-manuals/em385-1-1/toc.htm.

The survey team is responsible for maintaining a safe and healthy work environment for all employees at all times. This includes reasonable provisions for proper lighting, seating, and shelter from weather, and access to accommodations for adequate rest, food, and water. The survey team shall provide all personnel and equipment necessary for safe and effective completion of all archaeological and related services as detailed in this Description of Services. In addition, the following terms shall be met:

a. *Safety and Activity Hazard Analysis Plan.* In consultation with the Charleston District COR, the survey team shall determine the need for a Safety and Hazard Analysis Plan. This plan shall be required if the work environment or the work itself is found to be atypical of the work normally performed under this contract, and if that work presents hazards not normally encountered and accounted for as a routine part of task orders issued pursuant to the basic contract. When consultation determines that a Safety and Hazard Analysis Plan is required, the survey team shall adhere to applicable sections of EM 3851-1, "Safety and Health Requirements Manual," Appendix A, and the activity hazard analysis shall identify potential hazards that are specific to the work being conducted under this Description of Services. Requirements for the activity hazard analysis are presented in EM 3851-1 at Section 19, *Floating Plant and Marine Activities*. All employees shall be made aware of these hazards and the appropriate preventative, remedial, and first aid measures. The survey team's proposed Safety and Hazard Analysis Plan shall be submitted not later than 10 working days after receipt of notification of award. The Plan must include a tentative fieldwork schedule.

b. *Survey Vessel.* The survey vessel shall be supplied by the survey team and shall be of sufficient size to contain all required survey and safety equipment, and provide temporary shelter to the field crew. The survey vessel shall meet all relevant U.S. Coast Guard safety criteria for the crew size, equipment, and tasks being performed. The survey vessel shall have available a litter, emergency oxygen, first aid supplies, personal floatation devices, marine VHF radio, and cellular telephone.

c. *CPR and First Aid.* All field crew personnel shall have current and valid certification in CPR and First Aid.

12. **Project Points of Contact**

The USACE points of contact are provided below:

Technical Manager

Mr. Mark Messersmith (CESAC-PM-PL)
U.S. Army Corps of Engineers
69 A Hagood Ave
Charleston, SC 29412
Phone: 910/251-4696

Mark.J.Messersmith@usace.army.mil

GIS Coordinator

U.S. Army Corps of Engineers

Phil Wolf
69-A Hagood Ave
Charleston, SC 29403

Phone: 843/329-8069
Phillip.M.Wolf@usace.army.mil

Contracting Specialist

U.S. Army Corps of Engineers

Rose Smalls
69-A Hagood Ave
Charleston, SC 29403

Phone: 843/329-8193
Rose.Smalls@usace.army.mil

12. **Payment / Request for Proposal.** The survey team's offer shall include all provisions for weather delays, equipment repair and adjustment, holidays, etc. Payments shall be made on a monthly basis upon receipt and acceptance by the COR of a monthly progress letter and invoice. Invoices shall not be processed unless a progress letter has been provided that indicates in detail the progress of work during the billing period. Payment of partial or final invoices may be withheld until all deliverables are received and accepted by the Charleston District.

Contract Line Item Number (CLIN)

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE
0001	Hardbottom and Cultural	1	LS	$_________
0002	Resource Survey, Phase 1 Hardbottom and Cultural Survey, Phase 2 (N=5)	1	LS	$_________
Option	Additional Phase 2 survey day(s) NTE 3 days	1	Survey Day	$_________

13. **Ownership.** All survey team submittals including digital files, compact disks, hard-copy products, and source data acquired for this project, and related materials, including that furnished by the Government, shall become the property of the Government and shall not be issued, distributed, or published by the survey team without permission from the Grants Officer.

14. **Quality Control.** If work is found to be in error, incomplete, illegible or unsatisfactory after assignment is completed, the survey team shall be liable for all cost in connection with correcting such errors. Corrective work may be performed by Government personnel or survey team personnel at the discretion of the Grants Officer. In any event, the survey team shall be responsible for all costs incurred for correction of such errors, including salaries, transportation expenses, equipment rental, supervision, and any other costs in connection therewith.

15. **Government Provided Data**. All hydrographic survey data that has recently been collected by the Corps within the project area will be provided to the survey team.

16. **Schedules**. The tasks contained in this Description of Services shall be completed according to the Table 1 schedule. Adjustments to the schedule must be previously approved by the Contracting Officer. The work shall proceed in a continuous stepwise manner until complete.

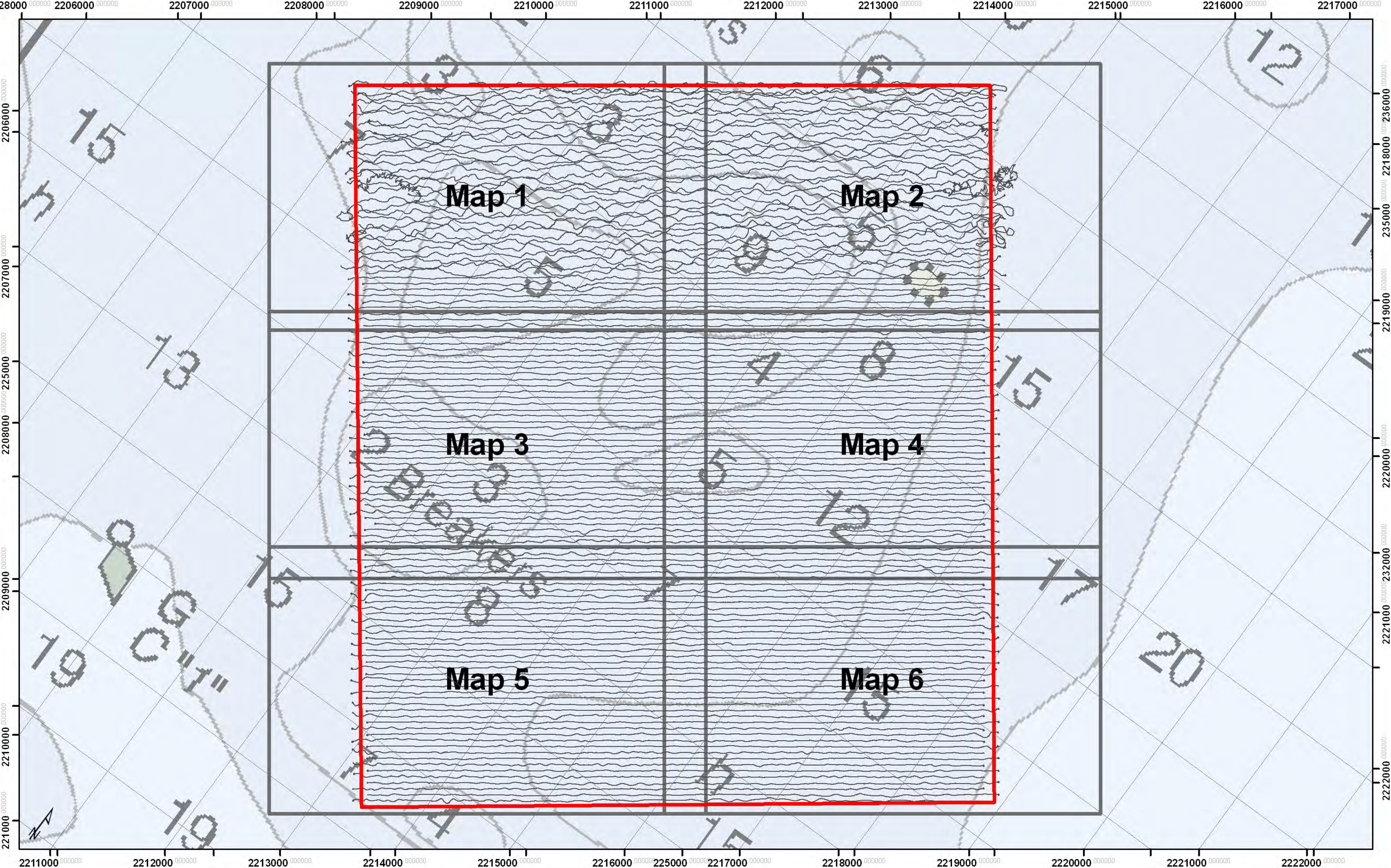
Table 1
Schedule
Estimated Schedule
Work Days After Award

Kick-off Meeting	2
Submit Draft Work/QAPP/APP	7
CESAC Comments on Work Plan/QAPP/APP	9
Begin Field Work/Assessment	10
Complete Field Work	20
Initial Field Appraisal	25
Submit Draft Report	30
Submit Final Report	50

17. **Quality Control.** If work is found to be in error, incomplete, illegible or unsatisfactory after assignment is completed, the survey team shall be liable for all cost in connection with correcting such errors. Corrective work may be performed by Government personnel or survey team personnel at the discretion of the Grants Officer. In any event, the survey team shall be responsible for all costs incurred for correction of such errors, including salaries, automotive expenses, equipment rental, supervision, and any other costs in connection therewith.

APPENDIX B

MAGNETIC ANOMALIES CONTOUR MAPS



Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Breakers
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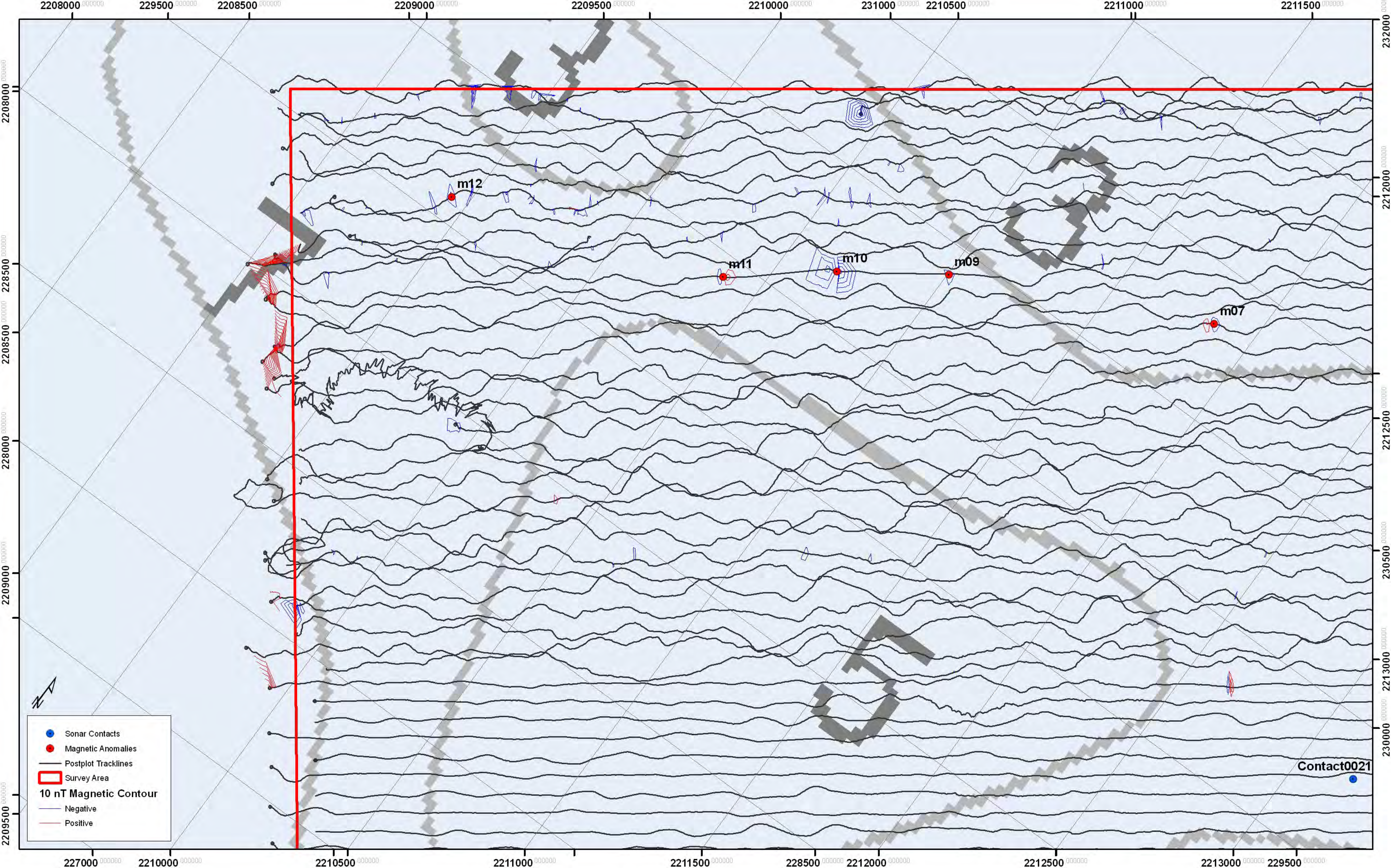
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2213000
229500
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m07
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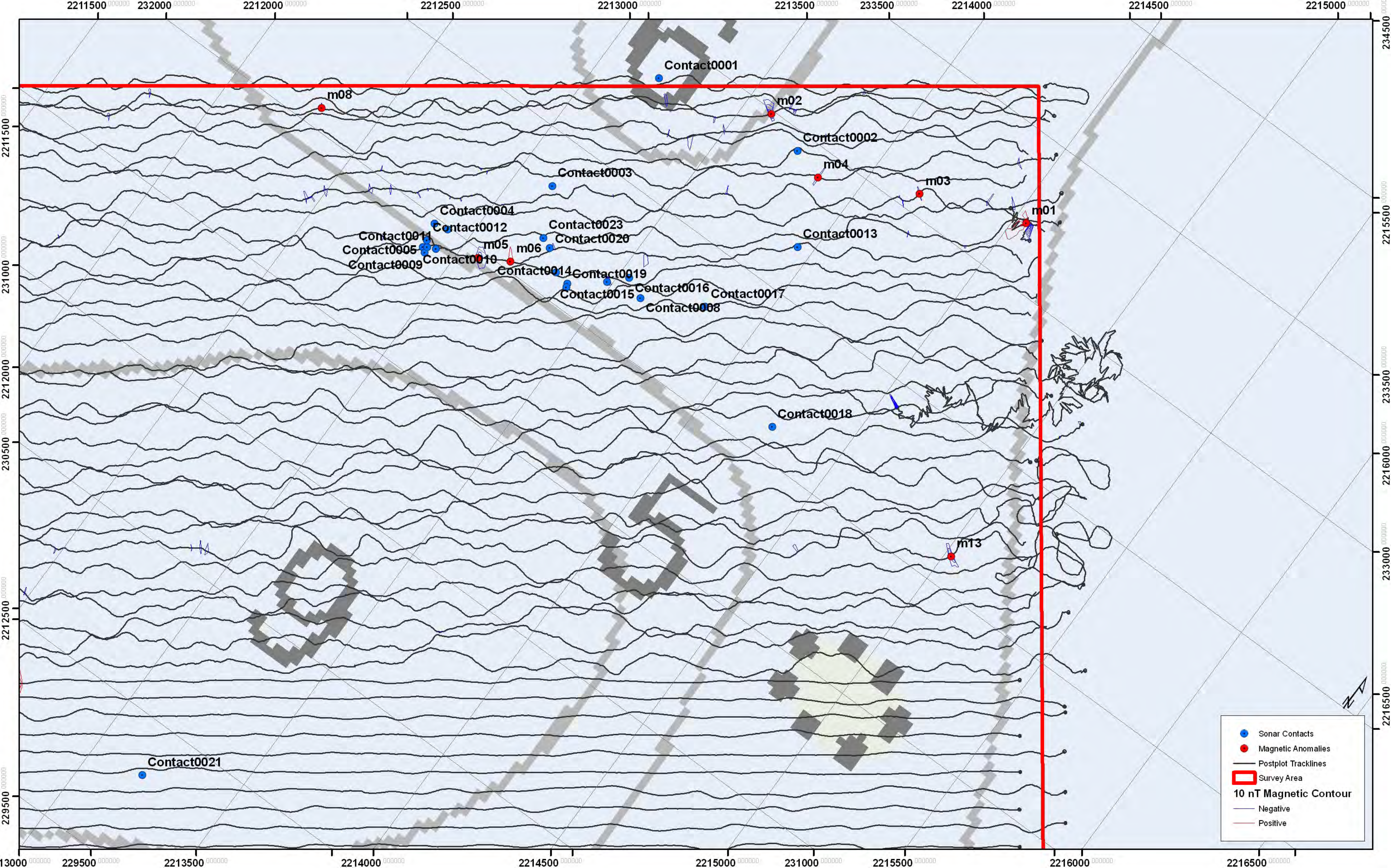
Sonar Contacts
Magnetic Anomalies
Postplot Tracklines
Survey Area
10 nT Magnetic Contour
Negative
Positive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Contact0014
Contact0019
Contact0016
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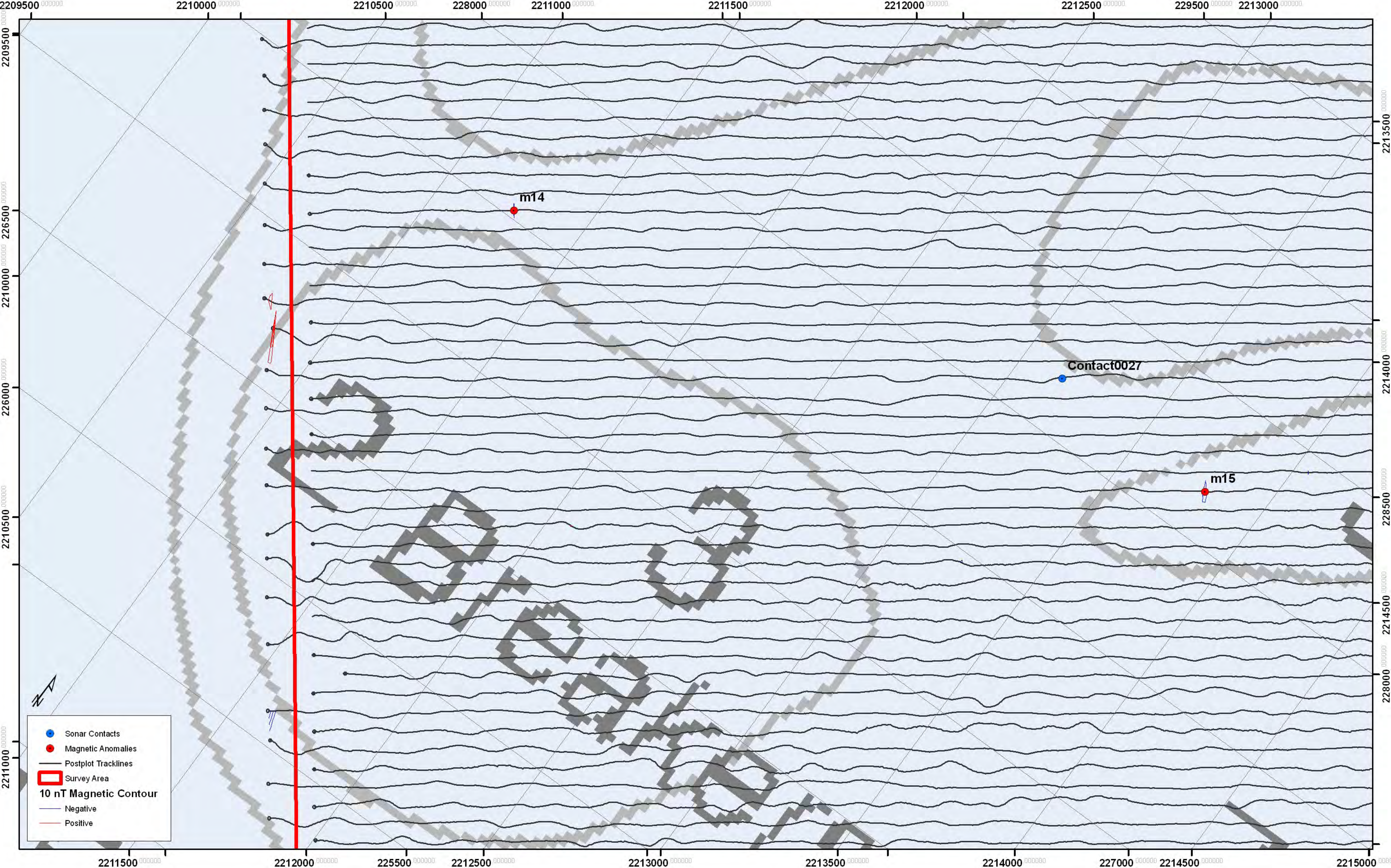
Sonar Contacts
Magnetic Anomalies
Postplot Tracklines
Survey Area
10 nT Magnetic Contour
Negative
Positive



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Postplot Tracklines
Survey Area
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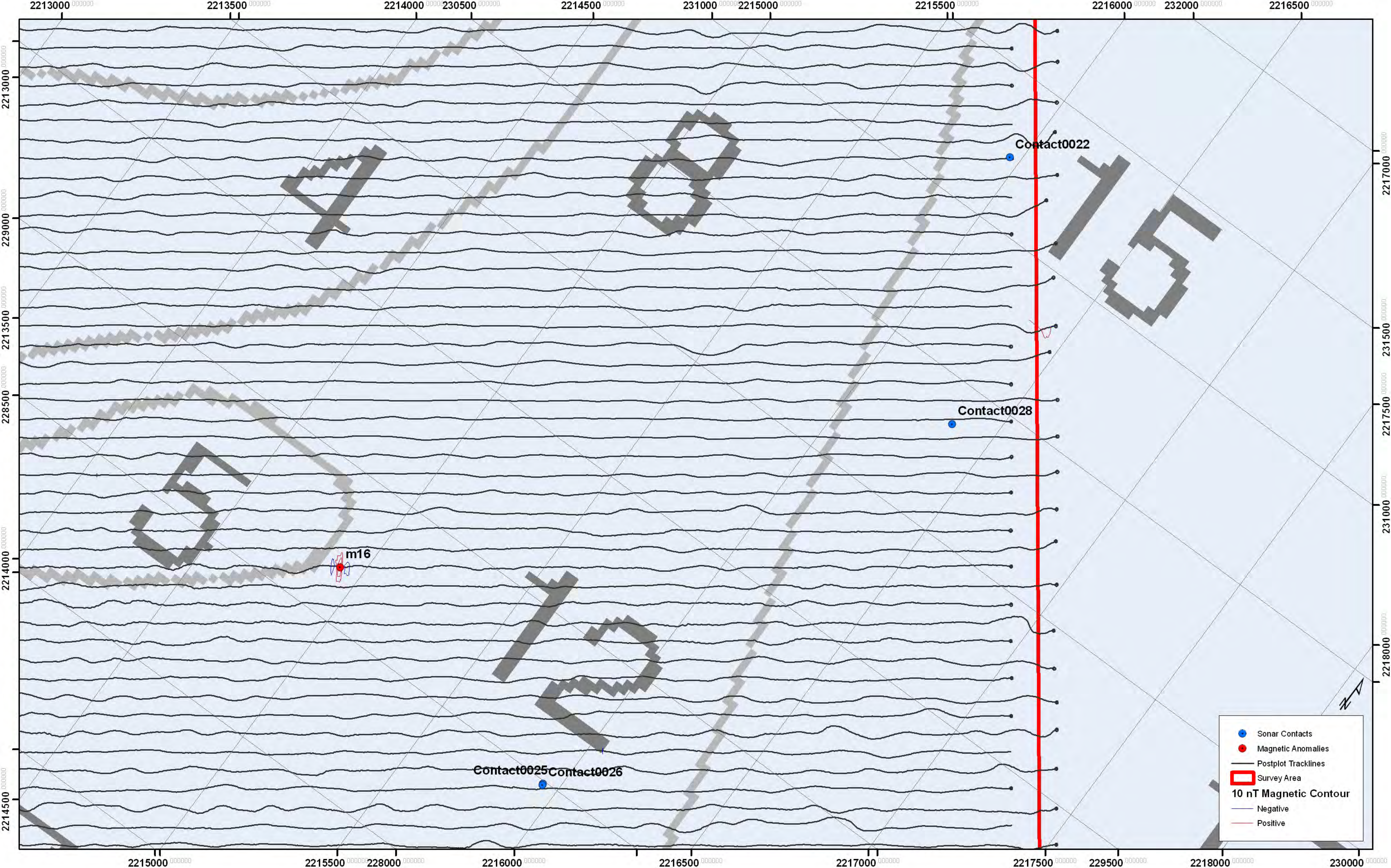
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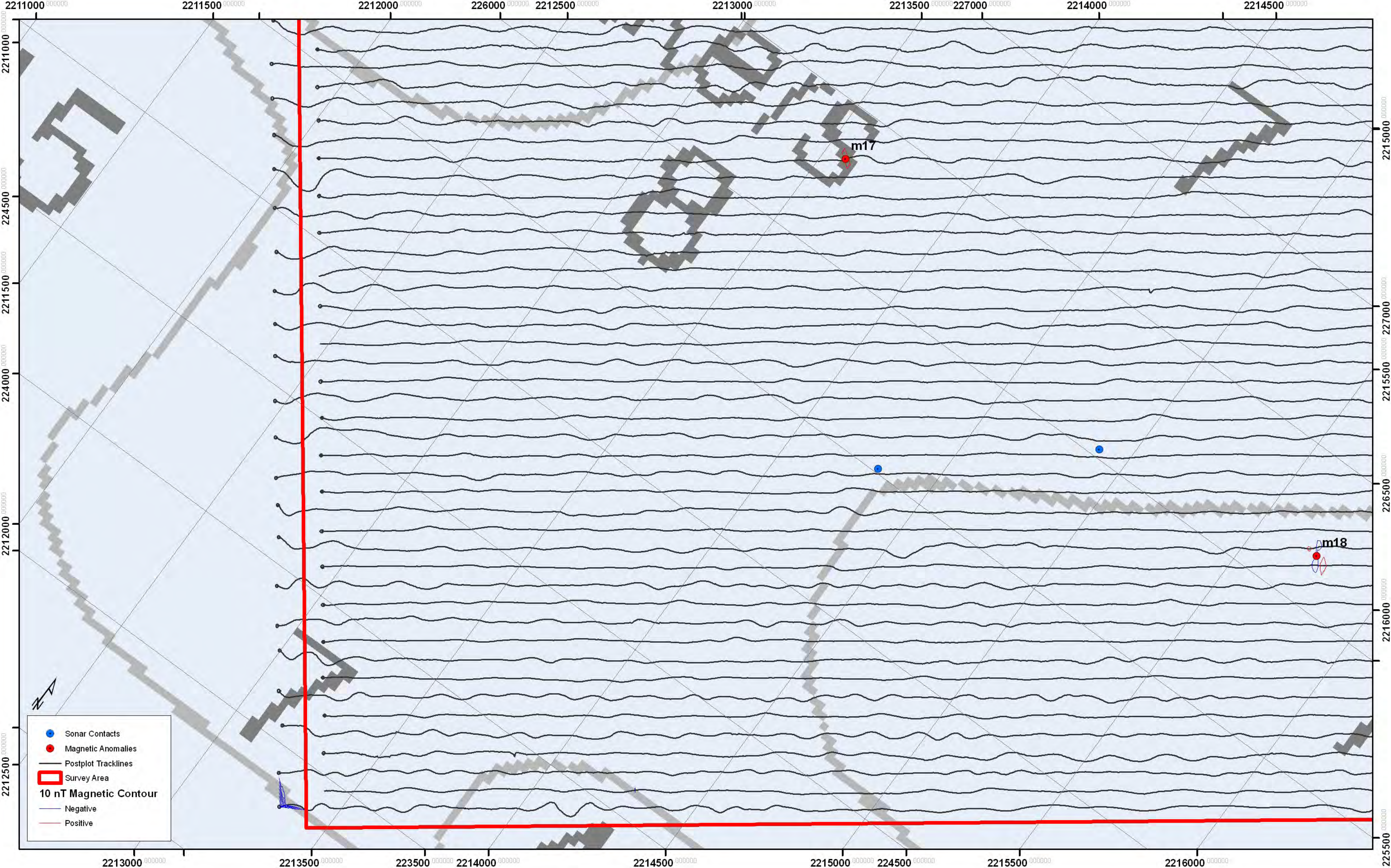
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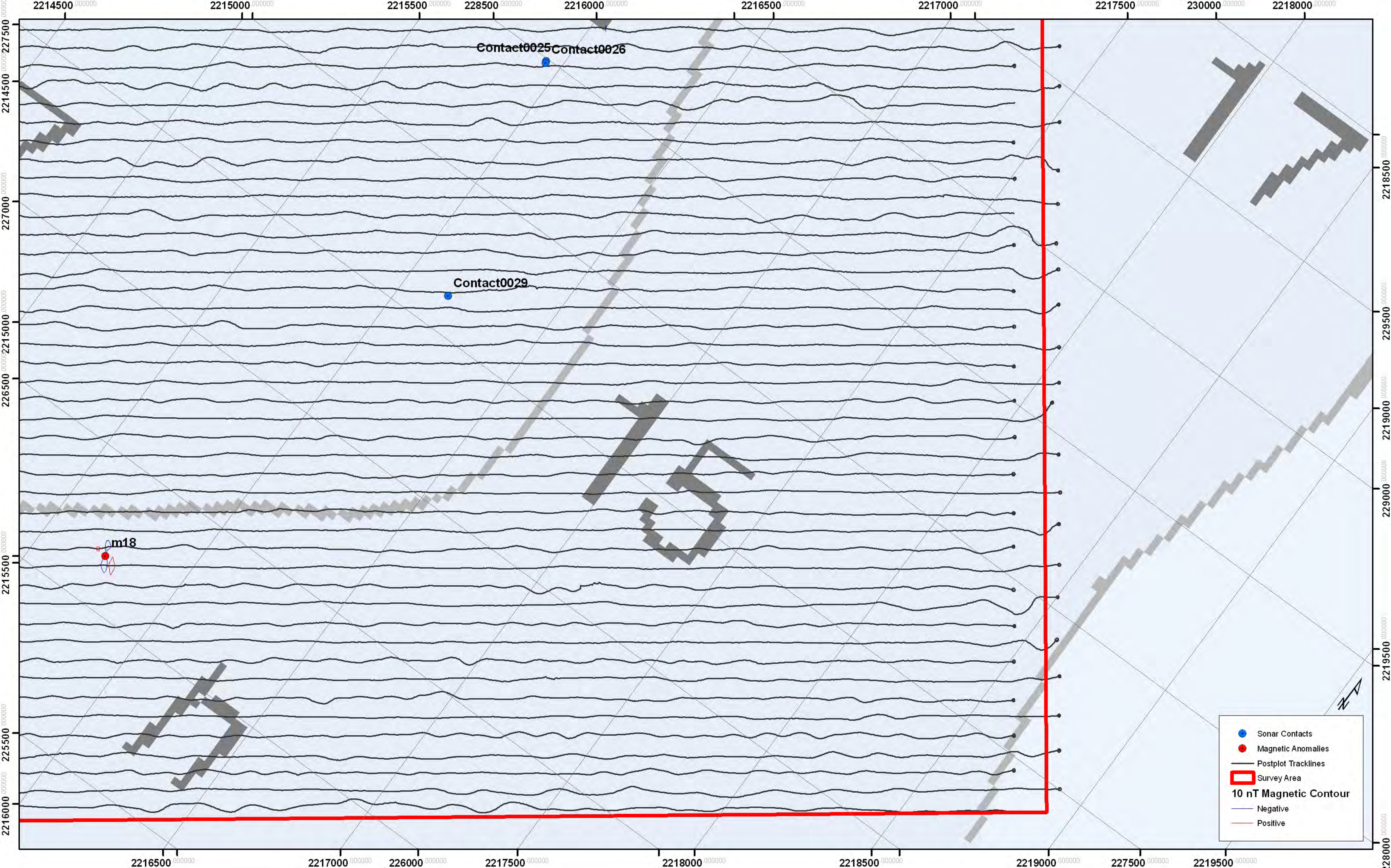

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Sonar Contacts
Magnetic Anomalies
Postplot Tracklines
Survey Area
10 nT Magnetic Contour
Negative
Positive

APPENDIX C

LETTER OF CONCURRENCE FROM THE SOUTH CAROLINA INSTITUTE OF ARCHAEOLOGY AND ANTHROPOLOGY

UNIVERSITY OF SOUTH CAROLINA
SOUTH CAROLINA INSTITUTE OF ARCHAEOLOGY AND ANTHROPOLOGY

12 April 2013

Alisha N. Means
Biologist
Planning & Environmental Branch
US Army Corps of Engineers-Charleston District
69A Hagood Avenue
Charleston SC 29403-5107

Re: Review of Edisto Beach Renourishment Project report.

Dear Ms. Means,

Our office has reviewed the draft report of the *Hardbottom and Cultural Resource Surveys, Edisto Beach Offshore Borrow Site, Edisto Beach, South Carolina*, prepared by Dial Cordy and Associates, Inc. for the Edisto Beach hurricane and storm damage protection project. Our review is focused on the submerged cultural resources aspects of the project. The report is a solid discussion of the scope, methods, research, and findings, especially in its awareness of inundated paleolandscapes bearing the potential of prehistoric cultural materials along the South Carolina coast.

We concur with the contractor's recommendations to place a 1,500 ft. buffer zone around the two arbitrary center points: Site 1—E2213373, N232446; and Site 2--E2218203, N227338 (NAD83 South Carolina State Plane East U.S. Survey Feet) as potential paleolandscape features. We also agree that no additional inspections of the magnetic, acoustic, or sub-bottom reflectors is warranted in the designated borrow site. We do, however, request that any inadvertent discovery of potential archaeological materials, i.e., wood structure, prehistoric lithics, ceramics, etc. during dredging operations cease from that area until inspections may reveal the source of this material. Please contact my office or the SHPO for further guidance in this instance. Our office has no objections from a submerged cultural resources viewpoint for dredging operations to occur in this borrow site. If plans change, please consult with our office for additional guidance.

We do though offer several editorial comments to improve the graphics for the final report:

1. Fig. 34, p. 47—please choose a color scheme to more fully reveal the trackline points, as well as to bring out the contours.
2. The above recommendation would also go for the Appendix B contour maps.
3. Please ensure the PDF images are of good quality in 100% zoom.

1321 Pendleton Street • Columbia, SC 29208-0071 • (803) 576-6566 • FAX (803) 254-1338

Thank you for this opportunity to review the report and your support of preserving the submerged archeological legacy in South Carolina waters. If you have any questions, comments, etc. about this matter please contact me.

Sincerely,

James D. Spirek
State Underwater Archaeologist
Maritime Research Division

Cc: Rebekah Dobrasko, SC SHPO

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX K
REAL ESTATE

Table of Contents

SECTION 1. THE REAL ESTATE REPORT

1.1 Statement of Purpose

This report is tentative in nature, focuses on the Tentatively Selected Plan, and is to be used for planning purposes only. There may be modifications to the plans that occur during Pre-construction, Engineering and Design (PED) phase, thus changing the final acquisition area(s) and/or administrative and land cost. The Real Estate Appendix is intended to support the Integrated Feasibility Report and Environmental Assessment the Edisto Beach Coastal Storm Damage Reduction Project. Numerous alternatives were considered for this project with Alternative 4 being the Tentatively Selected Plan which is also the National Economic Development Plan (NED). The author of this report is familiar with the Project area. The Town of Edisto Beach is the Non-Federal Sponsor (NFS) for the project. Date of this report is 27 June 2013.

1.2 Study Authority

The Edisto Beach Coastal Storm Damage Reduction GI Feasibility Study is being conducted in response to a resolution adopted on April 22, 1988 by the Committee on Environment and Public Works of the United States Senate:

> "*Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army in accordance with the provisions of Section 110 of the River and Harbor Act of 1962, is hereby authorized to study, in cooperation with the State of South Carolina, its political subdivisions and agencies and instrumentalities thereof, the entire Coast of South Carolina in the interests of beach erosion control, hurricane protection and related purposes. Included in this study will be the development of a comprehensive body of knowledge, information, and data on coastal area changes and processes for such entire coast.*"

1.3 Project Location

Edisto Beach is a barrier island located at the mouth of the South Edisto River in Colleton County, South Carolina, approximately 45 miles southwest of Charleston, South Carolina and approximately 20 miles east-northeast of Beaufort, South Carolina (Figure 1.3-1). The incorporated Town of Edisto Beach is located on the island, as is Edisto Beach State Park. Edisto Beach encompasses approximately six miles of sand shoreline, all of which are included as part of the current feasibility study. The study area also includes an offshore borrow site located approximately one mile offshore and extending to five miles offshore of Edisto Beach. The proposed borrow area shown on Figure 1.3-2 has been used previously for a locally funded project, and is known to contain beach compatible sand.

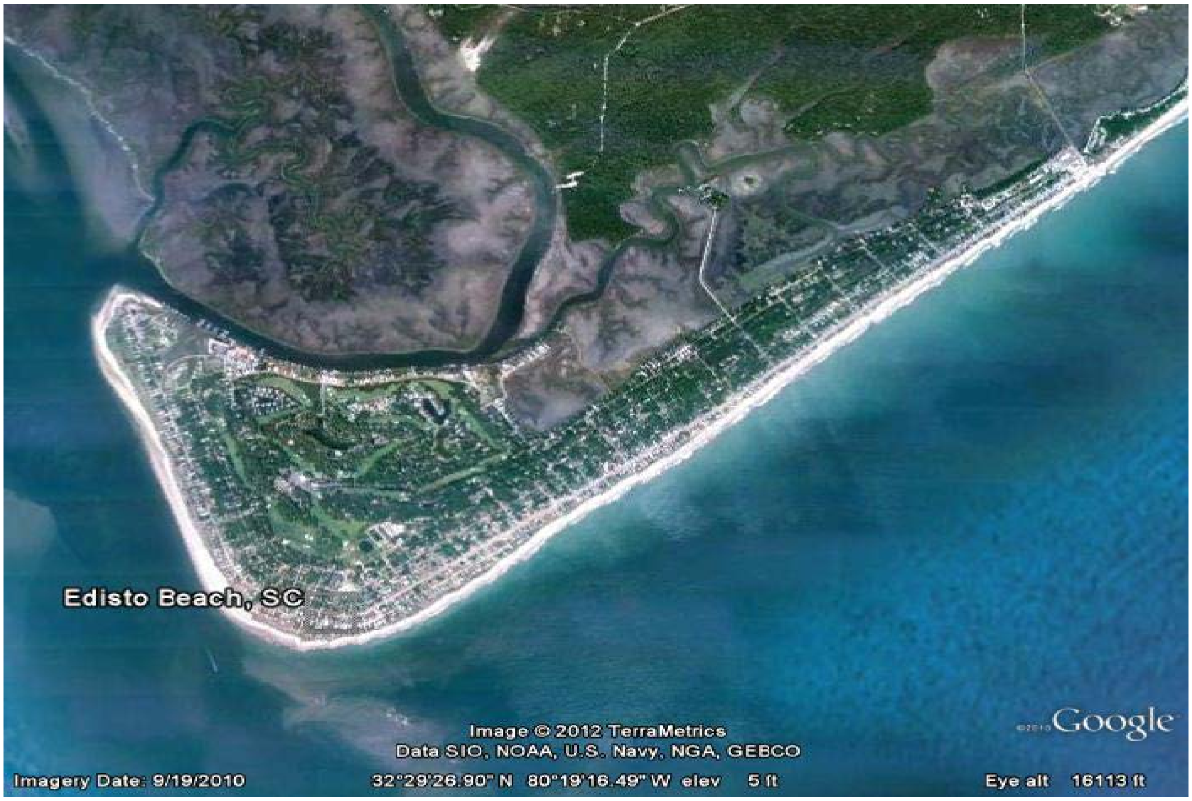

Figure 1.3-1 Project Vicinity\Location Map

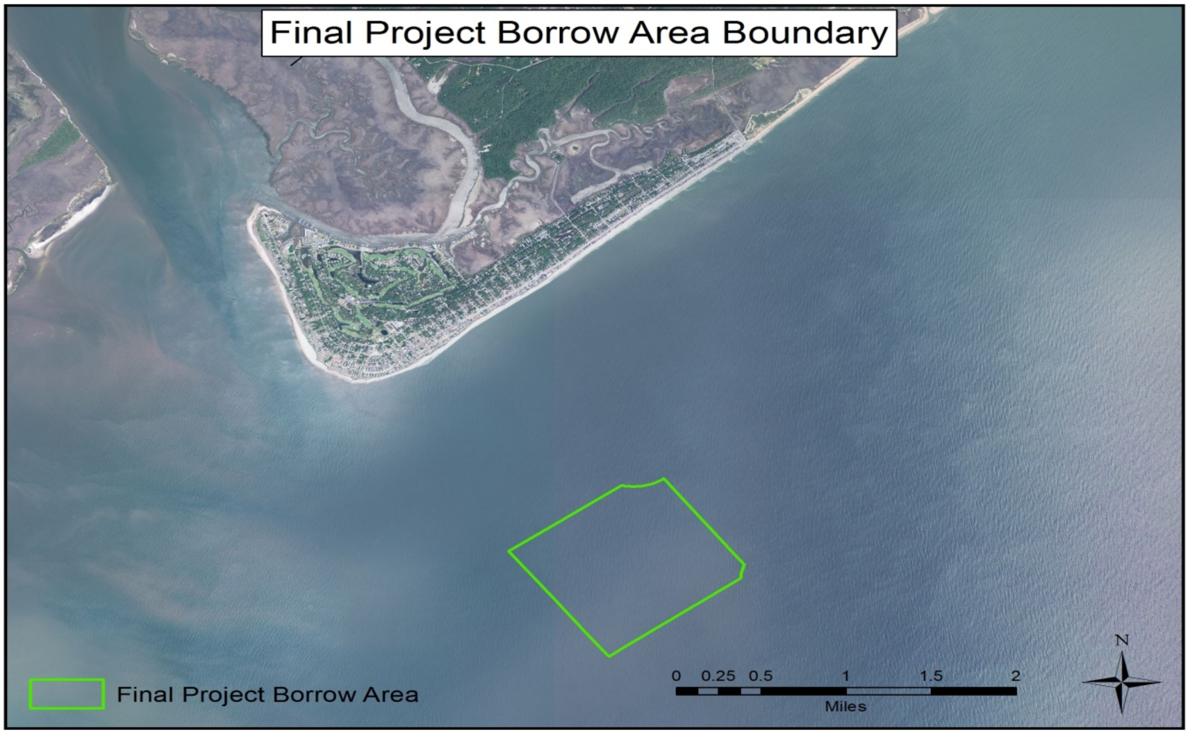

Figure 1.3-2 Location of Proposed Borrow Area

1.4 Project Description

This Real Estate Plan will focus on the recommended NED Plan which is alternative 4. For the purposes of alternative formulation, Edisto Beach was divided into three "planning reaches", which are distinguished based on their existing shoreline morphology. These reaches are the Inlet Reach (I1-I4), Atlantic Reach South (P1, P2, E1-E6), and Atlantic Reach North (E7-E15). No alternatives were formulated for the Edisto Beach State Park area (SP1, SP2) since the area was not subject to any without project condition damages. However, any berm feature constructed across the entire Atlantic North Reach would need to be tapered off, with this berm taper extending into the State Park. A map of the reaches is shown on Figure 1.4-1.

Figure 1.4-1 Project Reaches

Alternative 4 consists of the following elements:

1) a 5,290 ft long, 14 ft high, 15 ft wide dune starting at the southwest end of the Town of Edisto Beach, followed by a 16,530 ft long, 15 ft high, 15 ft wide dune.

2) A 16,530 ft berm feature built at the existing berm height. The berm would start at the beginning of the 15 ft high dune feature, and would gradually taper over 1,900 ft into a 50 ft wide feature that would extend 6,330 ft. The berm would then taper wider over another 560 ft into a 75 ft wide feature that would extend 7,740 ft to the end of Groin 1.

3) Approximately 1,130 ft of total groin lengthening across 23 of the existing 34 groins constructed by the Town of Edisto between 1948 and 1975.

Figure 1.4-2 is an example of an idealized shore profile cross-section. Figure 1.4-3 shows the locations in red of the groins to be lengthened.

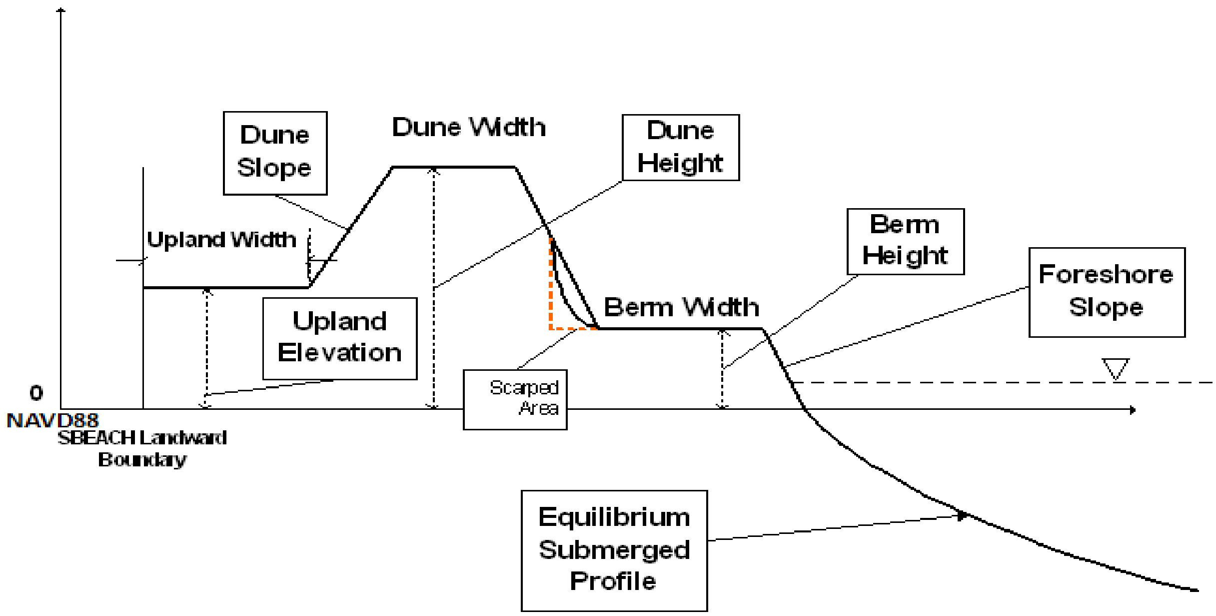

Figure 1.4-2 Shore profile cross-section

Figure 1.4-3 Existing groins to be lengthened

1.5 Real Estate Requirements

The requirements for lands, easements, right-of-ways and relocations, and disposal/borrow areas (LERRDs) include the right to construct a dune and berm system along the shoreline of Edisto Beach within the project limits. Based on project maps provided by Charleston District, the NFS will be required to acquire approximately 187 Perpetual Beach Storm Damage Reduction Easements over private property where the landward toe of the beach fill material is placed above the mean high water line. Improvements in the project area consist of 80 beach access walkovers throughout the project area and one fishing pier located on the north end of the project. The Storm Damage Reduction Easement does allow owners to construct and maintain walkover structures subject to sponsor approval. Damage to existing structures is not compensable and not creditable as the easement allows for the removal of obstructions within the limits of the easement. The landward construction line of the project will be placed to minimize effects on existing structures and every effort is made during construction to avoid damages to structures. The state of South Carolina claims ownership of all lands seaward of the last line a stable vegetation or all lands below the ordinary mean high water line. A real estate permit from the State of South Carolina Budget and Control Board will be required for the placement of fill material in State owned water bottoms. The permit from the State will include lands necessary for the berm taper into the State Park and groin lengthening.

Permits and/or consent agreements for sand removal from those portions of the borrow areas within three nautical miles of the shore will be from the appropriate state agencies. No permitting will be required from the Bureau of Ocean Energy Management since no sand mining will occur beyond the State’s coastal boundaries

There is one pier located within the study area, The Pavilion & Pier, which is privately owned and operated. Historically, in prior projects in North and South Carolina, fishing piers and their associated buildings have never been acquired, regardless of their location in relation to project lines. The primary reason is the significant economic impact that it would have on the community. Traditionally easements are acquired up to the face of the structures and beneath the pier. For purposes of this report, it is assumed that neither the pier nor appurtenances will be acquired. No values have been estimated for this structure. An aerial view of The Pavilion & Pier and staging area is shown in Figure 1.5-1.

Access to the project along with all staging areas will be on Sponsor Owned lands located throughout the project area. There are 38 existing public access points within the study area. As parking and access to the beach are considered items of local cooperation rather than real estate requirements, they are not creditable to the NFS as part of the LERRD credits. While detailed surveying and mapping of the project area has yet to be completed, examples of the uplands limit of construction are shown on Figures 1.5-2 and -3. Random photographs of the project area can be found in the exhibits portion of this report.

Figure 1.5-1 Staging Area & Pier

Figure 1.5-2 Sample Upland Construction Limits Atlantic Reach

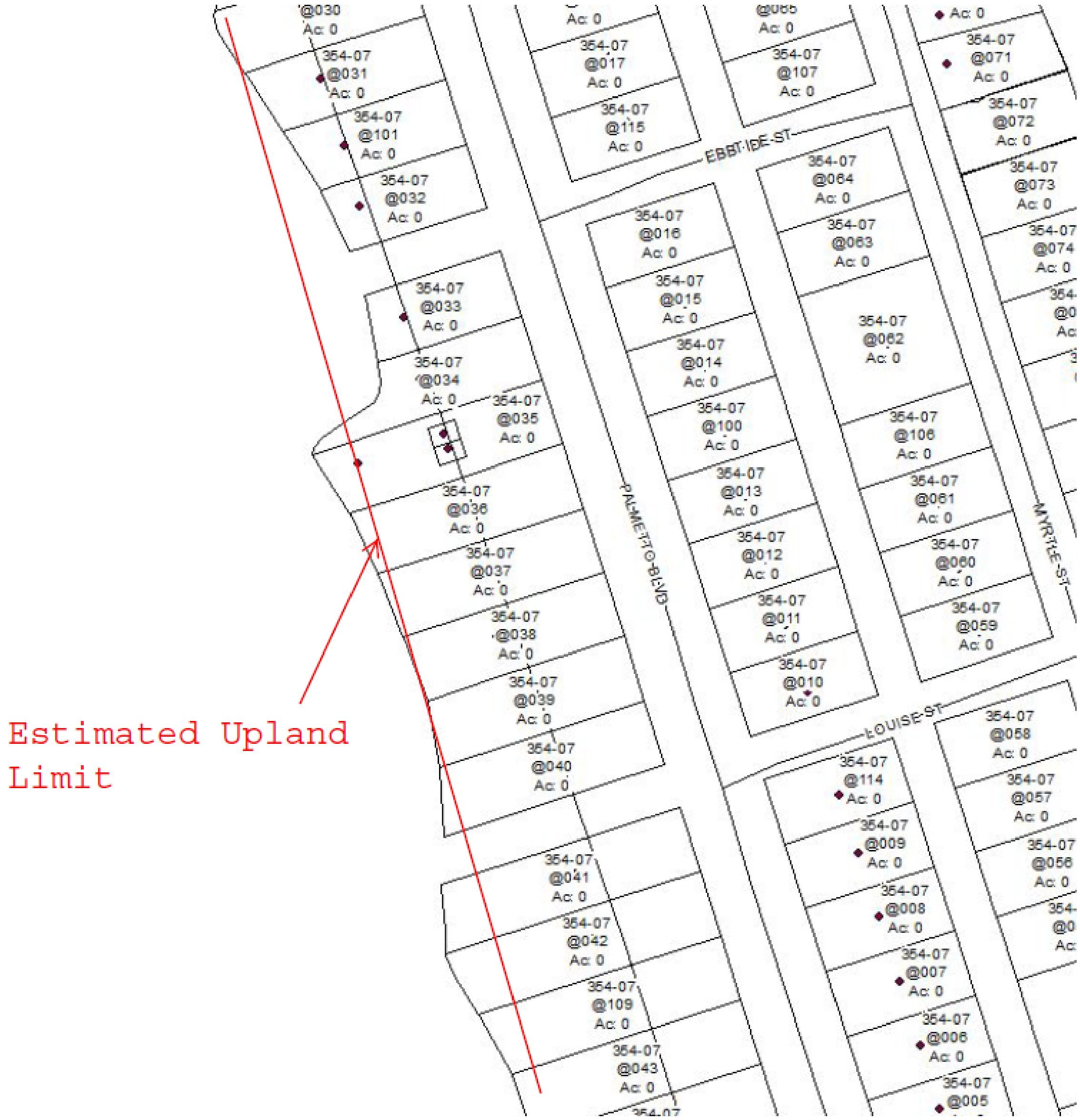

Figure 1.5-3 Sample Upland Construction Limits Inlet Reach

1.6 Utility/Facility Relocation

There are no public utilities or facilities located within the project construction area.

1.7 Existing Projects

There are no existing Federal Projects within the study area.

1.8 Environmental Impacts

There are no adverse environmental impacts associated within the scope of the proposed project.

1.9 Project Sponsor Responsibilities and Capabilities

The Town of Edisto Beach will be the non-Federal Project Sponsor (NFS). The NFS has the responsibility to acquire all real estate interests required for the Project. The NFS shall accomplish all alterations and relocations of facilities, structures and improvements determined by the government to be necessary for construction of the Project. The sponsor will have operation and maintenance responsibility for the project after construction is completed.

Title to any acquired real estate will be retained by the NFS and will not be conveyed to the United States Government. Prior to advertisement of any construction contract, the NFS shall furnish to the government an Authorization for Entry for Construction (Exhibit “A” to the Real Estate Appendix) to all lands, easements and rights-of-way, as necessary. The NFS will also furnish to the government evidence supporting their legal authority to grant rights-of-way to such lands. The NFS shall comply with applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, and amended by Title IV of the Surface Transportation Uniform Relocation Assistance Act of 1987, Public Law 100-17, effective 2 April 1989, in acquiring real estate interests for the Project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act(s). An Assessment of the Non-Federal Sponsor’s Capability to Acquire Real Estate is at Exhibit “B” to the Real Estate Appendix

The non-Federal sponsor is entitled to receive credit against its share of project costs for the value of lands it provides and the value of the relocations that are required for the project. Generally, for the purpose of determining the amount of credit to be afforded, the value of the LER is the fair market value of the real property interest, plus certain incidental costs of acquiring those interests, that the non-federal sponsor provided for the project as required by the Government. In addition, the specific requirements relating to valuation and crediting contained in the executed PPA for a project must be reviewed and applied. For shore damage reduction projects, lands subject to shore erosion, that are required for project purposes and that must be provided by the non-federal sponsor must be appraised for crediting purposes considering special benefits in accordance with relevant Federal statutes and Department of Justice guidance.

The NFS should not acquire lands required for the project prior to execution of the Project Partnership Agreement (PPA). Should the NFS proceed with acquisition of lands prior to execution of the PPA, it is at the risk of not receiving credit or reimbursement for any costs incurred in the connection with the acquisition process should the PPA not be signed. There is also risk in acquiring lands either not needed for the project or not acquired in compliance with requirements for crediting purposes in accordance with 49 CFR Part 24, dated March 2, 1989. A letter was provided to the NFS advising them of this risk and a copy is at Exhibit “C” to the Real Estate Appendix.

1.10 Government Owned Property

The NFS is the owner of the land proposed for staging areas for the project. There are no Federally owned lands within the areas proposed for construction of the project.

1.11 Historical Significance

There are no known sites of historical significance located within the scope of the proposed project.

1.12 Mineral Rights

There are no known mineral activities within the scope of the proposed project.

1.13 Hazardous, Toxic, and Radioactive Waste (HTRW)

There has been no HTRW identified within the scope of the proposed project.

1.14 Navigation Servitude

Navigation Servitude is not applicable to this project.

1.15 Zoning Ordinances

Zoning ordinances are not of issue with this project. Application or enactment of zoning ordinances is not to be used in lieu of acquisition.

1.16 Induced Flooding

There will be no flooding induced by the construction or the operation and maintenance of the project.

1.17 Public Law 91-646, Relocation Assistance Benefits

There are no relocations of individuals, businesses or farms for this project.

1.18 Attitude of Property Owners

The project is fully supported by the community. There are no known objections to the project from landowners within the project area.

1.19 Acquisition Schedule

The project sponsor is responsible for acquiring real estate interests required for the project. The NFS owns all lands proposed for staging areas. It is projected that Perpetual Storm Damage Reduction Easements can be accomplished within 12-18 months, and can begin when final plans and specs have been completed and the Project Participation Agreement has been executed. The Project Sponsor, Project Manager and Real Estate Technical Manager will formulate the milestone schedule upon project approval to meet dates for advertisement and award of a construction contract.

1.20 Estates for Proposed Project

The standard Perpetual Storm Damage Reduction Easement estate will be used for areas where placement of material falls above the ordinary MHW line. The standard Temporary Work Area Easement estate will be used for all staging and access areas. A non–standard estate (NSE) for use in the project if necessary has been approved by the Chief of Real Estate, Savannah District. The NSE and approval memorandum is at Exhibit D.

PERPETUAL BEACH STORM DAMAGE REDUCTION EASEMENT

A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract No. __) for use by the (Project Sponsor), its representatives, agents, contractors, and assigns, to construct; preserve; patrol; operate; maintain; repair;

rehabilitate; and replace; a public beach [a dune system] and other erosion control and storm damage reduction measures together with appurtenances thereto, including the right to deposit sand; to accomplish any alterations of contours on said land; to construct berms [and dunes]; to nourish and renourish periodically; to move, store and remove equipment and supplies; to erect and remove temporary structures; and to perform any other work necessary and incident to the construction, periodic renourishment and maintenance of the (Project Name), together with the right of public use and access; [to plant vegetation on said dunes and berms; to erect, maintain and remove silt screens and sand fences; to facilitate preservation of dunes and vegetation through the limitation of access to dune areas;] to trim, cut, fell, and remove from said land all trees, underbrush, debris, obstructions, and any other vegetation, structures and obstacles within the limits of the easement (except_____); [reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, the right to construct dune overwalk structures in accordance with any applicable Federal, State or local laws or regulations, provided that such structures shall not violate the integrity of the dune in shape, dimension or function, and that prior approval of the plans and specifications for such structures is obtained from the (designated representative of the Project Sponsor)and provided further that such structures are subordinate to the construction, operation, maintenance, repair, rehabilitation and replacement of the project; and further] reserving to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns all such rights and privileges as may be used and enjoyed without interfering with or abridging the rights and easements hereby acquired; subject however to existing easements for public roads and highways, public utilities, railroads and pipelines.

TEMPORARY WORK AREA EASEMENT.

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____), for a period not to exceed ___________________, beginning with date possession of the land is granted to the Town of Edisto, for use by the Town of Edisto, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the ____________________ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

1.21 Real Estate Estimate

The estimated real estate costs include the land cost for acquisition of land, relocation costs, and federal and non-federal administrative costs. Administrative costs are those costs incurred for verifying ownership of lands, certification of those lands required for project purposes, legal opinions, analysis or other requirements that may be necessary during Planning, Engineering and Design (PED). A 25% contingency is applied to the estimated total for these items. Table 1.22-1 is a summary of the real estate cost by measure.

Table 1.21-1 Real Estate Estimate

a. Lands				
	Fee			-
	Easement	187		0
	Permit	1		0
b. Improvements				-
	Residential			-
	Commercial			-
c. Mineral Rights				-
d. Damages				-
e. P. L.. 91-646				-
f. Acquisition cost - Admin				785,400.00
	Federal		130,900.00	
	Non-Federal		654,500.00	
			785,400.00	
Sub-Total				785,400.00
	25% contingencies			196,350.00
TOTAL				981,750.00
			ROUNDED	**982,000.00**

* The real estate cost at Table 6.2 in the main report is based on FY14 price levels and is therefore slightly higher than the cost shown in this Real Estate Appendix.

1.22 Chart of Accounts

The cost estimate for all Federal and non-Federal real estate activities necessary for implementation of the project after completion of the feasibility study for land acquisition, construction, LERRD, and other items are coded as delineated in the Cost Work Breakdown Structure (CWBS). This real estate cost estimate is then incorporated into the Total Current Working Estimate utilizing the Microcomputer Aided Cost Engineering System (MCACES).

Table 1.22-1 Chart of Accounts

01A	PROJECT PLANNING	FEDERAL	NON-FEDERAL	TOTALS
	Other			
	Project Cooperation Agreement	-	-	-
01AX	Contingencies (25%)	-	-	-
	Subtotal	-	-	-
01B	LANDS AND DAMAGES			
01B40	Acq/Review of PS	130,900.00		130,900.00
01B20	Acquisition by PS		654,500.00	654,500.00
01BX	Contingencies (25%)	32,725.00	163,625.00	196,350.00
	Subtotal	163,625.00	818,125.00	981,750.00
01H	AUDIT			
01H10	Real Estate Audit	-		-
01HX	Contingencies (15%)	-		-
	Subtotal	-		-
01R	REAL ESTATE LAND PAYMENTS			
01R1B	Land Payments by PS	-	-	-
01R2B	PL91-646 Relocation Pymt by PS	-	-	-
01R2D	Review of PS	-	-	-
01RX	Contingencies (25%)	-	-	-
	Subtotal	-	-	-
	TOTALS	163,625.00	818,125.00	981,750.00
	ROUNDED TO			**982,000.00**

Exhibits

Exhibit A - Authorization For Entry For Construction

Exhibit B – Assessment of Non-Federal Sponsor’s Real Estate Acquisition Capability

Exhibit C – Risk of Early Acquisition Letter to Sponsor

Exhibit D – Non-Standard Estate

Exhibit E – Photographs

AUTHORIZATION FOR ENTRY FOR CONSTRUCTION

I ______________________________, ________________________ for the
(Name of accountable official) (Title)

(Sponsor Name**)** ______, do hereby certify that the ___(Sponsor Name) has acquired the real property interest required by the Department of the Army, and otherwise is vested with sufficient title and interest in lands to support construction for (Project Name, Specifically identified project features, etc.). Further, I hereby authorize the Department of the Army, its agents, employees and contractors, to enter upon ______________________
(identify tracts)

to construct (Project Name, Specifically identified project features, etc.) as set forth in the plans and specifications held in the U. S. Army Corps of Engineers' (district, city, state)

WITNESS my signature as ____________________________ for the
(Title)

(Sponsor Name) this __ day of _____________, 20_________.

BY: ______________________
(Name)

____
(Title)

ATTORNEY'S CERTIFICATE OF AUTHORITY

I, ________________________ , ______________________________ for the
(Name) (Title of legal officer)

(Sponsor Name), certify that __________________________ has
(Name of accountable official)

authority to grant Authorization for Entry; that said Authorization for Entry is executed by the proper duly authorized officer; and that the Authorization for Entry is in sufficient form to grant the authorization therein stated.

WITNESS my signature as _____________________ for the
(Title)

(Sponsor Name**)**, this________day of_____________, 20____.

BY: ______________________
(Name)

____
(Title)

Exhibit A

Assessment of Non-Federal Sponsor's
Real Estate Acquisition Capability
Manteo Section 204

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **YES**

b. Does the sponsor have the power to eminent domain for this project? **YES**

c. Does the sponsor have "quick-take" authority for this project? **YES**

d. Are any of the land/interests in the land required for this project located outside the sponsor's political boundary? **NO**

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **NO**

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P. L. 91-646, as amended? **NO**

b. If the answer to II.a. is "yes", has a reasonable plan been developed to provide such training? (yes/no)

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **YES**

d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? **NO**

e. Can the sponsor obtain contractor support, if required in a timely fashion? **YES**

f. Will the sponsor likely request USACE assistance in acquiring real estate? **YES - only in advisory capacity**

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site? **YES**

b. Has the sponsor approved the project/real estate schedule/milestones? **NO – Project Milestone will be developed during PED; will be joint effort between RE, PM and NFS**

Exhibit B
1st page

IV. Overall Assessment:

a. Has the sponsor performed satisfactory on other USACE projects?
NA

b. With regard to the project, the sponsor is anticipated to be: **Highly capable**

V. Coordination:

a. Has this assessment been coordinated with the sponsor? **YES**

b. Does the sponsor concur with this assessment? **YES**

Prepared by:

John S. Hinely
Senior Realty Specialist

Reviewed and approved by:

Ralph J. Werthmann
Chief, Real Estate Division

Exhibit B
2nd page

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
100 W. OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3640

REPLY TO
ATTENTION OF:

Real Estate Division

SUBJECT: Edisto Beach Coastal Storm Damage Reduction Project

Honorable Burley Lyons
Mayor of Edisto Beach
2414 Murray Street
Edisto Beach, South Carolina 29438

Dear Mayor Lyons:

The intent of this letter is to formally advise the Town of Edisto, as the potential non-Federal sponsor for the proposed project, of the risks associated with land acquisition prior to the execution of the Project Partnership Agreement (PPA) or prior to the Government's formal notice to proceed with acquisition. If a non-Federal sponsor deems it necessary to commence acquisition prior to an executed PPA for whatever reason, the non-Federal sponsor assumes full and sole responsibility for any and all costs, responsibility, or liability arising out of the acquisition effort.

Generally, these risks include, but may not be limited to, the following:

(1) Congress may not appropriate funds to construct the proposed project;

(2) The proposed project may otherwise not be funded or approved for construction;

(3) A PPA mutually agreeable to the non-Federal sponsor and the Government may not be executed and implemented;

(4) The non-Federal sponsor may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA, as amended;

(5) The non-Federal sponsor may acquire interests or estates that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project;

(6) The non-Federal sponsor may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under P.L. 91-646 as well as the payment of additional fair market value to affected landowners which could have been avoided by delaying acquisition until after PPA execution and the Government's notice to commence acquisition and performance of LERRD; and

Exhibit C
1st page

(7) The non-Federal sponsor may incur costs or expenses in connection with its decision to acquire or perform LERRD in advance of the executed PPA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662 or the PPA.

We appreciate the City's participation in this project. Should you have questions or concerns pertaining to this letter, please feel free to contact Mr. John S. Hinely at (912) 652-5207.

Sincerely,

Ralph J.Werthmann
Savannah District
Chief, Real Estate Division

RE-AP
RE-A 2/14/13
RE
File

Exhibit C
2nd Page

CESAS-RE

Project: Edisto Beach Coastal Storm Damage Reduction Project
Non-Standard Perpetual Beach Storm Damage Reduction Easement Estate
A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract No. __) for use by the (Sponsor), its representatives, agents, contractors, and assigns, to construct; preserve; patrol; operate; maintain; repair; rehabilitate; and replace; a public beach a dune system, and other erosion control and storm damage reduction measures together with appurtenances thereto, including the right to deposit sand; to accomplish any alterations of contours on said land; to construct berms and dunes; to nourish and renourish periodically; to move, store and remove equipment and supplies; to erect and remove temporary structures; and to perform any other work necessary and incident to the construction, periodic renourishment and maintenance of the **Edisto Beach Coastal Storm Damage Reduction Project**, together with the right of public use and access; to plant vegetation on said dunes and berms; to erect, maintain and remove silt screens and sand fences; to facilitate preservation of dunes and vegetation through the limitation of access to dune areas; to trim, cut, fell, and remove from said land all trees, underbrush, debris, obstructions, and any other vegetation, structures and obstacles within the limits of the easement **(except *);** reserving, however, to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns, the right to construct dune overwalk structures in accordance with any applicable Federal, State or local laws or regulations, provided that such structures shall not violate the integrity of the dune in shape, dimension or function, and that prior approval of the plans and specifications for such structures is obtained from the (designated representative of the Project Sponsor) and provided further that such structures are subordinate to the construction, operation, maintenance, repair, rehabilitation and replacement of the project; and further reserving to the grantor(s), (his) (her) (its) (their) (heirs), successors and assigns all such rights and privileges as may be used and enjoyed without interfering with or abridging the rights and easements hereby acquired; subject however to existing easements for public roads and highways, public utilities, railroads and pipelines.

*** the right to remove or demolish the existing fishing pier and appurtenances thereto;**

In accordance with the provisions of paragraph 12-10c. of ER 405-1-12, I approve the use of the above non-standard estate for the Edisto Beach Coastal Storm Damage Reduction project. The estate serves the intended project purpose, substantially conforms with and does not materially deviate from the corresponding standard estate contained in the Real Estate Handbook and does not increase the costs nor potential liability of the Government.

Date: 22 May 2013

Ralph J. Werthmann
Savannah District
Chief, Real Estate

Exhibit D Page 2

Photographs

View facing south along Atlantic Reach

View facing north along Atlantic Reach

View along Inlet Reach

Typical Public Access

EDISTO BEACH
COASTAL STORM DAMAGE REDUCTION
GENERAL INVESTIGATION STUDY

APPENDIX L
COST ENGINEERING

TABLE OF CONTENTS

L. COST ESTIMATES

L1. GENERAL INFORMATION

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil
  Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 15 September 2008
- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 22 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304 (Tables Revised 31 March 2009), Civil Works Construction Cost Index System, 31 March 2000
- CECW-CP Memorandum for Distribution, Subject: Initiatives to Improve the Accuracy of Total Project Costs in Civil Works Feasibility Studies Requiring Congressional Authorization, 19 September 2007
- CECW-CE Memorandum for Distribution, Subject: Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs, 3 July 2007
- Cost and Schedule Risk Analysis Process, March 2008

The goal of the cost estimates for the Edisto Beach Shore Protection Feasibility Study are to present a Total Project Cost (Construction and Non-Construction costs) for the recommended plan at the current price level to be used for project justification/authorization and to escalate costs for budgeting purposes. In addition, the costing efforts are intended to produce a final product (cost estimate) that is reliable and accurate, and that supports the definition of the Government's and the Non-Federal sponsor's obligations.

The cost estimating effort for the study also yielded unit costs for dredging per cubic yard and mobilization/demobilization costs that were used within the Coastal Engineering modeling program Beach-FX to compare a series of alternative plan formulations for decision making based upon net benefits. The final set of plan formulation cost estimates used for plan selection rely on construction feature unit pricing and are prepared in Civil Works Work Breakdown Structure (CWWBS) format to the sub-feature level. The cost estimate supporting the National Economic Development (NED) plan (Recommended Plan) is prepared in MCACES/MII format to the CWWBS sub-feature level. This estimate is supported by the preferred labor, equipment, materials and crew/production breakdown. A fully funded (escalated for inflation through project completion) cost estimate, the Baseline Cost Estimate or Total Project Cost Summary, has also been developed. A risk analysis was prepared that addresses project uncertainties and sets contingencies for the Recommended Alternative Plan's cost items. The final Cost and Schedule Risk Analysis Report produced by the Charleston District Cost Engineering is attached to this appendix.

L.1.1 Recommended Alternative Plan

The final Recommended Plan was chosen by the Project Delivery Team (PDT) according to Cost Effectiveness/Incremental Cost Analysis procedures and resulted directly from the plan formulation described above. The Economics Appendix fully describes the plan selection.

The scope of work for the Recommended Plan consists of construction of a mid-size dune and berm fill along approximately 22,000 feet of the beach as shown in Table 5.4 of the main report. The initial construction consists of placement of 924,000 cubic yards of material. Periodic nourishments are calculated to occur every 8 years with a quantity of 220,398 cubic yards of material. In addition, groin lengthening is included at 23 locations for a total of 1,130 feet as outlined in Table 5.5 of the main report. Dune vegetation is also included along approximately 30 acres of the project area. The MCACES/MII cost estimate for the Recommended Alternative Plan (Section L.2, below) is based on that scope and is formatted in the CWWBS. The notes provided in the body of the estimate detail the estimate parameters and assumptions. The cost estimate includes pricing at the Fiscal Year 2013 price level (1 October 2012-30 September 2013). A detailed Cost and Schedule Risk Analysis (CSRA) was done to establish the contingency for the Recommended Plan. Non-construction costs were included as percentages of the total construction contract cost for this level of comparison and screening. For project justification purposes, the estimated costs are categorized under the appropriate CWWBS code and include both construction and non-construction costs.

The construction costs fall under the following feature codes:

- 10 Breakwaters and Seawalls
- 17 Beach Replenishment

The non-construction costs fall under the following feature codes:

- 01 Lands and Damages
- 30 Planning, Engineering and Design
- 31 Construction Management

L.1.2 Construction Cost

Construction costs were developed in MCACES/MII and include all major project components categorized under the appropriate CWWBS to the sub-feature level. The Total Project Cost Summary (TPCS) on the final Recommended Plan contains contingencies as noted in the estimate (below) and were determined as a result of the risk analysis. Additional information follows on the risk analysis.

L.1.3 Non-construction Cost

Non-construction costs typically include Lands and Damages (Real Estate), Planning Engineering & Design (PED) and Construction Management Costs (Supervision & Administration, S&A). These costs were provided by the PDT either as a lump sum cost or as a percentage of the total Construction Contract Cost. Lands and Damages are provided by Real Estate and are best described in the Real Estate Appendix, Appendix K. PED costs are for the preparation of contract plans and specifications (P&S) and include percentages of total construction costs, as well as percentages for Engineering During Construction (EDC) and Planning During Construction (PDC) that were provided by the Chief of Engineering. Construction Management costs are for the supervision and administration of a contract and include Project Management and Contract Admin costs. These costs were provided by the Chief of Construction and are included as a percentage of the total construction contract cost.

The main report details both cost allocation and cost apportionment for the Federal Government and the Non-Federal Sponsor. Also included in the main report are the Non-Federal Sponsor's obligations (items of local cooperation).

L.1.4 Plan Formulation Cost Estimates

For the plan formulation cost estimates, unit costs for dredging per cubic yard and mobilization/demobilization costs were developed in the Corps of Engineers Dredge Estimating Program (CEDEP) and used within the Coastal Engineering modeling program Beach-FX to compare a series of alternative plan formulations for decision making based upon net benefits. For the plan formulation estimates a contingency of 25% was assumed due to the preliminary nature of design. Unit prices for the remaining major construction elements were developed in MCACES/MII based on input from the PDT. Design details, information and assumptions were provided in the Engineering Appendix. A detailed Cost and Schedule Risk Analysis (CSRA) was done to establish the contingency for the Recommended Plan. Non-construction costs were included as percentages of the total construction contract cost for this level of comparison and screening.

Refer to Economics Section in the main report for final plan formulation cost tables.

L.1.5 Construction Schedule

Due to the relatively short durations for the initial construction (4 months) and periodic nourishment cycles (less than 1 month), a detailed construction schedule was not prepared. However, utilizing input from the PDT, a preliminary schedule was assumed with initial construction to begin in 2018. An 8 year period was calculated between nourishment cycles by Coastal Engineering resulting in 6 cycles through the 50 year life of this project. Since a hydraulic pipeline dredge was assumed to be used for construction, the only environmental restriction is the requirement for sea turtle nest observers during the period from April through October. Costs were included for these observers in the cost estimate and therefore construction can take place anytime during the year. The preliminary project schedule was used for the generation of the Total Project Cost Summary (TPCS), as well as the schedule portion of the Cost and Schedule Risk Analysis (CSRA). The construction schedule will change as the project moves through the various project lifecycle phases.

L.1.6 Total Project Cost Summary

The cost estimate for the Recommended Plan is prepared with an identified price level date and inflation factors are used to adjust the pricing to the project schedule. This estimate is known as the Fully Funded Cost Estimate or Total Project Cost Summary. It includes all Federal and Non-Federal costs: Lands, Easements, Rights of Way and Relocations; construction features; Preconstruction Engineering and Design; Construction Management; Contingency; and Inflation.

L2. RECOMMENDED PLAN (NED) COST ESTIMATE

Refer to MII Printout on the next page. During preparation of cost estimates for alternative methods of construction, it was determined that due to the proximity of the borrow area to the placement area; an ocean certified hydraulic pipeline would be more economical than a medium sized hopper dredge. Therefore, the costs shown in the estimate are based upon using a 30” hydraulic pipeline dredge for sand placement on the beach.

Edisto Beach First Cost Total 8-7-13

Edisto Beach, one of the barrier islands on the coast of South Carolina, is located in Colleton County, approximately 45 miles southwest of Charleston, South Carolina.
The US Army Corps of Engineers is studying the creation of a Federal Project to provide shoreline protection to Edisto Beach. This project consists of initial lengthening of existing groins and beach nourishment to Edisto Beach to maintain an adequate level of storm protection for the residents and businesses located on Edisto Beach.
The calculations for the dredging portion of this project is imported from the Corps of Engineers Dredge Estimating Program (CEDEP).

This estimate contains no contingency or escalation. These items are added in the Total Project Cost Summary. The contingencies in the TPCS were developed during Cost & Schedule Risk Analysis (CSRA).

Escalation is calculated inside the TPCS used the tables developed in the latest version distributed by the Cost MCX at Walla Walla District.

Estimated by	CESAC
Designed by	CESAC
Prepared by	Jeffery Fersner
Preparation Date	8/7/2013
Effective Date of Pricing	8/7/2013
Estimated Construction Time	120 Days

Description	UOM	Quantity	ProjectCost
Project Owner Summary			**49,142,708.53**
Initial Construction	**LS**	**1.00**	**16,769,480.86**
01 Lands and Damages	**LS**	**1.00**	**785,400.00**
10 Breakwaters and Seawalls	**LS**	**1.00**	**2,119,616.09**
17 Beach Replenishment	**LS**	**1.00**	**12,830,464.77**
30 Planning, Engineering and Design	**LS**	**1.00**	**839,000.00**
31 Construction Management	**LS**	**1.00**	**195,000.00**
First Nourishment Construction	**LS**	**1.00**	**5,395,537.94**
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**
Second Nourishment Construction	**LS**	**1.00**	**5,395,537.94**
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**
Third Nourishment Construction	**LS**	**1.00**	**5,395,537.94**
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**
Fourth Nourishment Construction	**LS**	**1.00**	**5,395,537.94**
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**
Fifth Nourishment Construction	**LS**	**1.00**	**5,395,537.94**
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**
Sixth Nourishment Construction	**LS**	**1.00**	**5,395,537.94**

Description	UOM	Quantity	ProjectCost
17 Beach Replenishment	**LS**	**1.00**	**5,049,537.94**
30 Planning, Engineering and Design	**LS**	**1.00**	**281,000.00**
31 Construction Management	**LS**	**1.00**	**65,000.00**

L3. RISK AND UNCERTAINTY ANALYSIS

A Cost and Schedule Risk Analysis was conducted according to the procedures outlined in the manual entitled, “Cost and Schedule Risk Analysis Process” dated March 2008.

L.3.1 Risk Analysis Methods

The entire PDT participated in a cost and schedule risk analysis brainstorming session to identify risks associated with the recommended plan. The risks were listed in the risk register and evaluated by the PDT. Assumptions were made as to the likelihood and impact of each risk item, as well as the probability of occurrence and magnitude of the impact if it were to occur. A risk model was then developed in Crystal Ball in order to develop a contingency to apply to the project cost and schedule. After the model was run, the results were reviewed and all parameters were re-evaluated by the PDT as a sanity check of assumptions and inputs. Adjustments were made to the analysis accordingly and the final contingency was established. The contingency was applied to the recommended plan estimate in the Total Project Cost Summary in order to obtain the Fully Funded Cost.

L.3.2 Risk Analysis Results

Refer to the Project Cost and Schedule Risk Analysis Report provided by Charleston District Cost Engineering as an attachment to this appendix.

L4. TOTAL PROJECT COST SUMMARY

The Total Project Cost Summary (TPCS) addresses inflation through project completion (accomplished by escalation to mid-point of construction for each phase of this project (initial construction and six nourishment cycles) per ER 1110-2-1302, Appendix C, Page C-2). It is based on the scope of the Recommended Plan and the official project schedule. The TPCS includes Federal and Non-Federal costs for Lands and Damages, all construction features, PED, S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the WBS and uses Civil Works Construction Cost Indexing System factors for escalation (EM 1110-2-1304) of construction costs and Office of Management and Budget (EC 11-2-18X, 20 Feb 2008) factors for escalation of PED and S&A costs.

The Total Project Cost Summary was prepared using the MCACES/MII cost estimate on the Recommended Plan, as well as the contingency set by the risk analysis and the official project schedule.

L.4.1 Total Project Cost Summary Spreadsheet

Refer to the Total Project Cost Summary Spreadsheet on the next page.

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
PROJECT NO: P2 - 113475
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	24-Jun-13 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
10	BREAKWATER & SEAWALLS	$2,120	$551	26%	$2,671	1.4%	$2,150	$559	$2,708	$0		$2,318	$603	$2,921
17	BEACH REPLENISHMENT	$43,130	$12,123	28%	$55,253	1.4%	$43,731	$12,292	$56,023	$0		$72,022	$20,466	$92,488
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	#N/A	$0	$0	-	$0	-	$0	$0	$0	$0		$0	$0	$0
	CONSTRUCTION ESTIMATE TOTALS:	$45,250	$12,674		$57,924	1.4%	$45,881	$12,851	$58,731	$0		$74,341	$21,068	$95,409
01	LANDS AND DAMAGES	$785	$204	26%	$989	1.4%	$796	$207	$1,003	$0		$815	$212	$1,027
30	PLANNING, ENGINEERING & DESIGN	$2,525	$707	28%	$3,232	1.4%	$2,561	$717	$3,278	$0		$4,066	$1,153	$5,219
31	CONSTRUCTION MANAGEMENT	$585	$164	28%	$749	1.4%	$593	$166	$759	$0		$960	$272	$1,232
	PROJECT COST TOTALS:	$49,145	$13,749	28%	$62,894		$49,831	$13,941	**$63,771**	$0		$80,182	$22,705	$102,887

Mandatory by Regulation CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Mandatory by Regulation PROJECT MANAGER, Dudley Patrick

Mandatory by Regulation CHIEF, REAL ESTATE, Savannah District

CHIEF, PLANNING, Brett Walters

CHIEF, ENGINEERING, Carole Works, PE

CHIEF, OPERATIONS, Brian Wells, PE

CHIEF, CONSTRUCTION, David Dodds, PE

CHIEF, CONTRACTING, Lauri Newkirk-Paggi

CHIEF, PM-P, Lisa Metheney

CHIEF, DPM, Bill Stein, PE

ESTIMATED FEDERAL COST:	**65%**	**$66,876**
ESTIMATED NON-FEDERAL COST:	**35%**	**$36,010**
ESTIMATED TOTAL PROJECT COST:		**$102,887**

Filename: TPCS_2013r5-Edisto Beach Total 8-7-13.xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
		Estimate Prepared:			8/7/2013	Program Year (Budget EC):			2014					
		Effective Price Level:			24-Jun-2013	Effective Price Level Date:			1 OCT 13					
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Initial Construction													
10	BREAKWATER & SEAWALLS	$2,120	$551	26%	$2,671	1.4%	$2,150	$559	$2,708	2018Q2	7.8%	$2,318	$603	$2,921
17	BEACH REPLENISHMENT	$12,830	$3,336	26%	$16,166	1.4%	$13,009	$3,382	$16,391	2018Q2	7.8%	$14,029	$3,648	$17,677
	#N/A	$0	$0	24%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	10%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	10%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$14,950	$3,887	26%	**$18,837**		$15,158	$3,941	$19,099			$16,347	$4,250	$20,597
01	LANDS AND DAMAGES	$785	$204	26%	$989	1.4%	$796	$207	$1,003	2015Q3	2.4%	$815	$212	$1,027
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$75	$20	26%	$95	1.4%	$76	$20	$96	2015Q3	2.4%	$78	$20	$98
0.5%	Planning & Environmental Compliance	$75	$20	26%	$95	1.4%	$76	$20	$96	2015Q3	2.4%	$78	$20	$98
2.0%	Engineering & Design	$299	$78	26%	$377	1.4%	$303	$79	$382	2015Q3	2.4%	$310	$81	$391
0.5%	Reviews, ATRs, IEPRs, VE	$75	$20	26%	$95	1.4%	$76	$20	$96	2015Q3	2.4%	$78	$20	$98
0.3%	Life Cycle Updates (cost, schedule, risks)	$45	$12	26%	$57	1.4%	$46	$12	$58	2015Q3	2.4%	$47	$12	$59
0.5%	Contracting & Reprographics	$75	$20	26%	$95	1.4%	$76	$20	$96	2015Q3	2.4%	$78	$20	$98
0.5%	Engineering During Construction	$75	$20	26%	$95	1.4%	$76	$20	$96	2018Q2	7.8%	$82	$21	$103
0.3%	Planning During Construction	$45	$12	26%	$57	1.4%	$46	$12	$58	2018Q2	7.8%	$49	$13	$62
0.5%	Project Operations	$75	$20	26%	$95	1.4%	$76	$20	$96	2015Q3	2.4%	$78	$20	$98
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$135	$35	26%	$170	1.4%	$137	$36	$173	2018Q2	7.8%	$148	$38	$186
0.2%	Project Operation:	$30	$8	26%	$38	1.4%	$30	$8	$38	2018Q2	7.8%	$33	$9	$41
0.2%	Project Management	$30	$8	26%	$38	1.4%	$30	$8	$38	2018Q2	7.8%	$33	$9	$41
	CONTRACT COST TOTALS:	$16,769	$4,360		**$21,129**		$17,003	$4,421	$21,424			$18,253	$4,746	**$22,999**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: / Effective Price Level:			8/7/2013 / 24-Jun-2013	Program Year (Budget EC): / Effective Price Level Date:			2014 / 1 OCT 13					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	1st Nourishment 2026													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2026Q2	25.4%	$6,419	$1,862	$8,281
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$6,419	$1,862	$8,281
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2025Q3	23.6%	$31	$9	$40
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2025Q3	23.6%	$31	$9	$40
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2025Q3	23.6%	$127	$37	$163
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2025Q3	23.6%	$31	$9	$40
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2025Q3	23.6%	$19	$5	$24
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2025Q3	23.6%	$31	$9	$40
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2026Q2	25.3%	$32	$9	$41
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2026Q2	25.3%	$19	$6	$25
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2025Q3	23.6%	$31	$9	$40
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2026Q2	25.3%	$57	$17	$74
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2026Q2	25.3%	$13	$4	$16
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2026Q2	25.3%	$13	$4	$16
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$6,855	$1,988	**$8,843**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			8/7/2013	Program Year (Budget EC):			2014					
		Effective Price Level:			24-Jun-2013	Effective Price Level Date:			1 OCT 13					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	2nd Nourishment Cycle 2034													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2034Q2	45.7%	$7,462	$2,164	$9,626
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$7,462	$2,164	$9,626
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2033Q3	43.7%	$36	$11	$47
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2033Q3	43.7%	$36	$11	$47
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2033Q3	43.7%	$147	$43	$190
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2033Q3	43.7%	$36	$11	$47
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2033Q3	43.7%	$22	$6	$28
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2033Q3	43.7%	$36	$11	$47
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2034Q2	45.7%	$37	$11	$48
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2034Q2	45.7%	$22	$6	$29
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2033Q3	43.7%	$36	$11	$47
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2034Q2	45.7%	$67	$19	$86
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2034Q2	45.7%	$15	$4	$19
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2034Q2	45.7%	$15	$4	$19
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$7,969	$2,311	**$10,280**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 8/7/2013 Effective Price Level: 24-Jun-2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	3rd Nourishment Cycle 2042													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2042Q2	69.4%	$8,675	$2,516	$11,191
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$8,675	$2,516	$11,191
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2041Q3	67.0%	$42	$12	$55
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2041Q3	67.0%	$42	$12	$55
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2041Q3	67.0%	$171	$50	$221
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2041Q3	67.0%	$42	$12	$55
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2041Q3	67.0%	$25	$7	$33
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2041Q3	67.0%	$42	$12	$55
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2042Q2	69.4%	$43	$12	$55
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2042Q2	69.4%	$26	$7	$33
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2041Q3	67.0%	$42	$12	$55
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2042Q2	69.4%	$77	$22	$100
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2042Q2	69.4%	$17	$5	$22
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2042Q2	69.4%	$17	$5	$22
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$9,264	$2,686	**$11,950**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 8/7/2013 Effective Price Level: 24-Jun-2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	4th Nourishment Cycle 2050													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2050Q2	97.0%	$10,085	$2,925	$13,009
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$10,085	$2,925	$13,009
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2049Q3	94.2%	$49	$14	$64
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2049Q3	94.2%	$49	$14	$64
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2049Q3	94.2%	$199	$58	$257
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2049Q3	94.2%	$49	$14	$64
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2049Q3	94.2%	$30	$9	$38
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2049Q3	94.2%	$49	$14	$64
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2050Q2	96.9%	$50	$14	$64
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2050Q2	96.9%	$30	$9	$39
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2049Q3	94.2%	$49	$14	$64
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2050Q2	96.9%	$90	$26	$116
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2050Q2	96.9%	$20	$6	$26
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2050Q2	96.9%	$20	$6	$26
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$10,769	$3,123	**$13,892**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**				**TOTAL PROJECT COST (FULLY FUNDED)**				
		Estimate Prepared: 8/7/2013				Program Year (Budget EC): 2014				FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level: 24-Jun-2013				Effective Price Level Date: 1 OCT 13								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	5th Nourishment Cycle 2058													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2058Q2	129.0%	$11,723	$3,400	$15,123
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$11,723	$3,400	$15,123
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2057Q3	125.7%	$57	$17	$74
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2057Q3	125.7%	$57	$17	$74
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2057Q3	125.7%	$231	$67	$298
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2057Q3	125.7%	$57	$17	$74
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2057Q3	125.7%	$34	$10	$44
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2057Q3	125.7%	$57	$17	$74
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2058Q2	128.9%	$58	$17	$75
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2058Q2	128.9%	$35	$10	$45
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2057Q3	125.7%	$57	$17	$74
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2058Q2	128.9%	$104	$30	$135
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2058Q2	128.9%	$23	$7	$30
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2058Q2	128.9%	$23	$7	$30
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$12,519	$3,630	**$16,149**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: EDISTO BEACH FEASIBILITY STUDY REPORT
LOCATION: EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA
This Estimate reflects the scope and schedule in report; EDISTO BEACH FEASIBILITY STUDY - AUGUST 2013

DISTRICT: CESAC CHARLESTON DISTRICT PREPARED: 8/7/2013
POC: CHIEF, DESIGN & GEN ENGINEERING, Nancy Jenkins, RA

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 8/7/2013 Effective Price Level: 24-Jun-2013				Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	INFLATED (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	6th Nourishment Cycle 2066													
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
17	BEACH REPLENISHMENT	$5,050	$1,465	29%	$6,515	1.4%	$5,120	$1,485	$6,605	2066Q2	166.2%	$13,629	$3,952	$17,581
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
	#N/A	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
							$0							
	CONSTRUCTION ESTIMATE TOTALS:	$5,050	$1,465	29%	**$6,515**		$5,120	$1,485	$6,605			$13,629	$3,952	$17,581
01	LANDS AND DAMAGES	$0	$0	0%	$0	0.0%	$0	$0	$0	0	0.0%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$25	$7	29%	$32	1.4%	$25	$7	$33	2065Q3	162.4%	$67	$19	$86
0.5%	Planning & Environmental Compliance	$25	$7	29%	$32	1.4%	$25	$7	$33	2065Q3	162.4%	$67	$19	$86
2.0%	Engineering & Design	$101	$29	29%	$130	1.4%	$102	$30	$132	2065Q3	162.4%	$269	$78	$347
0.5%	Reviews, ATRs, IEPRs, VE	$25	$7	29%	$32	1.4%	$25	$7	$33	2065Q3	162.4%	$67	$19	$86
0.3%	Life Cycle Updates (cost, schedule, risks)	$15	$4	29%	$19	1.4%	$15	$4	$20	2065Q3	162.4%	$40	$12	$51
0.5%	Contracting & Reprographics	$25	$7	29%	$32	1.4%	$25	$7	$33	2065Q3	162.4%	$67	$19	$86
0.5%	Engineering During Construction	$25	$7	29%	$32	1.4%	$25	$7	$33	2066Q2	166.1%	$67	$20	$87
0.3%	Planning During Construction	$15	$4	29%	$19	1.4%	$15	$4	$20	2066Q2	166.1%	$40	$12	$52
0.5%	Project Operations	$25	$7	29%	$32	1.4%	$25	$7	$33	2065Q3	162.4%	$67	$19	$86
31	CONSTRUCTION MANAGEMENT													
0.9%	Construction Management	$45	$13	29%	$58	1.4%	$46	$13	$59	2066Q2	166.1%	$121	$35	$157
0.2%	Project Operation:	$10	$3	29%	$13	1.4%	$10	$3	$13	2066Q2	166.1%	$27	$8	$35
0.2%	Project Management	$10	$3	29%	$13	1.4%	$10	$3	$13	2066Q2	166.1%	$27	$8	$35
	CONTRACT COST TOTALS:	$5,396	$1,565		**$6,961**		$5,471	$1,587	$7,058			$14,553	$4,220	**$18,774**

Filename: TPCS_2013r5-Edisto Beach Total 8-7-13.xlsx
TPCS

L5. COST MCX TPCS CERTIFICATION

The Recommended Plan estimate as well as the Cost and Schedule Risk Analysis and Total Project Cost Summary will undergo Cost Review and Certification by the Walla Walla Mandatory Center of Expertise following the final ATR, prior to submittal of the Final Report.

EDISTO BEACH, COLLETON COUNTY, SOUTH CAROLINA COASTAL STORM DAMAGE REDUCTION FEASABILITY REPORT RISK ANALYSIS

Prepared by:
U.S. Army Corps of Engineers,
Charleston District

Date: August 7, 2013

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APPENDIX

EXECUTIVE SUMMARY

Report Purpose

The US Army Corps of Engineers (USACE), Charleston District, presents this cost and schedule risk analysis (CSRA) report for the Edisto Beach Coastal Storm Damage Reduction Feasibility Report. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis, *Monte-Carlo* based-study was conducted by the Project Development Team (PDT) on the first cost as well as the periodic renourishment costs of the project. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommend 80% confidence level of successful execution to project completion.

Project Scope

The project area is located on Edisto Beach, a barrier island on South Carolina's coast in Colleton County. The entire island is approximately 7 miles in length. However, due to lack of any significant structures on the northern section, the project area consists of approximately 4 mile section of Edisto Beach. The plan calls for an initial placement of 924,000 cubic yards of material and a periodic nourishment of 220,398 cubic yards every eight years for the project life (6 total nourishments). Material for the project is to be dredged from an offshore location.

Risk Analysis Results

A Cost and Schedule Risk Analysis (CSRA) update was performed on August 7, 2013 on this project to identify the 80% confidence level contingencies for the initial construction and renourishments. The study was performed on the Federal NED plan. The contingencies considered both cost and schedule with the schedule risk being converted to an additional cost risk. The results are that the examination of the of the risks for the first cost result in a 26% contingency at the 80% confidence level and the renourishments risk result in a slightly higher 29% contingency at the 80% level. These contingencies are applied to the remaining project activities such as Lands and Damages, Design and Construction Management as applicable. The following results were observed based on the MCACES Cost Estimate:

Construction Results	**Contingency Amount ($k)**	**Contingency %**
Initial Construction	$4,360	26%
Periodic Renourishments	$9,388	29%

High Risk Items

The following were high risk items affecting cost. The complete risk register and analysis can be viewed in Appendix A.

- Market Conditions

Discussion: Dredging is a highly competitive industry and there are limited windows when dredging can be performed in this area. The PDT has planned to allow multiple types of dredges to be considered to increase competition for this project.

- Dredge size

Discussion: The choice of dredge size can affect efficiency and productivity, causing a difference between the government estimate and the bid price of the contract. The estimate assumed a 30" hydraulic pipeline dredge will be utilized, but the actual equipment is not restrictive within the proposed contract. The only restriction is the fact that the borrow area is outside the line of demarcation which requires an ocean certified dredge to be used.

- Contract Modifications/Claims:

Discussion- Contract modifications are always a risk in dredging. This work has a preferred window for construction and any environmental impacts in the region could potentially stop or delay the work that season resulting in remobilization costs.

- Other risks- Fuel, Quantities, and Borrow assumptions

Discussion- With dredging work the price of fuel is a significant cost and is usually a high risk factor along with the quantities and borrow assumptions. The quantity of material required to be placed is uncertain and can be affected by increases in erosion due to more frequent storm events. In addition, due to the time period between the feasibility study and initial construction, the expected quantity could change dramatically. Overall this is a relatively straightforward project and many of the risks are typical of similar projects.

Mitigation Recommendations

A positive outcome of the CSRA was a thorough discussion of the risks and their mitigation measures. PDT members worked through each risk item and how the risks would affect the overall project. Most could not be mitigated such as adverse weather and funding issues

Major recommendations are as follows for high risk items:

- Modifications/Claims during Project Construction Execution – Research into specific risk events which cause modification or claim during previous construction periods. Identify potential risk mitigation efforts from results.
- For the periodic renourishments, the quantities of material to be placed should be evaluated each year to ensure that the planned quantities are sufficient to maintain the level of protection required as the project progresses.

Total Project Cost Summary

The following table portrays the first cost of the initial construction and the 6 periodic nourishments features based on the anticipated contracts. The costs are intended to address the necessary costs at authorization of the project. Costs are in thousands of dollars. The contingency is based on an 80% confidence level, as per USACE Civil Works guidance. First Costs are in FY14 dollars.

Table 1 - Project First Cost Summary

ACCT	DESCRIPTION	FIRST COSTS (FY14) COST ($k)	CONTG ($k)	TOTALS ($k)	FULLY FUNDED COSTS COST ($k)	CONTG ($k)	TOTALS ($k)
1	Lands & Damages	$796.0	$207.0	$1,003.0	$815.0	$212.0	$1,027.0
17	Beach Replenishment	$13,009.0	$3,382.0	$16,391.0	$14,029.0	$3,648.0	$17,677.0
10	Breakwaters & Seawalls	$2,150.0	$559.0	$2,709.0	$2,318.0	$603.0	$2,921.0
Construction Costs		**$15,955.0**	**$4,148.0**	**$20,103.0**	**$17,162.0**	**$4,463.0**	**$21,625.0**
30	Planning, Engineering & Design	$851.0	$223.0	$1,074.0	$878.0	$227.0	$1,105.0
31	Supervision & Administration	$197.0	$52.0	$249.0	$214.0	$55.0	$269.0
	Summary 30 & 31 Account	**$1,048.0**	**$275.0**	**$1,323.0**	**$1,092.0**	**$282.0**	**$1,374.0**
	Total	**$17,003.0**	**$4,423.0**	**$21,426.0**	**$18,254.0**	**$4,745.0**	**$22,999.0**

PURPOSE/BACKGROUND

The US Army Corps of Engineers (USACE), Charleston District, presents this cost and schedule risk analysis (CSRA) report for the Edisto Beach Coastal Storm Damage Reduction Feasibility Report. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated September 15, 2008, a formal risk analysis, *Monte-Carlo* based-study was conducted by the Project Development Team (PDT) on the costs to implement the selected alternative. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined and respective project contingencies at a recommend 80% confidence level of successful execution to project completion

REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both the initial construction cost and the periodic nourishments risks for all project features. The project schedule was examined and schedule risks for the initial construction are only considered as the schedule risks for the long term nourishments are primarily limited by the funding received and are beyond the team to influence. The schedule risk for the initial construction is generally minor and is converted to costs and added to the cost risk model. It is assumed that after the initial construction is complete that the project would receive the necessary funding to complete future nourishment of the beach segments. The study and presentation can include or exclude consideration for operation and maintenance or life cycle costs, depending upon the program or decision document intended for funding.

Project Scope

Major Project Features studied from the civil works work breakdown structure (CWWBS) for this project includes:

01 – Lands & Damages

10 – Breakwaters & Seawalls

17 – Beach Replenishment

30 - Planning, Engineering & Design

31 - Construction Management

USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering MCX). The risk analysis process reflected within the risk analysis report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted. The risk study utilizes the MCACES cost estimate amount for all features then applies the resultant percentage of risk/contingency to the project first and fully funded costs.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.
- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.

METHODOLOGY/PROCESS

The initial CSRA meeting was held via teleconference on July 09 2013 for the purposes of identifying and assessing risk factors. Participants include the following PDT members:

Dudley Patrick, Project Manager, SAC

Mark Messersmith, Biologist, SAC

Jeffery Fersner, Cost Engineer, SAC

Jeffrey Lin, Plan Formulator, SAW

Julie McGuire, Economist, SAM

Mark Gravens, Coastal Engineer, ERDC

Kevin Conner, Coastal Engineer, SAW

John Hinely, Real Estate, SAS

Monica Dodds, Plan Formulator, SAS

Ben Lackey, Geotechnical Engineer, SAW

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering MCX guidance for cost and schedule risk analysis generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. Because Crystal Ball is an Excel add-in, the schedules for each option are recreated in an Excel format from their native format. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results would be provided in section 6.

Identify and Assess Risk Factors

Identifying the risk factors via the PDT are considered a qualitative process that results in establishing a risk register that serves as the document for the further study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered.

The initial formal meeting focused primarily on risk factor identification using brainstorming techniques, but also included some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Discussions focused primarily on risk factor assessment and quantification.

Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

Risk discussions focused on the various project features as presented within the USACE Civil Works Work Breakdown Structure for cost accounting purposes. It was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity, and design progress.

The resulting product from the PDT discussions is captured within a risk register as presented in Appendix A, for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For schedule contingency analysis, the option schedule contingency is calculated as the difference between the P80 option duration forecast and the base schedule duration. These contingencies are then used to calculate the time value of money impact of project delays that are included in the presentation of total cost contingency in section 6. The resulting time value of money, or added risk escalation, is then added into the contingency amount to reflect the USACE standard for presenting the “total project cost” for the fully funded project amount.

Schedule contingency is analyzed only on the basis of each option and not allocated to specific tasks. Based on Cost Engineering MCX guidance, only critical path and near critical path tasks are considered to be uncertain for the purposes of contingency analysis.

KEY CONSIDERATIONS AND ASSUMPTIONS

Key assumptions include the following:

- Adequate Borrow currently exists for the project within the defined borrow area.
- Life Cycle costs have not been included in this cost estimate.
- Contract acquisition strategy will be full and open.

RISK ANALYSIS RESULTS

Risk Register

Risk is unforeseen or unknown factors that can affect a project’s cost or schedule. Time and money have a direct relationship due to the time value of money. A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and Crystal Ball risk models. The risk register describes risks in terms of cost and schedule. A summary risk register that includes typical risk events studied (high and moderate levels) is presented in this section. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. A more detailed risk register is provided in Appendix A. The detailed risk registers of Appendix A include low level and unrated risks, as well as additional information regarding the specific nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing and communicating identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.

- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls.

- Communicating risk management issues.

- Providing a mechanism for eliciting risk analysis feedback and project control input.

- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

A correlation is a dependency that exists between two risks and may be direct or indirect. An indirect correlation is one in which large values of one risk are associated with small values of the other. Indirect correlations have correlation coefficients between 0 and -1. A direct correlation is one in which large values of one risk are associated with large values of the other. Direct correlations have correlation coefficients between 0 and 1. Correlations were not identified in this analysis.

The risk register identifies thirty one different risks. There are eight that are either moderate or high risks. An abridged version of the risk register is presented below.

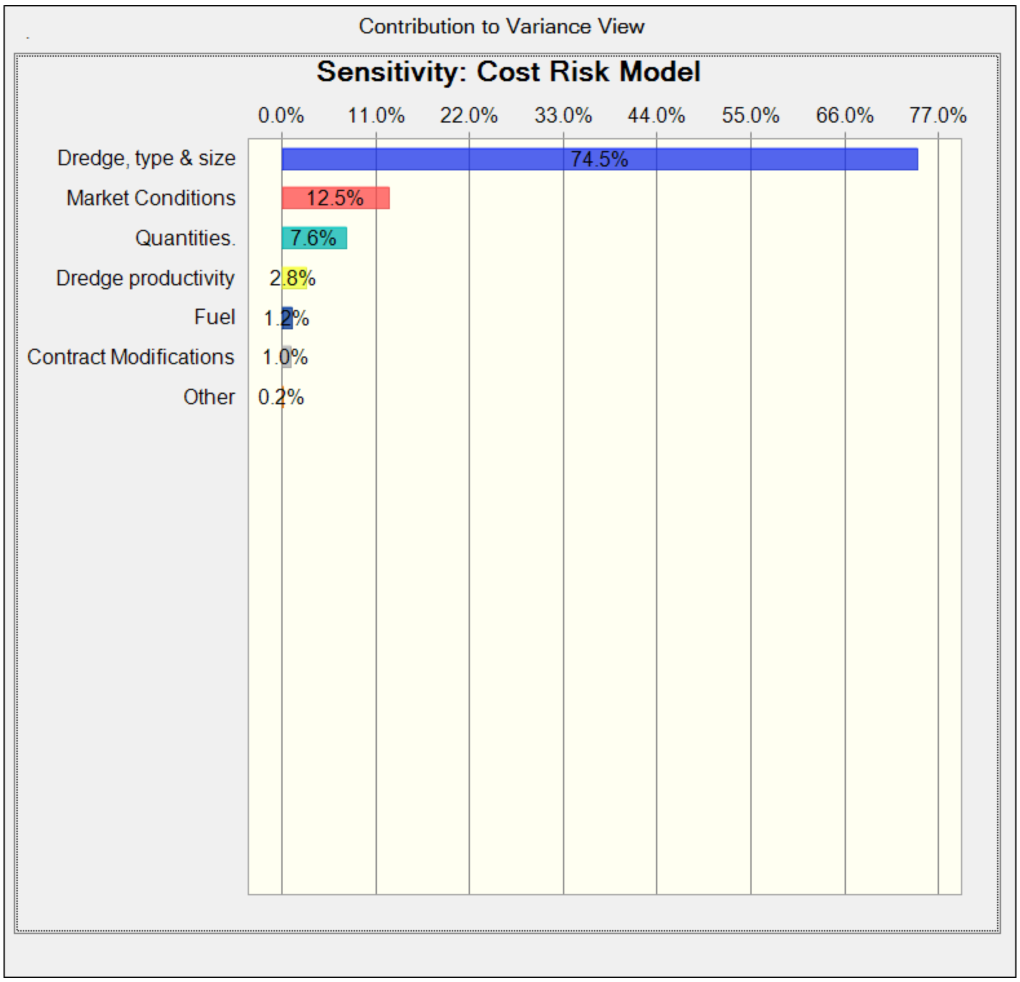
Table 2 - Risk Register (Abridged)

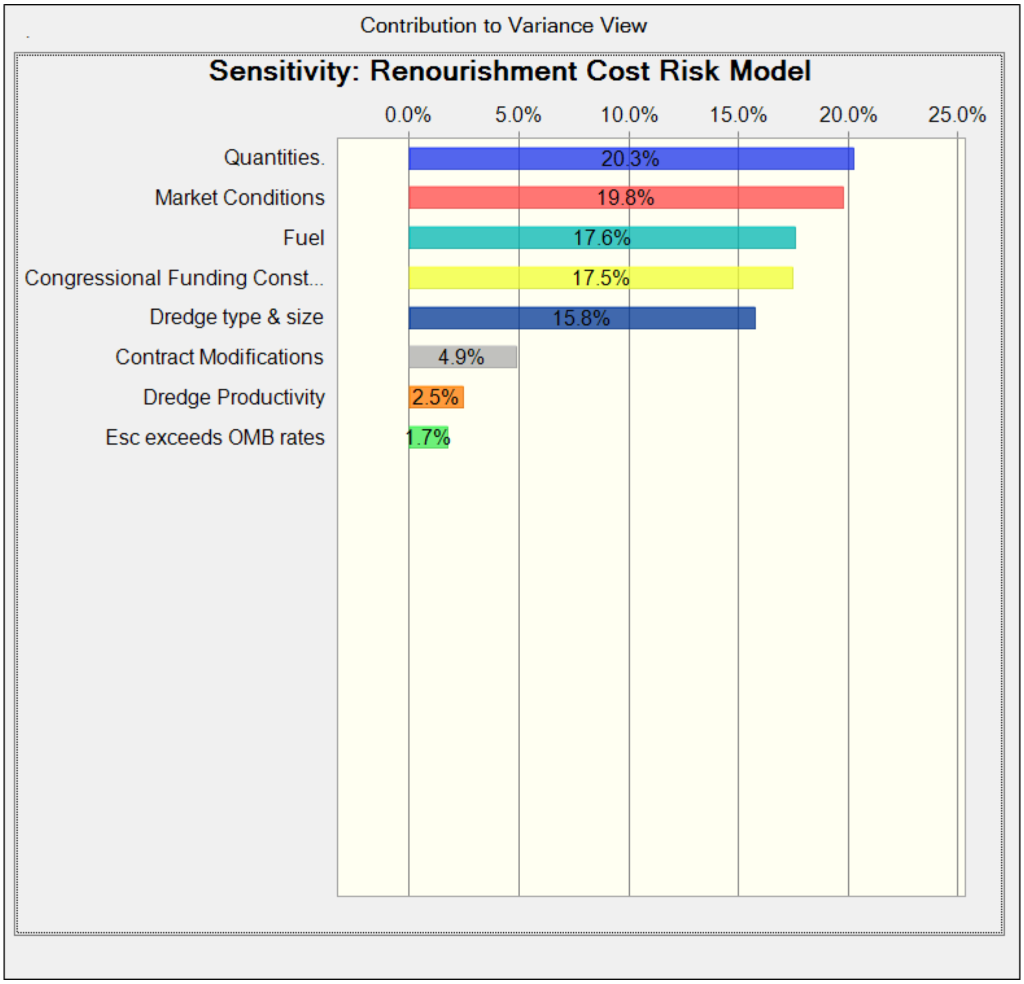
Edisto Beach Feasability Study 2013 CSRA

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost			Project Schedule			
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*	
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)										
PROJECT & PROGRAM MGMT										
PPM-3	Congressional Funding - Construction	Concern is that construction funding will not be appropriated in accordance with the project schedule and incur additional escalation for the project.	Due to relatively low B/C ratio and elimination of earmarks, Congressional funding for construction could be delayed.	Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE	1
TECHNICAL RISKS										
T-2	Quantities of material.	Required quantities defined by Beach-FX. However, quantities can change over time due to beach erosion during the PED phase and geotechnical overfill ratios--additionally funding delays may increase quantities.	Overall quantities are based on average volumes. There could be variation over time over the models .	Likely	Significant	HIGH	Likely	Marginal	MODERATE	2
CONSTRUCTION RISKS										
CON-1	Contract Modifications	There may be modification issues that have not been captured in current risks.	The normal modifications for dredging is quantities. Each contract will likely carry the intended quantities per contract. Competing work, loss of dredger, quantity assumption can cause modifications such as remobilizations and delays. Other modification potentials could include borrow source remobilization resulting from environmental impacts.	Likely	Marginal	MODERATE	Unlikely	Significant	MODERATE	3
ESTIMATE AND SCHEDULE RISKS										
EST-1	Dredge, type & size	Estimate choice can effect efficiency and productivity, causing a change to the estimate.	Estimate assumed a single 30" pipeline dredge but equipment is not restrictive w/in contract. The chosen estimate dredge size can affect the cost and productivity. A large pipeline results in greater efficiency as compared to smaller pipeline dredges, but may be impacted by weather/wave conditions. Due to requirement for ocean certified dredge, expect either 27" or 30" pipeline.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE	4
EST-2	Fuel	Fuel fluctuations can impact dredging costs.	On dredging projects, fuel is a major cost driver for equipment. Fuel costs have been very volatile in the past 18 months. Study should be for time of funding date estimate.	Likely	Significant	HIGH	Unlikely	Marginal	LOW	5
EST-3	Dredge Productivity	The estimate assumes a certain productivity based on a 30" pipeline dredge. Productivity may vary if different dredge is used.	The current estimate makes assumptions in the size and productivity for a single 30" pipeline dredge with an average pumpimng distance of 18,220 LF. Those estimate assumptions establish the schedule. Productivity of a pipeline dredge can vary due to various conditions such as weather/waves and mechanical failure. Productivity could be 60-80% EWT.	Likely	Marginal	MODERATE	Likely	Negligible	LOW	6
Programmatic Risks		(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)								
EXT-1	Market Conditions	Market conditions and competing projects may impact bid competition.	Currently, there are a lot of projects planned when considering the number of dredges available. It is a tough bidding climate based on dwindling number of dredging contractors.	Likely	Significant	HIGH	Likely	Negligible	LOW	7
EXT-5	Esc exceeds OMB rates	Over longer periods of time, the actual market may be greater than the OMB rates, impacting contract costs.	Volatile fuel, being a larger risk on dredging projects, may not correlate with the OMB rates and may be higher as time passes.	Likely	Marginal	MODERATE	Unlikely	Negligible	LOW	8

Cost Risk Analysis - Cost Contingency Results

The project Cost Contingency at the 80% confidence level for the initial construction is 25%. This level was established by analyzing the different cost risk factors that affect the project. Cost contingencies can be either positive or negative. The cost sensitivity chart demonstrates relative cost contingency of individual risks for the initial construction. The chart for the renourishments is similar with long term variables such as escalation, fuel, and the borrow sources having slightly higher rankings. The sensitivity charts for the initial construction cost and renourishments ares depicted below.





- Dredge type/size

Discussion: The choice of dredge size can affect efficiency and productivity, causing a difference between the government estimate and the bid price of the contract. The estimate assumed a 30" hydraulic pipeline dredge will be utilized, but the actual equipment is not restrictive within the proposed contract. The only restriction is the fact that the borrow area is outside the line of demarcation which requires an ocean certified dredge to be used.

- Market Conditions

Discussion: Dredging is a highly competitive industry and there are limited windows when dredging can be performed in this area. The PDT has planned to allow multiple types of dredges to be considered to increase competition for this project.

- Quantities:

Discussion- The quantity of material required to be placed is uncertain and can be affected by increases in erosion due to more frequent storm events. In addition, due to the time period between the feasibility study and initial construction, the expected quantity could change dramatically.

Schedule Risk Analysis - Schedule Contingency Results

No specific schedule risk was derived from team's analysis. Schedule risks for the construction window were assessed for their impacts to cost and added to the cost contingency for both the first and the nourishment costs. The cost contingency analysis results are in the tables below.

Table 3 - Contingency Analysis Results

	MCACES First Costs	Contingency	Baseline w/ Contingency	%	Rounded %	Rounded $
0%	$16,769,000	**($258,991)**	**$16,510,009**	**-1.54%**	-2%	$ (335,380)
5%	$16,769,000	**$892,021**	**$17,661,021**	**5.32%**	6%	$ 1,006,140
10%	$16,769,000	**$1,234,627**	**$18,003,627**	**7.36%**	8%	$ 1,341,520
15%	$16,769,000	**$1,559,926**	**$18,328,926**	**9.30%**	10%	$ 1,676,900
20%	$16,769,000	**$1,810,865**	**$18,579,865**	**10.80%**	11%	$ 1,844,590
25%	$16,769,000	**$1,966,886**	**$18,735,886**	**11.73%**	12%	$ 2,012,280
30%	$16,769,000	**$2,137,253**	**$18,906,253**	**12.75%**	13%	$ 2,179,970
35%	$16,769,000	**$2,300,124**	**$19,069,124**	**13.72%**	14%	$ 2,347,660
40%	$16,769,000	**$2,462,214**	**$19,231,214**	**14.68%**	15%	$ 2,515,350
45%	$16,769,000	**$2,626,449**	**$19,395,449**	**15.66%**	16%	$ 2,683,040
50%	$16,769,000	**$2,779,893**	**$19,548,893**	**16.58%**	17%	$ 2,850,730
55%	$16,769,000	**$2,999,271**	**$19,768,271**	**17.89%**	18%	$ 3,018,420
60%	$16,769,000	**$3,174,162**	**$19,943,162**	**18.93%**	19%	$ 3,186,110
65%	$16,769,000	**$3,413,604**	**$20,182,604**	**20.36%**	21%	$ 3,521,490
70%	$16,769,000	**$3,628,466**	**$20,397,466**	**21.64%**	22%	$ 3,689,180
75%	$16,769,000	**$3,928,328**	**$20,697,328**	**23.43%**	24%	$ 4,024,560
80%	$16,769,000	**$4,210,730**	**$20,979,730**	**25.11%**	26%	$ 4,359,940
85%	$16,769,000	**$4,541,411**	**$21,310,411**	**27.08%**	28%	$ 4,695,320
90%	$16,769,000	**$4,869,448**	**$21,638,448**	**29.04%**	30%	$ 5,030,700
95%	$16,769,000	**$5,536,000**	**$22,305,000**	**33.01%**	34%	$ 5,701,460
100%	$16,769,000	**$7,730,143**	**$24,499,143**	**46.10%**	47%	$ 7,881,430

	MCACES ESTIMATE of One Nourishment	Contingency	Baseline w/ Contingency	%	Rounded %	Rounded $
0%	$5,395,537	**$98,205**	**$5,493,742**	**1.82%**	2%	$ 107,911
5%	$5,395,537	**$538,069**	**$5,933,606**	**9.97%**	10%	$ 539,554
10%	$5,395,537	**$677,033**	**$6,072,570**	**12.55%**	13%	$ 701,420
15%	$5,395,537	**$778,012**	**$6,173,549**	**14.42%**	15%	$ 809,331
20%	$5,395,537	**$851,558**	**$6,247,095**	**15.78%**	16%	$ 863,286
25%	$5,395,537	**$922,490**	**$6,318,027**	**17.10%**	18%	$ 971,197
30%	$5,395,537	**$966,659**	**$6,362,196**	**17.92%**	18%	$ 971,197
35%	$5,395,537	**$1,037,196**	**$6,432,733**	**19.22%**	20%	$ 1,079,107
40%	$5,395,537	**$1,091,278**	**$6,486,815**	**20.23%**	21%	$ 1,133,063
45%	$5,395,537	**$1,141,035**	**$6,536,572**	**21.15%**	22%	$ 1,187,018
50%	$5,395,537	**$1,189,706**	**$6,585,243**	**22.05%**	23%	$ 1,240,974
55%	$5,395,537	**$1,244,860**	**$6,640,397**	**23.07%**	24%	$ 1,294,929
60%	$5,395,537	**$1,307,432**	**$6,702,969**	**24.23%**	25%	$ 1,348,884
65%	$5,395,537	**$1,354,088**	**$6,749,625**	**25.10%**	26%	$ 1,402,840
70%	$5,395,537	**$1,399,419**	**$6,794,956**	**25.94%**	26%	$ 1,402,840
75%	$5,395,537	**$1,467,519**	**$6,863,056**	**27.20%**	28%	$ 1,510,750
80%	$5,395,537	**$1,516,181**	**$6,911,718**	**28.10%**	29%	$ 1,564,706
85%	$5,395,537	**$1,606,780**	**$7,002,317**	**29.78%**	30%	$ 1,618,661
90%	$5,395,537	**$1,730,476**	**$7,126,013**	**32.07%**	33%	$ 1,780,527
95%	$5,395,537	**$1,851,139**	**$7,246,676**	**34.31%**	35%	$ 1,888,438
100%	$5,395,537	**$2,552,464**	**$7,948,001**	**47.31%**	48%	$ 2,589,858

APPENDIX A
DETAILED RISK REGISTER

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions & Conclusions	Project Cost Likelihood*	Project Cost Impact*	Project Cost Risk Level*	Project Schedule Likelihood*	Project Schedule Impact*	Project Schedule Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)									
PROJECT & PROGRAM MGMT									
PPM-1	Congressional Funding - Feasibility	Due to additional requirements for CSRA and IEPR, Congressional funding to complete the feasibility study is in question	Funding is in place to complete feasibility study in FY13 with signature in FY14. If additional changes are required, funding is not available in FY14.	Likely	Negligible	LOW	Likely	Negligible	LOW
PPM-2	Congressional Funding - PED	Concern is that the PED Congressional funding is uncertain, post feasibility.	Chiefs report scheduled for June 14. Request for PED funding is in for FY15.	Likely	Negligible	LOW	Unlikely	Marginal	LOW
PPM-3	Congressional Funding - Construction	Concern is that construction funding will not be appropriated in accordance with the project schedule and incur additional escalation for the project.	Due to relatively low B/C ratio and elimination of earmarks, Congressional funding for construction could be delayed.	Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-4	Stakeholder funding capability	Sponsor has small tax base, but is expected to provide cost share agreement for funding.	Sponsors must fund portion of 50% feasibility, 25% PED and 35% initial construction plus 100% real estate acquisition.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
PPM-5	Adequate PDT Resources	PDT has been through significant personnel changes during study.	The District feels that there is adequate District support and team development for future efforts.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
PPM-6	Sponsor Support	Sponsor support and agreement with the project plan.	Official Sponsor coordination and support is ongoing. However, some concerns about selected plan exists with residents of Edisto.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
PPM-7	Schedule quality	Concern whether current schedule is realistic, optimistic.	The PED is confident of the schedule for PED and construction durations.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
CONTRACT ACQUISITION RISKS									
CA-1	Contract Acquisition Strategy	The acquisition strategy could impact the construction cost and schedule.	Work type is not complicated. It is likely that it will be a FFP large business, based on historical and small business does not have capability. The contract packages will consider the estimate schedule projections related to productivity.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
TECHNICAL RISKS									
T-1	Borrow material Quality	Limited borings done on borrow source. However, there is a pretty good data set from previous projects.	There may be pockets of material that are not suitable but overall we have enough material to complete the project. More data will be obtained in PED phase but generally thought to be a low risk.	Unlikely	Marginal	LOW	Unlikely	Negligible	LOW
T-2	Quantities of material.	Required quantities defined by Beach-FX. However, quantities can change over time due to beach erosion during the PED phase and geotechnical overfill ratios--additionally funding delays may increase quantities.	Overall quantities are based on average volumes. There could be variation over time over the models .	Likely	Significant	HIGH	Likely	Marginal	MODERATE
T-3	Hard Bottom Encounter	Hard bottoms may be uncovered later in out years .	Sand bottom may be covering hard bottoms, leaving a risk in the borrow quantity available at each site. It could damage the hopper dredge. Risk is increased in the out years, because in the near term the dredge can simply relocate. Better clarification should occur during PED phase with better surveys.	Very Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
LANDS AND DAMAGES RISKS									
RE-1	Acquire real estate	Concern that RE cannot acquire real estate easements in timely fashion to support the construction contracts.	Historically, RE has a good track record of acquiring easements.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
RE-2	Real Estate Estimate	Real Estate estimate may cause cost impact.	Historical information is good. The estimate currently includes a 25% contingency. This should be re-evaluated within the risk analysis outcome.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
ENVIRONMENTAL RISKS									
ENV-1	UXO	Area is near sites for Civil War naval battles.	Area surveyed for cultural resources with magnetometer. No UXO detected.	Very Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
ENV-2	"Critical Habitat Designation Sea Turtle Site	Designation of area as critical habitat could change work window.	"Area could be designated as a "critical habitat" and have more restrictions on work window, sand quality, etc.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
ENV-3	SAD Turtle Incidental Take	Other projects encountering sea turtles	Other SAD impacts or "takes" should not impact this project. Project expected to use hydraulic pipeline dredge and should not be impacted.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
ENV-4	Bird Nesting	TES Bird nesting impacts construction.	Nesting areas are generally outside of construction zone. Risk is minimized, but such an encounter may shut down work activity for a period of time.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
ENV-5	Right Whale Restrictions	Encounter potential impacts dredge.	The current estimate assumes hydraulic pipeline dredge which should not encounter right whales during dredging operations due to slow movements.	Very Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
ENV-6	Environmental Monitoring	Environmental monitoring required during dredging.	Dredge relocation to another borrow source would be required if impacts are found. Environmental group will have a separate monitoring contract. The monitoring costs have been included for the initial construction.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
ENV-7	Dune vegetation	Dune Revegetation required	Estimate includes first vegetation. Smaller Dune Revegetation is included in nourishment cycles.	Likely	Negligible	LOW	Likely	Negligible	LOW
ENV-8	Archeological	Concern that there may be uncovered archeological finds during the underwater excavations.	Borrow area has been well established with adequate investigation to determine exclusion areas. If anything was discovered, another section of the larger borrow areacould be used.	Very Unlikely	Marginal	LOW	Very Unlikely	Marginal	LOW
CONSTRUCTION RISKS									
CON-1	Contract Modifications	There may be modification issues that have not been captured in current risks.	The normal modifications for dredging is quantities. Each contract will likely carry the intended quantities per contract. Competing work, loss of dredger, quantity assumption can cause modifications such as remobilizations and delays. Other modification potentials could include borrow source remobilization resulting from environmental impacts.	Likely	Marginal	MODERATE	Unlikely	Significant	MODERATE
CON-2	Hopper Dredge	The estimate assumes a pipeline dredge because of proximity of borrow site to Edisto.	Hopper dredge not likely due to proximity of borrow area and relatively low quantities of material.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
ESTIMATE AND SCHEDULE RISKS									
EST-1	Dredge, type & size	Estimate choice can effect efficiency and productivity, causing a change to the estimate.	Estimate assumed a single 30" pipeline dredge but equipment is not restrictive w/in contract. The chosen estimate dredge size can affect the cost and productivity. A large pipeline results in greater efficiency as compared to smaller pipeline dredges, but may be impacted by weather/wave conditions. Due to requirement for ocean certified dredge, expect either 27" or 30" pipeline.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
EST-2	Fuel	Fuel fluctuations can impact dredging costs.	On dredging projects, fuel is a major cost driver for equipment. Fuel costs have been very volatile in the past 18 months. Study should be for time of funding date estimate.	Likely	Significant	HIGH	Unlikely	Marginal	LOW
EST-3	Dredge Productivity	The estimate assumes a certain productivity based on a 30" pipeline dredge. Productivity may vary if different dredge is used.	The current estimate makes assumptions in the size and productivity for a single 30" pipeline dredge with an average pumpimng distance of 18,220 LF. Those estimate assumptions establish the schedule. Productivity of a pipeline dredge can vary due to various conditions such as weather/waves and mechanical failure. Productivity could be 60-80% EWT.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
Programmatic Risks	(External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)								
EXT-1	Market Conditions	Market conditions and competing projects may impact bid competition.	Currently, there are a lot of projects planned when considering the number of dredges available. It is a tough bidding climate based on dwindling number of dredging contractors.	Likely	Significant	HIGH	Likely	Negligible	LOW
EXT-2	External Opposition	External opposition may cause scope or schedule change.	Feds adhering to the environmental requirements. Sponsors in favor of project. No serious historical intervention because it is a beach renourishment project.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
EXT-3	Acts of God	Severe weather may impact cost or schedule.	Nor'easters, tropical storms or hurricanes could impact construction as well as beach profile. Construction can occur anytime and storms are a potential impact. As long as the estimate and schedules assume some inefficiency, it should not be a serious issue.	Likely	Negligible	LOW	Likely	Negligible	LOW
EXT-4	Borrow Competition	External entities may compete for the borrow sources.	For initial construction this is unlikely. Due to the exclusion of the state park from the Federal Project, the state may decide to nourish state park in the future. Due to the large borrow area for this project and the relatively small quantities required for the nourishment cycles, there should not be a significant impact.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
EXT-5	Esc exceeds OMB rates	Over longer periods of time, the actual market may be greater than the OMB rates, impacting contract costs.	Volatile fuel, being a larger risk on dredging projects, may not correlate with the OMB rates and may be higher as time passes.	Likely	Marginal	MODERATE	Unlikely	Negligible	LOW