

ST. LUCIE COUNTY, FLORIDA COASTAL STORM RISK
MANAGEMENT PROJECT FINAL INTEGRATED FEA-
SIBILITY STUDY AND ENVIRONMENTAL ASSESS-
MENT, AUGUST 2017

COMMUNICATION

FROM

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

TRANSMITTING

THE CORPS' REPORT ON ST. LUCIE COUNTY, FLORIDA COASTAL
STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEA-
SIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT FOR AUGUST
2017



OCTOBER 30, 2018.—Referred to the Committee on Transportation and
Infrastructure and ordered to be printed

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WASHINGTON : 2018



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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

SEP 13 2018

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building
Washington, D.C. 20515

Dear Mr. Speaker:

In response to House Resolution 2757, adopted July 23, 1998 and Resolution 2634 passed on April 11, 2000, by the Committee on Transportation and Infrastructure of the United States House of Representatives, the Secretary of the Army recommends a coastal storm risk management project for St. Lucie County, Florida. The proposal is described in the report of the Chief of Engineers, dated December 15, 2017, which includes other pertinent documents.

The project study was conducted to analyze and formulate improvements for reducing coastal storm damages along the shoreline of St. Lucie County, Florida. The recommended plan is the National Economic Development (NED) Plan and includes the following elements:

- a) Construction of a 20-foot berm extension along 3.3 miles of shoreline with a dune feature that reflects the average 2008 dune position.
- b) Periodic renourishments of the project planned at 18 year intervals.

Based on October 2017 (Fiscal Year 2018) price level, the total nourishment cost of the NED Plan is estimated to be \$53,296,000, which includes the project first cost of initial construction of \$20,276,000 and a total of two periodic renourishments at a total cost of \$33,020,000. The Federal share of the project first cost of initial construction would be approximately \$7,097,000 and the non-Federal share would be approximately \$13,179,000, which equates to 35 percent Federal and 65 percent non-Federal. The Federal share of two future periodic renourishments is estimated to be \$8,915,000 and the non-Federal share is estimated to be \$24,105,000 which equates to 27 percent Federal and 73 percent non-Federal. The costs of lands, easements, rights-of-way, relocations and dredged or excavated material disposal areas are estimated at \$725,000.

Based on FY 2018 price level, a discount rate of 2.75 percent, and a 50-year period of economic analysis, the total equivalent average annual costs of the project are estimated to be \$1,335,000, including operation, maintenance, repair, replacement and rehabilitation (OMRR&R). St. Lucie County would be the non-Federal sponsor responsible for OMRR&R of the project after construction, at an estimated average annual cost of \$32,245. The recommended plan would reduce average annual coastal

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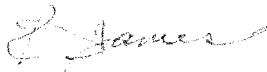
storm damages by about \$2,186,000. The equivalent average annual benefits, which include incidental recreation, are estimated to be \$1,672,000 with net average annual benefits of \$604,000. The benefit to cost ratio is 2.25 to 1.

An Environmental Assessment and a Finding of No Significant Impact was prepared in accordance with the National Environmental Policy Act. All practicable means to avoid and minimize adverse environmental effects have been incorporated into the recommended plan. Impacts to hardbottom resources within the project area have been previously mitigated by the project sponsor, therefore no compensatory mitigation will be required for the recommended project.

The requirement to perform Independent External Peer Review (IEPR) was waived by the U.S. Army Corps of Engineers, Headquarters (HQUSACE) since there was no Environmental Impact Statement for the study, the recommended project is expected to have negligible adverse impacts to the environment and is not controversial. An IEPR exemption was approved by HQUSACE on April 20, 2016.

The Office of Management and Budget (OMB) advised that it had no objection to the submission of the report to Congress and concluded that the report recommendation is not consistent with the policy and programs of the President. The OMB also noted that the Army intends on using emergency supplemental funds appropriated in Title IV of Division B, Subdivision 1 of the Bipartisan Budget Act of 2018 (Public Law 115-123) to implement the project. A copy of OMB's letter, dated September 5, 2018, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Sincerely,



R.D. James
Assistant Secretary of the Army
(Civil Works)

Enclosures

5 Enclosures

1. Report of the Chief of Engineers, December 15, 2017
2. OMB Clearance Letter, September 5, 2018
3. Finding of No Significant Impact, September 7, 2018
4. State and Agency Review Letters
5. St. Lucie County, Florida, Final Integrated Feasibility Study and Environmental Assessment, August 2017



DEPARTMENT OF THE ARMY
 CHIEF OF ENGINEERS
 2600 ARMY PENTAGON
 WASHINGTON, DC 20310-2600

DAEN

DEC 15 2017

SUBJECT: St. Lucie County, Florida Coastal Storm Risk Management Project

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on coastal storm risk management at St. Lucie County, FL. It is accompanied by the report of the district and division engineers. This report is an interim response to the study authority contained in two resolutions by the Committee on Transportation and Infrastructure of the U.S. House of Representatives: Resolution 2634, St. Lucie County, Florida Shore Protection (11 April 2000) and Resolution 2757, St. Lucie County, Florida Shore Protection (23 July 1998). Pre-construction engineering and design activities for the project will continue under the authority cited above.
2. The reporting officers recommend a project that will contribute to economic efficiency for providing coastal storm risk management. Based on an evaluation of alternative plan costs and economic benefits the Recommended Plan is the NED plan. The non-federal sponsor, St. Lucie County, supports the NED plan.
 - a. The Recommended Plan includes beach and dune nourishment within the South Hutchinson Island reach. The design includes construction of a 20- foot equilibrated berm extension from the +7.0 foot 1988 North Atlantic Vertical Datum (NAVD88) contour between the R monuments R98.5 and R115+1000 feet to the Martin County line along 3.3 miles of shoreline. The project template will include a dune feature that reflects the average 2008 dune position. Tapers of a maximum length of one thousand feet will extend from the northern and southern ends of the berm extension, connecting the extension to the existing shoreline. The addition of tapers results in sand placement from R97.5 to R002 along 3.7 miles of shoreline.
 - b. Initial construction will require approximately 422,000 cubic yards of sand, and each periodic nourishment event will require approximately 390,000 cubic yards. The periodic nourishment interval is expected to be approximately 18 years, equaling 2 periodic nourishment events in addition to initial construction over the 50-year period of Federal participation.
 - c. The sand source identified for the project is the St. Lucie Shoals, located approximately 3.5 miles offshore from the project. There is approximately 10.6 million cubic yards (mcy) of beach quality sand in the St. Lucie Shoal complex. This volume is more than adequate to meet the initial construction volume. The periodic nourishment volume is approximately 390,000 cubic yards every 18 years.
 - d. Native vegetation will be planted on areas of the existing dune disturbed by construction, as well as the newly constructed dune to stabilize the fill. It is assumed that dune planting will only

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be necessary for initial construction and that vegetation will naturally grow and spread to any areas that are nourished in the future.

e. Coastal Barrier Resources System (CBRS) Unit P11 occupies a portion of the project area. In coordination with the U.S. Fish and Wildlife Service, it was determined that the portion of the project (Dollman Park) located on non-Federal public lands in P11 is compliant with the Coastal Barrier Resources Act because it meets the Section 6 (G) exception (16 U.S.C. § 3505) permitting Federal expenditures on this publically owned parcel. The non-Federal sponsor shall be responsible for all costs associated with the portion of the project located on privately-owned lands within Unit P11.

3. St. Lucie County is the non-federal cost sharing sponsor for all features. Based on FY18 price levels, the estimated total nourishment cost of the NED Plan is \$53,296,000, which includes the cost of initial construction of \$20,276,000 and two periodic renourishments at a total cost of \$33,020,000. Periodic renourishments are planned at approximately 18-year intervals. Cost sharing is applied in accordance with the provisions of Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended by Section 215 of WRDA 1999, as follows:

a. The Federal share of the project first cost for initial construction would be approximately \$7,097,000 and the non-federal share would be approximately \$13,179,000, which equates to 35 percent Federal and 65 percent non-federal. The non-federal costs include the value of lands, easements, rights-of-way, relocations and dredged or excavated material disposal areas (LERRD) estimated to be \$725,000.

b. The Federal share of two future periodic renourishments is estimated to be \$8,915,000 and the non-federal share is estimated to be \$24,105,000 which equates to 27 percent Federal and 73 percent non-federal.

4. Based on a 2.75% percent discount rate and a 50-year period of analysis, the total equivalent average annual costs of the project are estimated to be \$1,335,000. All project costs are allocated to the authorized purpose of coastal storm risk management. The selected plan would reduce average annual coastal storm damages by approximately \$2,186,000. The equivalent average annual benefits, inclusive of recreation benefits, are estimated to be \$3,007,000 with net average annual benefits of \$1,672,000. The benefit to cost ratio is approximately 2.25 to 1. The project would reduce coastal damages including reduction of potential damage to a hurricane evacuation route, State Road A1A. The project would also establish at least 17,300 linear feet of suitable sea turtle and shorebird nesting habitat along 3.3 miles of shoreline.

5. Risk and uncertainty has been explicitly factored into the economic analysis of this project using a life cycle approach. A statistical risk based model, Beach-fx, was used in this study to formulate and evaluate the project in a life-cycle approach. Beach-fx integrates the engineering and economic analyses and incorporates uncertainty in both physical parameters and environmental forcing, which enables quantification of risk with respect to project evolution and economic costs and benefits of project implementation. The application of Beach-fx in this study is to estimate future without project damages and quantify the damages prevented by various

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storm damage reduction alternatives for St. Lucie County over the 50 year project life. The project is intended to address erosion and prevent damages to structures and infrastructure; it is not intended to, nor will it, reduce the risk to loss of life during major storm events. Loss of life can only be prevented by residents and visitors following the local evacuation plans that are already in place. These residual risks have been communicated to the residents of St. Lucie County.

6. In accordance with the Corps Engineering Regulation (ER 1100-2-8162) on sea level change, the study performed a sensitivity analysis to evaluate the effects that different rates of sea level change could have on the recommended plan. The NED plan was formulated using the historical or low rate of sea level change. Beach-fx was used to model the performance of the NED plan for what the ER defines as intermediate and high rates of sea level rise. The benefits of the project increase significantly in the intermediate and high sea level rise scenarios, but the costs also increase. Thus, the project performance (in terms of the benefit-cost ratio) is relatively constant throughout the three scenarios. As both costs and benefits are increasing, the net benefits actually increase with increasing rates of sea-level rise. Overall, these results suggest that the NED plan is both effective and robust in all three simulated sea level rise scenarios. Adaptive management will be used including adjusting the timing of periodic renourishments and project volume requirements based on monitoring reports to compensate for any significant accelerated sea level rise beyond the historical or low rate should it become necessary.

7. In accordance with the Corps Engineering Circular (EC 1165-2-214) on review of decision documents, all technical, engineering and scientific work underwent an open, dynamic and rigorous review process to ensure technical quality. This included District Quality Control review, Agency Technical Review (ATR), Major Subordinate Command (MSC) review and a Corps Headquarters policy and legal review. All concerns of the ATR have been addressed and incorporated into the final report. The requirement to perform Independent External Peer Review (IEPR) was waived by HQUSACE since there was no EIS for the study, it had negligible adverse impacts to the environment and is not controversial. All comments from the above referenced reviews have been addressed and incorporated into the final documents. Overall, the reviews resulted in improvements to the technical quality of the report.

8. Washington level review indicates that the project recommended by the reporting officers is technically sound, environmentally and socially acceptable, and economically justified. The plan complies with all essential elements of the 1983 U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation studies and complies with other administrative and legislative policies and guidelines. Also the views of interested parties, including Federal, state and local agencies have been considered.

9. I concur in the findings, conclusions and recommendations of the reporting officers. Accordingly, I recommend that the plan to reduce hurricane and storm damages for St. Lucie County, Florida is authorized in accordance with the reporting officers' recommended plan at an estimated project first cost of \$53,296,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing, financing and other applicable requirements of Federal and state laws and policies, including Section 103

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SUBJECT: St. Lucie County, Florida Coastal Storm Risk Management Project

of the Water Resources Development Act (WRDA) of 1986, as amended. The non-federal sponsor would provide the non-federal cost share and all LERRD. Further, the non-federal sponsor would be responsible for all Operations, Maintenance, Repair, Replacement & Rehabilitation (OMRR&R). This recommendation is subject to the non-federal sponsor agreeing to comply with all applicable Federal laws and policies.

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) Provide, during design, 35 percent of design costs allocated to hurricane and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) 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, and operation and maintenance of the project, all in compliance with applicable provisions of the Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1970, as amended (42 U.S.C. 4601-4655) and the regulations contained in 49 C.F.R. Part 24;

(3) Provide, during construction, any additional amounts as are necessary to make their 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. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, 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;

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

d. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated

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SUBJECT: St. Lucie County, Florida Coastal Storm Risk Management Project

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 the initial construction, periodic nourishment, 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;

e. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

f. Agree 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, and repair the project in a manner that will not cause liability to arise under CERCLA;

g. Inform affected interests, at least yearly, of the extent of protection afforded by the project features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and 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 obstruction of or encroachment on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) including but not limited to any new development on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project or the level of protection it affords, or that would hinder future periodic nourishment and/or the operation and maintenance of the project;

i. 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;

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

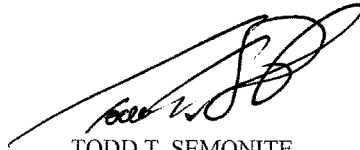
k. At least twice annually, and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal government.

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10. The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. These recommendations do not reflect program and budgeting priorities inherent in the formulation of 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 authorization and implementation funding. However, prior to transmittal to the Congress, the non-federal sponsor, the state, interested Federal agencies and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

A handwritten signature in black ink, appearing to read 'TODD T. SEMONITE', is written over a horizontal line.

TODD T. SEMONITE
Lieutenant General, USA
Chief of Engineers

XII



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D. C. 20503

September 5, 2018

The Honorable R.D. James
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Mr. James:

As required by Executive Order 12322, the Office of Management and Budget has reviewed an August 2017 Army Corps of Engineers Final Integrated Feasibility Study and Environmental Assessment for a Coastal Storm Management Project in St. Lucie County, Florida. The report estimates total nourishment costs of \$53,296,000 (2018 price level), with project first cost of initial construction of \$20,276,000, and total periodic nourishment costs of \$33,020,000.

According to the information provided in the report, the benefit-cost ratio of the project is 2.2 with recreation benefits, and 1.61 without recreation benefits at a discount rate of 2.875 percent, which is the discount rate the Corps is required to use for FY 2017 under section 80 of the Water Resources Development Act of 1974. The Corps estimates the benefit-cost ratio with recreation benefits is 1.17 at a seven percent discount rate, which is the discount rate that the Administration uses in the Budget to measure the performance of Corps construction projects whose primary purpose is to provide an economic return to the Nation. The Corps estimates a benefit-cost ratio of 0.96 considering storm risk management and land loss benefits. As a matter of Federal investment policy, a Federal flood damage reduction project must have enough flood damage reduction and related benefits to justify its construction on its own, independent of any recreation benefits.

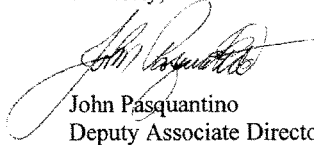
The Army announced July 5, 2018 that it will allocate the full amount of funding that the Corps estimates that it will require for the initial construction of this project, using emergency supplemental funds appropriated in Title IV of Division B, Subdivision 1 of the Bipartisan Budget Act of 2018 (Public Law 115-123). The Army did so based upon a determination by the Corps that this law allows for the funding of projects of this kind, which the Congress has not specifically authorized for construction, as long as the Chief of Engineers signed a report on the project prior to the enactment of that subdivision.

ENCL 2

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The Office of Management and Budget does not object to you submitting this report to the Congress. However, when you do so, please advise the Congress that the project is not consistent with the policy and programs of the President because its costs exceed its benefits from a National investment perspective. In addition, should the Congress authorize this project for construction, future funding for this project would need to compete with other proposed investments in future Budgets.

Sincerely,

A handwritten signature in dark ink, appearing to read "John Pasquantino", with a large, sweeping flourish extending from the end of the signature.

John Pasquantino
Deputy Associate Director
Energy, Science, and Water



US Army Corps of Engineers
JACKSONVILLE DISTRICT

FINDING OF NO SIGNIFICANT IMPACT

ST. LUCIE COUNTY, FLORIDA COASTAL STORM RISK MANAGEMENT INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

The U.S. Army Corps of Engineers, Jacksonville District (Corps), has conducted an environmental assessment in accordance with the National Environmental Policy Act of 1969, as amended. The Corps assessed the effects of the following actions in the Final Integrated Feasibility Report and Environmental Assessment (IFR/EA), dated August 2017 for the St. Lucie County Coastal Storm Risk Management Study, Florida. The final recommendation is contained in the report of the Chief of Engineers, dated 15 December 2017. These reports are incorporated herein by reference. The recommended plan includes the following:

- Beach and dune nourishment within the South Hutchinson Island reach;
- The design includes construction of a 20- foot equilibrated berm extension from the +7.0 foot 1988 North Atlantic Vertical Datum (NAVD88) contour between the R monuments R98.5 and R115+1000 feet to the Martin County line along 3.3 miles of shoreline;
- The project template will include a dune feature that reflects the average 2008 dune position;
- Tapers of a maximum length of one thousand feet will extend from the northern and southern ends of the berm extension, connecting the extension to the existing shoreline. The addition of tapers results in sand placement from R97.5 to R002 along 3.7 miles of shoreline.

Initial construction will require approximately 422,000 cubic yards of sand, and each periodic nourishment event will require approximately 390,000 cubic yards. The periodic nourishment interval is expected to be approximately 18 years, equaling 2 periodic nourishment events in addition to initial construction over the 50-year period of Federal participation.

The sand source identified for the project is the St. Lucie Shoals, located approximately 3.5 miles offshore from the project. There is approximately 10.6 million cubic yards of beach quality sand in the St. Lucie Shoal complex. This volume is more than adequate to meet the initial construction volume. The periodic nourishment volume is approximately 390,000 cubic yards every 18 years.

Native vegetation will be planted on areas of the existing dune disturbed by construction, as well as the newly constructed dune to stabilize the fill.

ENCLOSURE 3

It is assumed that dune planting will only be necessary for initial construction and that vegetation will naturally grow and spread to any areas that are nourished in the future.

In addition to the "no action" alternative, a final array of five alternatives with varying levels of benefits and costs were evaluated, including the recommended plan. The alternative with the highest net-benefits is the 20 foot extension of the existing berm and maintenance of the existing dune, and with a benefit-cost ratio greater than 1.0, it becomes the National Economic Development Plan and the recommended plan. There is not a locally preferred plan. The recommended plan is also the environmentally preferable alternative.

All practicable means to avoid and minimize adverse environmental effects have been incorporated into the recommended plan. Environmental commitments as detailed in the IFR/EA will be implemented to minimize impacts.

Pursuant to the Clean Water Act of 1972, as amended, any discharge of dredged or fill material associated with the recommended plan have been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Attachment G, Attachment 1 of the IFR/EA.

The Florida Department of Environmental Protection (DEP) has concluded that the proposed St. Lucie County Coastal Storm Risk Management Project is consistent with the Florida Coastal Zone Management Program and its associated statutes. DEP stated that the project would likely qualify for a Joint Coastal Permit, which would include water quality certification. A water quality certification pursuant to section 401 of the Clean Water Act will be obtained from DEP prior to construction. All conditions of the water quality certification will be implemented in order to minimize adverse impacts to water quality.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, coordination with the US Fish and Wildlife Service and the National Marine Fisheries Service has been completed.

Coastal Barrier Resources System Unit P11 occupies a portion of the project area. In coordination with the U.S. Fish and Wildlife Service, it was determined that the portion of the project (Dollman Park) located on non-Federal public lands in P11 is compliant with the Coastal Barrier Resources Act because it meets the Section 6 (G) exception (16 U.S.C. § 3505) permitting Federal expenditures on this publically owned parcel. The non-Federal sponsor shall be responsible for all costs associated with the portion of the project located on privately-owned lands within Unit P11.

Pursuant to section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended, the Florida State Historic Preservation Officer and the Seminole Tribe of Florida concurred with the Corps determination of no effect to historic properties.

Public review of the draft IFR/EA was completed on 30 June 2016. All comments submitted during the public comment period were responded to in the Final IFR/EA.

Technical, environmental, economic, and cost-effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resource Council's 1983 Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in the evaluation of the alternatives. Based on these reports, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not significantly affect the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date: _____

7 Sep 18



Andrew D. Kelly, Jr.
Colonel, U.S. Army
District Commander

XVII

St. Lucie County, Florida Coastal Storm Risk Management Study Final Report State and Agency Summary

The 30 day State and Agency Review period for the St. Lucie County Study ended on September 28, 2017. No agency provided any comments. The Department of Interior provided a response letter on September 27, 2017 stating they had no comments. The Florida State Clearinghouse provided an email response on October 25, 2017 stating that the state had no objections to the subject project and, therefore, it is consistent with the Florida Coastal Management Program.

As the report only contained an Environmental Assessment (EA), no final NEPA review was required or conducted.

ENCL 4



United States Department of the Interior

Office of the Secretary
Office of Environmental Policy and Compliance
1849 C Street, NW - MS 5538 - MIB
Washington, D.C. 20240

SEP 27 2017

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PEP/NRM

ER 17/0402

Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

Re: St. Lucie County Flood Risk Management Project – Draft Chief of Engineers’ Report

Dear Mr. Brown:

The Department of the Interior (Department) has reviewed the U.S. Army Corps of Engineers’ draft Chief of Engineers’ Report (Chief’s Report) regarding the St. Lucie County Flood Risk Management Project in St. Lucie County, Florida. The Department has no comments on the Chief’s Report.

For questions or further information regarding this response, please contact Cheryl Kelly on my Natural Resources Management Team, at 202-208-7565 or at cheryl_kelly@ios.doi.gov.

Thank you for the opportunity to review and comment on this Chief’s Report.

Sincerely,

Michaela E. Noble
Director, Office of Environmental Policy
and Compliance

Electronic distribution: st-lucie-chiefs-report@usace.army.mil

cc: Joyce Stanley, REO Atlanta, joyce_stanley@ios.doi.gov
Patricia Bee, USACE: patricia.l.bee@usace.army.mil

TRANSMITTED ELECTRONICALLY – NO HARDCOPY TO FOLLOW

XIX

O'Donnell, Patrick E CIV USARMY CESAD (US)

Subject: FW: State_Clearance_Letter_For_FL201709078139C_Coastal Storm Risk Management Project Final Integrated Feasibility Study and Environmental Assessment, St. Lucie County (UNCLASSIFIED)

Classification: UNCLASSIFIED

-----Original Message-----

From: Brown, Theodore A SES USARMY USACE (US)

Sent: Wednesday, October 25, 2017 1:39 PM

To: Strahan, Jeffery P CIV USARMY CEHQ (US) <Jeffery.P.Strahan@usace.army.mil>; Lin, Jeffrey P CIV USARMY CEHQ (US) <Jeffrey.P.Lin@usace.army.mil>; Brown, Stacey E CIV USARMY CEHQ (US) <Stacey.E.Brown@usace.army.mil>; Bee, Patricia L CIV CEHQ NCR2 (US) <Patricia.L.Bee@usace.army.mil>

Cc: Coleman, Wesley E Jr CIV USARMY CEHQ (US) <Wesley.E.ColemanJr@usace.army.mil>

Subject: FW: State_Clearance_Letter_For_FL201709078139C_Coastal Storm Risk Management Project Final Integrated Feasibility Study and Environmental Assessment, St. Lucie County (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

FYI

Tab

Theodore A. "Tab" Brown, P.E., SES

Chief, Planning and Policy HQUSACE

Directorate of Civil Works

(202) 761-0115 (work)

(202) 527-0184 (cell)

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From: Stahl, Chris [mailto:Chris.Stahl@dep.state.fl.us]

Sent: Wednesday, October 25, 2017 1:37 PM

To: Brown, Theodore A SES USARMY USACE (US) <Theodore.A.Brown@usace.army.mil>

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Cc: State_Clearinghouse <State.Clearinghouse@dep.state.fl.us>

Subject: [EXTERNAL] State_Clearance_Letter_For_FL201709078139C_Coastal Storm Risk Management Project Final Integrated Feasibility Study and Environmental Assessment, St. Lucie County

October 25, 2017

Theodore A. Brown, P.E.

U.S. Army Corps of Engineers, Headquarters

Planning And Policy Division, CECW-P (SA)

7701 Telegraph Road

Alexandria, Virginia 22315-3860

RE: Department of Defense, Department of the Army, Corps of Engineers, Coastal Storm Risk Management Project Final Integrated Feasibility Study and Environmental Assessment, St. Lucie County, Florida

SAI # FL201709078139C

Dear Theodore:

Florida State Clearinghouse staff has reviewed the proposal under the following authorities: Presidential Executive Order 12372; § 403.061(42), Florida Statutes; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

The project was reviewed by the Florida Department of Environmental Protection's Southeast District and has the following comments: 1. Please be advised that an NPDES Stormwater (CGP) may be required if construction activities that will result in the disturbance of 1 or more acres of land if stormwater from the activity has the potential to enter a surface water of the State or a municipal separate storm sewer system." [Construction GP Permit Rule 62-621.300(4)(a)]." 2. Please note that there is a Formerly Used Defense Site (FUDS) at and in the vicinity of this Project. The 19,280.48 acre site is known by the US Army Corps of Engineers as the "Fort Pierce Naval Amphibious Training Base"

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that was used in support of World War II. A February 2017 fact sheet is attached to this e-mail. Further coordination with the Corps may be needed.

Based on the information submitted and minimal project impacts, the state has no objections to the subject project and, therefore, it is consistent with the Florida Coastal Management Program (FCMP). Thank you for the opportunity to review the proposed plan. If you have any questions or need further assistance, please don't hesitate to contact me at (850) 717-9076.

Chris Stahl

Chris Stahl, Coordinator

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CLASSIFICATION: UNCLASSIFIED

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT



August 2017



**US Army Corps
of Engineers** *
Jacksonville District

Using this Document



Report Reference Materials: To ease navigation through the report, prompts are provided throughout the document, alerting the reader to reference additional sections or graphics, or to explain the purpose of an ensuing discussion. In this report, these prompts can be identified by this blue box format.

Additionally, informational foldouts **REF-1, REF-2, REF-3, and REF-4** are provided at the end of the report to be used while reading the document to serve as reference maps with key points and landmarks. In addition, an overall table of contents is provided, along with detailed tables of contents as well as an index at the end of the report.

Organization of this report follows Exhibit G-7 (Feasibility Report Content) provided in Appendix G of ER 1105-2-100 (30 June 2004), documenting the iterative U.S. Army Corps of Engineers (USACE) Plan Formulation Process. The planning process consists of six major steps:

- (1) Specification of problems and opportunities
- (2) Inventory, forecast, and analysis of existing conditions within the study area
- (3) Formulation of alternative plans
- (4) Evaluation of the effects of the alternative plans
- (5) Comparison of the alternative plans
- (6) Selection of the recommended plan based upon the comparison of the alternative plans.

Steps may be repeated as problems become better understood and new information becomes available.

Steps 1 and 2 are discussed in Chapters 1-2, and provide the foundation for developing alternative plans and selection of a recommended plan outlined in Chapter 3.

Each chapter and summary graphic, as well as the executive summary, describes plan development as it progresses through the four integrated environments that shape a coastal storm risk management (CSRM) project: the built environment (upland development, etc.); the natural environment (species of concern and their habitat); the physical environment (currents, tides, sea level rise, etc.), and the economic environment (vulnerability of built environment to damages). Concerns relative to plan formulation and National Environmental Policy Act (NEPA) review are summarized and encapsulated in the discussions of these four main environments.

The recommended format of an Environmental Assessment (EA) is provided in 40 CFR 1502.10 and has been integrated into the Feasibility Report. The basic table of contents for the report outlines how the EA format has been integrated into the planning process to develop a recommended plan that meets the requirements of both USACE Plan Formulation Policy and NEPA.

Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

St. Lucie County Coastal Storm Risk Management Project

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

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**FINAL INTEGRATED FEASIBILITY REPORT
AND ENVIRONMENTAL ASSESSMENT
St. Lucie County, Florida**



Please refer to informational foldouts REF-1, REF-2, REF-3, and REF-4.

EXECUTIVE SUMMARY

Introduction

Infrastructure along the St. Lucie County shoreline is subject to damage from waves, erosion, and inundation caused by coastal storms. Developed areas, as well as portions of State Road A1A (SR A1A), the major evacuation route for the region, are vulnerable. This study investigates alternatives for a unified plan that addresses these vulnerabilities, as well as provides incidental opportunities for habitat restoration and recreation for four reaches along the Atlantic shoreline of St. Lucie County, Florida.

Purpose and Need

This report is an interim response to the study authority contained in two resolution dockets by the Committee on Transportation and Infrastructure of the U.S. House of Representatives: **Resolution Docket 2634 St. Lucie County, Florida Shore Protection (11 April 2000)** and **Resolution Docket 2757 St. Lucie County, Florida Shore Protection (23 July 1998)**. This single purpose Coastal Storm Risk Management (CSRM) study focuses on the erosion problems and potential storm vulnerability of structures on the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. The non-federal sponsor is St. Lucie County, Florida.

Study Area

The study area is from Florida Department of Environmental Protection (FDEP) range monument (R) R-77 to the Martin County line (approximately R-1), and covers the following four reaches, from north to south: North Hutchinson Island reach, Power Plant reach, Narrows of Hutchinson Island reach, and South Hutchinson Island reach. **(Figure REF-1)**

Alternative Plans and the Recommended Plan

Federal Interest Determination and the Description of the Recommended Plan

It has been determined there is Federal Interest in a project along the southern portion of Hutchinson Island, based on the Recommended Plan (recommended plan) identified using the U.S. Army Corps of Engineers (USACE) Planning Process. The Benefit-to-Cost Ratio (BCR) for the recommended plan is 2.20.

Plan Formulation

A description of the alternatives, their performance in terms of benefits and costs, and the methods used for screening are provided in the subsections that follow.

Management Measures

Management measures are specific structural or nonstructural actions that would take place at geographical locations within the project areas. For the first iteration of evaluating measures, the entire project area was split into two geographical locations:

- 1) The Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island reaches were grouped together due to their proximity and similarity in physical and built features.
- 2) The South Hutchinson Island reach was evaluated separately due to its erosive nature and more densely developed coastline.

Structural management measures initially considered included: seawalls, revetments, sand covered soft structures, beach nourishment, groins, submerged artificial reefs, nearshore berm placement, emergent breakwaters, and dunes with vegetation.

Non-structural management measures initially considered included: no-action, coastal construction control line, moratorium on construction, establishment of a no-growth program, relocation of structures, floodproofing of structures, and acquisition of land and structures.

During the plan formulation process, management measures were screened using the four Federal accounts, planning objectives, and constraints using a qualitative assessment in a matrix. Ultimately, most of these measures were screened out, and the three northern reaches (Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island) were screened from further consideration, due mainly to the few structures in the area and as a result, few damages. The South Hutchinson Island reach, with a length of approximately 3.4 miles, was carried forward to the modeling stage with two structural measures: 1) beach nourishment and 2) dunes with vegetation. The beach nourishment measure would include initial construction of a beach fill and future periodic nourishment at planned intervals. The dune and vegetation measure would include placement of beach compatible material, from either upland or offshore sources, as an extension of the existing dune feature. Vegetation would be planted after initial placement of the dune material. The screening process is described in detail in **Chapter 3** of the main report.

Alternative Development

An alternative plan is a set of one or more management measures functioning in tandem to address project objectives.

Dunes and Vegetation: Preliminary engineering design work concluded that the most feasible plan for dunes and vegetation would be extending the existing dune by either 10 or 20 feet. This measure was expanded into two alternatives, known as “Dune10” and “Dune20” respectively. Periodic nourishment triggers would occur once the extended dunes were fully eroded and construction would be completed with dredging material from an offshore sand source.

Beach Nourishment: The measure was further expanded into five different “design berm” template alternatives which included various widths as follows: 1) maintaining the existing berm width, or 0-foot berm (ABerm), 2) 20-foot berm (BBerm), 3) 40-foot berm (CBerm), 4) 60-foot berm (DBerm), and 5) 80-foot berm (EBerm). Using these design berm template alternatives, a “sacrificial fill” amount was then

considered in 20-foot increments. Much like the dunes and vegetation alternatives, periodic nourishment triggers would occur once sacrificial berm lengths have been fully eroded. Using truck transportation of fill was considered as a possible option for beach nourishment but was found to be cost prohibitive. As a result, dredging material from an offshore sand source would be used for these measures as well.

For a more detailed explanation of periodic nourishment triggers and related specifications please refer to the **Engineering Appendix** of this report.

Through the process described above, the 2 measures of dunes with vegetation (dune extension) and beach nourishment (maintain the existing dune with beach nourishment berm extensions) were then expanded into a total of 42 alternatives for initial modeling, as well as the no-action alternative, which considers a scenario where a project is not built. The two dune extension options (10-foot and 20-foot) were modeled individually and also in combination with the beach nourishment berm extensions.

After initial modeling it was apparent that the only economically justifiable design template was maintaining the existing berm (a 0-foot design berm extension¹) (A), and only sacrificial fill extensions up to 40-feet. The various alternatives provided nearly the same level of total benefits, but the costs increased greatly with the size of the project. Dune extensions, in combination with beach nourishment berm extensions, were also unjustifiable, but a stand-alone project of Dune10 was carried forward to the final array. Upon realizing larger projects had no justification, the decision was made to add alternatives and model sacrificial-fill amounts in 10-foot increments. The alternatives carried into the final array for Beach-fx modeling (100 iterations) were as follows: no-action, ABerm10DuneEx², ABerm20DuneEx, ABerm30DuneEx, ABerm40DuneEx, and Dune10².

Alternative Comparison

All of the alternatives described above were modeled in Beach-fx using full (100 iteration) life cycle simulations in order to calculate benefits and costs, resulting in the information in **Table ES-1-1**. These plans were evaluated using FY2017 price levels and the FY2017 Federal water resources discount rate of 2.875%. The evaluation covered the span of a 50-year period of analysis with a base year of 2020. Benefit values in this table include those derived from land loss estimations and incidental recreation benefits. It is important to note that this table represents costs and benefits estimated during the alternative evaluation process based on the best available information at that time.

The alternative with the highest net-benefits is the 20 foot extension of the existing berm and maintenance of the existing dune, and with a BCR greater than 1.0, it becomes the National Economic Development (NED) Plan and the recommended plan. There is not a locally preferred plan.

¹0-foot berm refers to using the existing berm width as the "design", where "0" would be the starting reference point for sacrificial fill.

² These alternatives were determined too small for dredging so trucking costs were used in Beach-fx modeling.

Table ES-1-1. Average Annual Equivalent (AAEQ) Benefits and Costs for Final Array of Alternatives.³

Alternative Name	Total AAEQ Costs	Net Benefits	BCR
No-action	-	-	-
20-foot Berm (R-98.5 to Martin County line)	\$1,314,927	\$1,650,356	2.26
30-foot Berm (R-98.5 to Martin County line)	\$1,462,493	\$1,503,541	2.03
10-foot Berm (R-98.5 to Martin County line)	1,411,990	\$1,545,923	1.82
10-foot Dune (R-98.5 to Martin County line)	1,485,348	\$1,441,501	1.97
40-foot Berm (R-98.5 to Martin County line)	\$1,627,343	\$1,335,742	1.82

The recommended plan consists of beach nourishment and periodic nourishment along approximately 3.3 miles of shoreline between FDEP monuments R-98.5 and the Martin County line, to include an additional taper with a maximum length of 1,000 feet on the north and sound boundary (from R-97.5 to R-98.5 and from R-001 to R-002) for a total of 3.7 miles. The design beach fill template is characterized by a 20-foot berm extension (+7 ft-NAVD88) from the toe of the 2008⁴ dune profile. Beach fill material required under the base sea level rise (SLR) case includes an average of 422,000 cubic yards for initial construction of the design beach profile and approximately 2 periodic nourishment events averaging 390,000 cubic yards each. It is important to clarify that the placed volume will be referenced throughout this report; however, the dredged volume is notably important as well for coordination of sand sources. The dredged volume is anticipated to be approximately 30% greater than placed volume. This project proposes to use sand from St. Lucie Shoal, which contains material compatible with the native sand within the study area, and has a sufficient quantity for a 50-year period of analysis. The St. Lucie Shoal sand resources identified for this project are located greater than three nautical miles offshore within Outer Continental Shelf (OCS) waters and are under the jurisdiction of the Bureau of Ocean Energy Management (BOEM).

Benefits of the Recommended Plan

The economic benefits of the plan are generated in the USACE certified Beach-fx model by reductions in erosion, wave, and inundation damages. The model results suggest that the recommended plan is highly effective at reducing nearly all damages. The 20-foot berm extension protects St. Lucie County from 98% of all damages in the period of analysis and nets \$1,616,660 Average Annual Equivalent (AAEQ) worth of benefits.

³ October 1, 2017 Price Level @ 2.875% (2017) discount rate. This table presents inclusion of storm damage reduction, land loss and recreation benefits. OMRR&R and IDC were not yet factored in at this point of the process; they are included, however, in the recommended plan economic costs and benefits.

⁴ In order to ensure that emergency nourishment efforts in response to the 2004 and 2005 hurricane season, and local fill project completed in May 2013 did not influence the outcome of the ongoing feasibility study, it was agreed that the "without-project" shoreline for the study would be established using survey data collected in the summer of 2006. However, subsequent analysis of the data showed that the 2006 survey did not provide adequate foreshore and offshore coverage of the project area to complete the Beach-fx analysis. A comparison of the available portions of the 2006 survey and a comprehensive shoreline survey taken in August 2008 showed insignificant difference in shoreline dimensions between the two. Therefore, the 2008 shoreline was determined to be a good representative of the 2006 shoreline and was adopted as the "without-project" condition.

Sea Level Rise (SLR)

The recommended plan performs satisfactorily in each SLR scenario (base, intermediate, and high) and establishes itself as a robust option when considering risk and uncertainty. Benefits increase at a much greater magnitude than costs and the BCR increases by over 50% from base SLR to intermediate SLR. There is also a significant increase in BCR from the intermediate SLR to the high SLR. The recommended plan remains an efficient and effective plan for any of the three possible SLR scenarios.

Environmental Considerations

In accordance with permits issued by the State of Florida and USACE, St. Lucie County constructed a 60 foot berm consisting of beach quality material from R-98 to the St. Lucie / Martin County Line in 2012/2013. The permits required that the County construct 1.89 acres of artificial reef to mitigate for impacts to naturally occurring hardbottom. USACE Regulatory Division has determined that the beach placement, mitigation, and monitoring have been performed in compliance with the County's permit SAJ-2009-03448. The compliance letter dated 3 April 2017 can be found in Appendix G, Attachment 3. A total of 1.93 acres of artificial reef were constructed (refer to Section 2.2.5 for more information). The Recommended Plan consists of a 20 foot berm and would be constructed from R-99 to the St. Lucie/ Martin County Line. This is a smaller template both in length and width of berm than the project built by St. Lucie County. Based on the equilibrated profile determination and the equivalence of sand grain size characteristics proposed for placement and those previously placed, the Recommended Plan would have no additional impact on hardbottom resources lying within the equilibrium toe of fill. Therefore, no additional mitigation is proposed.

The beneficial effects of periodic nourishment along the proposed project area include establishing a larger buffer beach to protect upland infrastructure against coastal storm inundation, erosion, and wave attack, and additional habitat for beach flora and fauna, as well as more space for recreational activities. The National Marine Fisheries Service (NMFS) has designated loggerhead sea turtle critical habitat within the study area.

The proposed project would likely produce more favorable environmental conditions than exist at present, although construction operations would produce some temporary adverse effects. The affected resources would return to pre-construction conditions either immediately after dredging, with respect to resources such as aesthetics and noise, or within one or two years, with respect to sea turtle nesting and benthic resources.

Coastal Barrier Resource System (CBRS) unit P11 occupies approximately 15% (roughly R-98 to R-98+210 and R-101.5 to R-103.5) of the project area proposed by the recommended plan. The purposes of the Coastal Barrier Resources Act (CBRA) include minimizing the loss of human life, wasteful expenditure of Federal revenues, and damage to fish, wildlife, and other natural resources associated with CBRS units. There are limits to Federal expenditures related to actions that could affect a unit. Section 6 of CBRA (16 U.S.C. § 3505) permits certain Federal expenditures assistance within the CBRS if it meets one of the exceptions A-G and it is also consistent with the three purposes of CBRA, which include: 1) minimize the loss of human life; 2) minimize wasteful expenditure of Federal revenues; and 3) minimize damage to fish, wildlife, and other natural resources. There are a small number of privately owned parcels within the project area, and within P11, which are not under any perpetual conservation designation. Federal

expenditures for any alternative implementation, including beach nourishment, in this area would be prohibited by the CBRA due to the fact that such action could encourage development. A Section 6 CBRA exception would only apply if these private parcels were covered under a perpetual conservation easement, which is not the case. However, non-federal funds could be used to nourish the beach in this area. Dollman Park, a publicly owned parcel within the project area, does meet the Section 6 exception since development is prohibited in this location; therefore, Federal funds could be used to nourish the beach adjacent to the park. The U.S. Fish and Wildlife Service, by letter dated 2 November 2016, determined that the Recommended Plan meets the section 6 (G) exception and is consistent with three purposes of CBRA. Exception 6 (G) is for nonstructural shoreline stabilization that is designed to mimic, enhance, or restore a natural stabilization system (refer to Appendix H: Pertinent Correspondence).

Cost Estimate and Implementation

Table ES-1-2. Pertinent Project Information.

Recommended Plan Description	The Recommended Plan includes:
Average # Nourishment Events	1 initial construction event, approximately 2 periodic nourishment events
Average Volume of Initial Construction	422,000 cubic yards
Average Volume of Each Periodic Nourishment	First nourishment: 390,000 cubic yards Second nourishment: 390,000 cubic yards
Average Periodic Nourishment Interval	approximately 18 years
Initial Construction Duration	approximately 4 months
Recommended Plan project first cost (including contingency)	\$ 53,296,000 (October 1, 2017 (FY18) Price Level)
Cost sharing	Initial construction: 35% Federal / 65% non-federal Periodic nourishments: 27% Federal / 73% non-federal
Benefit-to-Cost Ratio (BCR)	2.20 @ 2.875% discount rate (FY17).

As shown in Table ES-1-3, the total cost of initial project construction, based on average volume requirements, is estimated at \$20,276,000. Total future periodic nourishment costs are estimated at \$33,020,000, with periodic nourishment expected at approximately 18 year intervals⁵. Under the base SLR case, an estimate of the total cost incurred over the 50-year period of Federal participation is \$53,296,000.

⁵ Note that vegetating the dune for periodic nourishment events (after initial construction) is a non-federal responsibility and cost, per U.S. Army Corps of Engineers (USACE) Policy Guidance Letter No. (PGL) 27, dated 17 November 1992. For this project, it is assumed that dune vegetation for periodic nourishment will occur by natural recruitment, and therefore no cost is associated with periodic dune vegetation.

Table ES-1-3. Recommended Plan Cost Summary (Project First Cost)(FY 18 Price Levels).

		Initial Construction	Periodic Nourishments
WBS Code	Item	Total Project First Cost (FY18)	Total Project First Cost (FY18)
017	Mob/Demob	\$4,303,000	\$8,606,000
017	Beach Fill	\$8,227,000	\$15,046,000
017	Associated General Items	\$1,235,000	\$802,000
	Subtotal	\$13,764,000	\$24,454,000
01	Lands and Damages		
	- lands and damages		
	- administrative		
	-Federal Admin	\$1,041,000	\$47,000
	-non-federal Admin	\$694,000	\$31,000
30	PED	\$1,492,000	\$4,151,000
31	Construction Management	\$2,012,000	\$2,931,000
30	Post-Project Monitoring	\$1,273,000	\$1,406,000
			(x 2 periodic nourishments)
	Total Project First Cost	\$20,276,000	\$33,020,000
	Total Project Cost for 50 year period of Federal participation = \$53,296,000		

Operation and Maintenance (also known as Operation, Maintenance, Repair, Replacement, Rehabilitation, or OMRR&R) include all activities which are not related to the initial or periodic nourishments, and are borne 100% by the non-federal sponsor. Based on the size and scope of the Recommended Plan and the cost of similar activities for similar projects, the annual average costs for OMRR&R are estimated to be \$32,245 per year, as shown in Table ES-1-4, which also includes interest during construction (IDC).

St. Lucie County Coastal Storm Risk Management Project

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Table ES-1-4. Equivalent Annual Benefits and Costs.

Costs and Benefits	
(Constant Dollar Basis is FY17 Price Level, Average Equivalent Uses 50-Year POA and 2.875% Discount Rate)	
Cost	
Initial Construction (Constant Dollars)	\$ 20,276,000
1st Periodic Nourishment (Constant Dollars)	\$ 16,629,000
2nd Periodic Nourishment (Constant Dollars)	\$ 16,391,000
Total First Cost (Constant Dollars)	\$ 53,296,000
Interest During Construction (IDC)	\$ 54,900
Total Investment Cost	\$ 53,350,900
Average Yearly OMRR&R (100% non-federal)	\$ 32,245
Total Average Annual Equivalent Cost	\$ 1,348,623
Benefits	
Average Annual Equivalent Storm Damages Reduction Benefits (Including Land-Loss)	\$ 2,399,612
Average Annual Equivalent Recreation Benefits	\$ 565,671
Average Annual Equivalent Total Benefits	\$ 2,965,283
Average Annual Equivalent Net-Benefits	\$ 1,616,660
Benefit-Cost Ratio	2.20

Activities which are needed in direct relationship to the initial and periodic nourishments are cost shared, as described below. Assessing the performance of the project is a two-part process consisting of 1) shoreline monitoring and 2) assessing measured wind, wave, and water level information, in conjunction with sea level rise assessments.

First, physical monitoring of the project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year period of analysis. The monitoring plan will include systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project periodic nourishment is necessary.

Post-construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. Other monitoring efforts include bathymetric mapping of the borrow site to assess capacity, which will be done as part of the engineering and design prior to each periodic nourishment.

Second, measured wind, wave, and water level information will be obtained from the best available existing data sources. This data will be applied in support of the shoreline and borrow site monitoring efforts. It will also be used to periodically assess the state of sea level rise and to determine if reassessment of the project volumes, and/or periodic nourishment intervals based on an acceleration of sea level rise is required.

Coordination with Agencies and the Public

An initial scoping period for the project was conducted from 31 May through 30 June 2006. The NMFS Habitat Conservation Division (HCD) responded to the scoping letter with concerns about hardbottom impacts, the proposed dredging of the offshore shoals, and requested that the EFH assessment and NEPA documents on this action be prepared with sufficient detail. Subsequent scoping for the local project was conducted from 21 April through 20 June 2010. Finally, the draft integrated report was made available for public and agency review in May 2016.

The NMFS responded to the draft integrated report with concerns about the hardbottom mitigation previously provided by St. Lucie County. The EFH assessment is included in Sections 2.2.6 and 5.1.6 of this report. Information on the hardbottom mitigation previously provided by St. Lucie County is provided in Section 2.2.5 and Appendix G, Attachment 3. Essential Fish Habitat conservation recommendations provided by NMFS, as well as USACE responses to the recommendations, including the dredging of the offshore shoals, are provided in Section 6.4. The NMFS letter, dated 9 June 2016, and the USACE response letter, dated 28 December 2016, a subsequent NMFS letter dated 9 January 2017, and the USACE response dated 31 March 2017 are also provided in Appendix G, Attachment 3. The NMFS letter dated 9 January 2017 expressed additional concerns regarding compliance with the Department of Army permit issued to St. Lucie County (refer to Appendix G, Attachment 3). Specifically, these concerns are in regard to the beach nourishment project previously constructed by St. Lucie County, and mitigation that the County provided for impacts to hardbottom habitat (refer to Section 2.2.5 and Appendix G, Attachment 3 for more info). USACE Regulatory Division has determined that the Federal project beach placement, mitigation, and monitoring have been performed in compliance with the County's permit SAJ-2009-03448, and this determination has been coordinated with NMFS. The compliance letter dated 3 April 2017 can be found in Appendix G, Attachment 3.

The Florida State Clearinghouse of the Florida Department of Environmental Protection (FDEP) coordinated a review of the scoping letter and the proposed project with the appropriate state agencies. By letter dated 8 July 2016, FDEP stated that "based on the information contained in the submittal, the state finds that the proposed Draft Environmental Assessment is consistent with the Florida Coastal Management Program (FCMP). The state's continued concurrence will be based on the activities' compliance with FCMP authorities, including Federal and state monitoring of the activities to ensure their continued conformance, and the adequate resolution of issues identified during this and subsequent regulatory reviews. The state's final concurrence of the project's consistency with the FCMP will continue to be determined during the ongoing state's environmental permitting process, in accordance with Section 373.428, Florida Statutes." By letter dated 9 August 2017, FDEP reiterated that "the proposed St. Lucie County Coastal Storm Risk Management Project is consistent with Florida's Coastal Zone Management Program and its associated statutes." FDEP also stated that "it is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification (see Appendix H)."

St. Lucie County was issued USACE and state permits for the local beach nourishment project conducted in the study area in 2012/2013. An Environmental Impact Statement (EIS) was prepared and completed in 2012 as part of the issuance of the USACE permit, which was subsequently coordinated with the agencies and general public. In accordance with 43 CFR 46.140, the EA for this study tiers off of that EIS.

USACE, in coordination with St. Lucie County Erosion District, held a public meeting on 2 June 2016, during the public review period for this document. The format of the meeting included an overview of the Recommended Plan as well as a formal comment period. Meeting comments are summarized in Section 6.4 of this document.

All correspondence associated with this NEPA scoping process is included in Appendix H and Appendix G, Attachment 3 of the main report.

Residual Risk

The proposed project would greatly reduce, but not completely eliminate, future coastal storm risk and damages. Coastal storm damages, caused primarily by erosion, are reduced by approximately 98% (not including prevention of land loss) in the location of the recommended plan over the 50 year period of analysis; therefore, the residual damages would be 2% in this area. The volumes and damages discussed throughout the report are averages. The methods of monitoring and data assessment, while periodically revisiting sea level rise trends described earlier, will be crucial for adaptive management to manage risk.

The Recommended Plan will 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. During study scoping, it was determined that the vast majority of coastal storm risk is within 600 feet landward from the dune line and therefore this boundary was selected as the landward extent of the study area. As a result, the project is not claiming any benefits beyond this designation as damages to structures past this extent were not calculated. Notably, infrastructure on the backside of the barrier island on which the project area is located, although outside of the project area, are susceptible to impacts from sea level rise in the future. Structures within the project area would continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from these processes. The project purpose is coastal storm risk management, and the recommended plan is not designed to prevent loss of life. Public safety risks can be reduced by actions taken at the local, state, and Federal levels.



Introduction

1 INTRODUCTION*

 Please refer to informational foldout REF-1 throughout Chapter 1.

1.1 FEDERAL PROJECT PURPOSE*

The Water Resources Development Act (WRDA) of 1986 assigns costs of Federal projects to appropriate project purposes. Project reaches that provide hurricane and storm damage reduction are assigned a 65% Federal share for initial construction. Specifically for beach periodic nourishment projects, WRDA 1999 assigned a 50% Federal share for future periodic nourishments. Project reaches that provide for separable recreation are not federally cost shared. The Federal government does not participate in work realizing separable recreation benefits such as constructing a beach only for recreational purposes, and not hurricane and storm damage reduction purposes, or constructing recreation facilities. Recreation is not considered to be a high priority output or primary project output under current Department of Army policy, as described in ER 1105-2-100. This policy precludes Federal funds to support construction of CSRMP projects which depend on separable recreation benefits for economic justification, or for which incidental recreation benefits are greater than 50% needed for justification (ER 1105-2-100 section 3-4.b(4)(a)).

The BOEM is authorized under Public Law 103-426 [43 United States Code (U.S.C.) 1337(k)(2)] to negotiate on a non-competitive basis the rights to outer Continental Shelf (OCS) sand resources for coastal storm risk management projects. BOEM may undertake a connected action (i.e., authorize use of the OCS sand source areas) that is related to, but unique from USACE's proposed action. BOEM's proposed action is to issue a negotiated agreement authorizing use of the sand source areas at the request of St. Lucie County and USACE.

1.2 STUDY BACKGROUND AND LOCATION*

St. Lucie County is located along the east coast of south-central Florida, approximately 225 miles south of Jacksonville and 100 miles north of Miami (REF-1). The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island, bordered by the Atlantic Ocean to the east, and the Indian River Lagoon (Atlantic Intracoastal Waterway) to the west. As a point of reference, St. Lucie Inlet is located approximately 7 miles south of the study area, in Martin County.

The scope of the feasibility study includes a 7.4⁶ mile stretch of shoreline located on Hutchinson Island. This area extends along the southern region of St. Lucie County's Atlantic coastline, from FDEP survey range monuments⁷ R-77, which corresponds to a region of shoreline extending from approximately 1 mile north of the Florida Power and Light Nuclear Power Plant (FPL power plant) southward to the St. Lucie County/Martin County line.

⁶ See Section 1.5 for a discussion on the study area length and authorities.

⁷ FDEP reference (R) monuments are located approximately every 1,000 feet along the shoreline and serve as geographic reference points for historic and contemporary shoreline monitoring. They are used as reference points throughout this report.

The study area is largely dominated by a large U.S. Fish and Wildlife Service (USFWS) designated Coastal Barrier Resource System (CBRS) unit, known as CBRS unit P11.

According to the USFWS website, Congress recognized that certain actions and programs of the Federal government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. To remove the Federal incentive to develop these areas, the Coastal Barrier Resource Act of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these areas ineligible for most new Federal expenditures and financial assistance. CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development, such as Federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.

In particular, CBRS unit P11 extends from approximately R-77 to R-103, with three relatively small gaps, known as “excluded” areas, at approximately R-80 to R-84, R-88.5 to R-90, R-98+600 feet to R-101, and from R-103 to R-115+1000 feet (REF-1). Of the approximate 7.4 miles of shoreline within the study area, roughly 3.4 miles of shoreline are in the CBRS. The three CBRS excluded areas have a total length of about 1.4 miles of shoreline. The non-CBRS affected shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R-103 to the St. Lucie/Martin County line at approximately R-001. Altogether, the CBRS comprises about 46% of the study area.

The area has been delineated into four reaches:

- North Hutchinson Island (R-77 to R-80): This reach is approximately .57 miles long, with an average erosion rate of -1.8 feet per year. There is no development in this reach and it is entirely within the CBRS unit.
- Power Plant Area (R-80 to R-90): This reach is approximately 1.9 miles long, with an average shoreline change rate of +0.06 feet per year (slightly accretional). The only structure in this reach is the Florida Power and Light (FPL) Nuclear Power Plant. With the exception of the power plant, the remainder of the reach is entirely within the CBRS unit.
- Narrows of Hutchinson Island (R-90 to R-98): This reach is approximately 1.5 miles long and the average erosion rate is -1.0 feet per year. The area consists of low density development within the CBRS unit, with the exception of one excluded area with one condominium development.
- South Hutchinson Island (R98 to R115 plus 1,000 feet (to the Martin County line)): This reach is approximately 3.4 miles long and the average erosion rate is -.4 feet per year. A small portion of the CBRS unit ends at approximately 200 feet south of R-98, and begins again at roughly R-101.5 to R-103.5 (Dollman Park), and then ends for the remainder of the reach.

State Road A1A is the only north/south access road for Hutchinson Island and is the island’s only hurricane evacuation route. Development along the study area portion of Hutchinson Island consists mainly of the FPL power plant near the north end of the project area, parks and multi-story condominiums on the east (ocean) side of SR A1A, and a couple of single-family residential developments west of A1A in the southern

portion of the study area. The Nettles Island community is located west of R-106 and the Waveland community is located between R-111 and R-115. There is no coastal armoring, such as seawalls or revetments, within the study area.

Within the study area, there are 7 public access points which provide public parking and beach access. As of June 2017, St. Lucie County has created an additional 3 public access points which use existing parking. Public access and related parking are discussed in Chapter 2 and Chapter 3.

1.3 STUDY SPONSOR

The non-federal sponsor is St. Lucie County, Florida, represented by the Board of County Commissioners. A Feasibility Cost Sharing Agreement was executed on 29 June 2004.

1.4 STUDY PURPOSE AND NEED

The purpose of this study is to determine whether there is economic justification and Federal interest in coastal storm risk management (CSRM) within the study area of the St. Lucie County, Florida coastline. St. Lucie County's barrier Islands can be eroded by frequent winter storms (northeasters) as well as tropical storms and hurricanes.

Offshore sand resources identified to support CSRM alternatives for this project are located greater than three nautical miles offshore within OCS waters and are under the jurisdiction of BOEM. According to the Outer Continental Shelf Lands Act (OCSLA, 43 U.S.C. §§ 1331 et seq.), outer Continental Shelf (OCS) mineral resources are subject to the jurisdiction, control, and power of the United States (43 U.S.C. § 1332(1)). These minerals, which include sand and gravel, are a vital national resource reserve, which should be made available for expeditious and orderly development, subject to environmental safeguards (43 U.S.C. §§ 1332(3) and 1337(k)(2)(A)). BOEM is the Federal agency charged with managing OCS sand and gravel resources. These resources are not reserved or held for the exclusive use of any particular jurisdiction or entity, especially in a noncompetitive use context. BOEM is authorized under Public Law 103-426 [43 United States Code (U.S.C.) 1337(k)(2)] to negotiate on a non-competitive basis the rights to OCS sand resources for coastal storm risk management projects. BOEM may undertake a connected action (i.e., authorize use of the OCS sand source areas) that is related to, but unique from USACE's proposed action. BOEM's proposed action is to issue a negotiated agreement authorizing use of the sand source areas at the request of St. Lucie County and USACE. BOEM is serving as a cooperating agency under the National Environmental Policy Act (NEPA), with USACE as the lead agency due to the potential use of offshore sand sources located within OCS waters.

There is a need to reduce the damages to coastal infrastructure during hurricane and tropical storm events in the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. Based on National Hurricane Center (NHC) records, 55 hurricanes and tropical storms have passed within a 50-mile radius from the center of the study area over the 159-year period of record, averaging one storm every 2.8 years.

Historic records for St. Lucie County indicate that the most memorable and damaging storms affected the county in September 1928, September 1933, September 1947, August 1949, October 1964 (Hurricane

Isbell), March 1962 (the “Ash Wednesday northeaster”), 1979 (David), 1999 (Irene), and 2004 (Frances and Jeanne), and 2012 (Hurricane Sandy).

- During the 1947 hurricane, storm tides at Ft. Pierce were over 5 feet above mean sea level.
- The 1962 Ash Wednesday northeaster produced tides of over 6 feet above mean sea level at Ft. Pierce and caused the most severe beach erosion on record in St. Lucie County (Bush et al, 2004).
- Hurricane Irene in 1999, a Category 2 storm, caused significant erosion and cost approximately \$6 million in damages to St. Lucie County as it made landfall on the west coast of Florida and exited the east coast directly over the county (Bush et al, 2004).
- In 2004, Hurricanes Frances and Jeanne significantly impacted St. Lucie County, prompting emergency dune restoration efforts in the southern half of the county.
- In 2012, Hurricane Sandy passed through St. Lucie County, with 49 mile-per-hour winds, damaging boardwalks, sand dunes, and beach crosswalks. The storm was reported to cause nearly \$12 million in damages along the Treasure Coast, which includes Indian River County, St. Lucie County and Martin County, according to county officials.

The purpose and scope of this study are also influenced by USACE Environmental Operating Principles and USACE Campaign Plan Fiscal Year (FY) 2015-2019, which are discussed further in Chapter 2.

1.5 STUDY AUTHORITIES

A Reconnaissance Study (Section 905(b), WRDA 1986 Analysis) was initiated on 25 February 2002 as an initial response to two resolutions by the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The two resolutions are listed below:

Resolution Docket 2634 St. Lucie County, Florida Shore Protection dated 11 April 2000 states:
Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County in the area north of the Ft. Pierce Inlet, the southern five miles of St. Lucie County, and adjacent shorelines.

Resolution Docket 2757 St. Lucie County, Florida Shore Protection dated 23 July 1998 states:
Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage

reduction to the shoreline areas in St. Lucie County from the current project for Ft. Pierce Beach, Florida southward to the Martin County Line.

The final St. Lucie County, Florida Section 905(b) Reconnaissance Study was approved on 1 August 2003 and resulted in the finding that there was a Federal interest in proceeding into the feasibility phase.

The USACE South Atlantic Division (SAD) approved moving from the reconnaissance study phase into the feasibility study phase in a memorandum dated 1 August 2003.

At the initiation of the study, there was discussion within the USACE vertical team as to whether the full study area boundary of 7.4 miles (R-77 to the Martin County line) fits within the Authorization. The discussion was resolved in favor of pursuing the 7.4 mile study area, given that 1) The 905(b) Reconnaissance Report included a map of the 7.4 mile area, 2) the 1998 resolution docket referenced an area between Ft. Pierce to the Martin County line, which would include the additional length, and 3) the 2000 resolution docket mentioned studying not only the southernmost 5 miles of St. Lucie County and the area north of Ft. Pierce, but also the adjacent shorelines. This was taken to mean including the shorelines in between those two points in the study area.

1.6 RELATED DOCUMENTS*

1.6.1 RELATED USACE AND NEPA STUDIES

A summary of primary Federal study most relevant to this study is as follows:

- Section 905(b) (WRDA 86) Analysis, St. Lucie County, FL, Hurricane and Storm Damage Reduction Study November 2002, APPROVED August 2003. This report concluded that there is Federal interest in participating in a cost-shared feasibility study for hurricane and storm damage reduction in the study area of Hutchinson Island, St. Lucie County, Florida.

The only prior Federal study of the subject project area is the section 905(b), WRDA 1986 analysis which was approved in August 2003 and subsequently authorized this feasibility study for the southern 5 miles of St. Lucie County and “adjacent shorelines.” Given the close proximity and influence of the Fort Pierce Inlet Project and Fort Pierce Hurricane and Storm Damage Reduction project to the north, there are several other Federal studies completed for Fort Pierce which are relevant to this particular study. A list of Federal reports pertaining to Fort Pierce Inlet and the hurricane and storm damage reduction project is provided below:

- U.S. Army Corps of Engineers (USACE). 1963. Beach Erosion Control Report on Cooperative Study of Fort Pierce, Florida. October 1963. This report recommended restoration of 1.3 miles of shoreline south of Fort Pierce Inlet with periodic nourishment as needed for a period of ten years following initial construction of the project. The authorization allowed for project construction by the non-federal sponsor, St. Lucie County, with subsequent reimbursement of the Federal share of costs.

- U.S. Army Corps of Engineers (USACE). 1982. Section 111 Report for Fort Pierce Beach, St. Lucie County, Florida. This study disclosed that the combined effects of the jetties and the required maintenance dredging of the Federal Navigation Project at Fort Pierce Inlet causes about 60% of the historical erosion along 6,900 feet of shoreline immediately south of the inlet.
- U.S. Army Corps of Engineers (USACE). 2004 Fort Pierce Shore Protection Project, St. Lucie County, Florida. General Re-evaluation Report (GRR) with Draft Environmental Assessment. April 2004. This GRR was submitted in September 2004 to USACE Jacksonville District by Taylor Engineering, Inc. on behalf of St. Lucie County, the local sponsor. The September 2004 draft GRR evaluated project alternatives, including shoreline stabilization structures, for both 15-year and 50-year analysis periods. The 15-year project evaluated the project over its remaining authorized life, currently scheduled to expire in 2020. The 50-year project evaluation, conducted at the request of the local sponsor, examined the project over a renewed 50-year life, beginning circa 2005. A crucial recommendation of the Independent Technical Review (ITR) was to split the September 2004 draft GRR into two documents: 1) a Limited Reevaluation Report (LRR) to address the 15-year period of analysis remaining in the original authorization and 2) a GRR to address the renewed 50-year period of analysis. This report also provides a comprehensive list of Federal and non-federal studies pertaining to Fort Pierce Inlet and shore protection.
- U.S. Army Corps of Engineers (USACE). 2005. Project Information Report (PIR), Rehabilitation Effort for the Fort Pierce, Florida, Hurricane and Storm Damage Reduction Project. USACE Jacksonville District prepared this report in support of the 2005 Fort Pierce Shore Protection Project (SPP) periodic nourishment. The report provides a history of the project and the 2004 hurricane season and summarizes the economics for emergency rehabilitation efforts and the requirements to restore the Federal project.
- U.S. Army Corps of Engineers (USACE). 2006. Fort Pierce Shore Protection project, St. Lucie County, Florida. Limited Reevaluation Report (LRR) including Final Environmental Assessment (1998) and Final Environmental Impact Statement (2002). This Limited Reevaluation Review (LRR) evaluated and updated the Fort Pierce SPP for current conditions as of 2004. The report summarized a cooperative cost-shared feasibility study on shore protection problems along the shoreline of Fort Pierce, St Lucie County, Florida. This LRR stemmed from the Independent Technical Review (ITR) process of the 1998 General Reevaluation Report (GRR) for the Fort Pierce Shore Protection Project.
- Final Environmental Impact Statement, St. Lucie County South Beach and Dune Restoration Project, St. Lucie County, Florida, Prepared by Taylor Engineering, February 2012. This document was prepared by Taylor Engineering on behalf of the St. Lucie County Erosion District for a local nourishment from R-87.7 to R-90.3 and R-98 to the St. Lucie/Martin County line at R-115+1000 feet, consisting of a beach fill and dune restoration. BOEM served as a cooperating agency in the development of this document.

1.6.2 PRIOR NON-FEDERAL STUDIES

Many studies and reports relevant to the project have been completed by non-federal interests in relation to the shorelines of St. Lucie County. A list of the most relevant studies is provided in the references of

this report. Included is a select list of historic and current studies which were evaluated during the development of this feasibility study for southern St. Lucie County:

- University of Florida (UF). 1958. Coastal Engineering Study of Fort Pierce Beach, Florida. University of Florida, Coastal Engineering Laboratory. Gainesville, Florida. September 1958. This report is one of the first detailed coastal engineering studies completed for St. Lucie County. It was completed for the Fort Pierce Beach Erosion District (FPBED). The report provides data on beach erosion and accretion in the FPBED, the quantity of littoral drift, the development and stability of beach and offshore profiles, recommendations for protective measures, including an estimate of the amount of material needed for artificial nourishment of the beach, and measures to prevent breakthrough of the barrier island south of Fort Pierce Inlet during extreme storm and tide conditions.
- Coastal Technology Corporation. 2007. St. Lucie County, Florida, South County Beach Project Conditions Assessment. This report provides data on environmental resources, as well as shoreline conditions.
- Coastal Technology Corporation. Updated January 2010. St. Lucie County, South County, Beach and Dune Restoration Project, Design Document. This report documents the rationale, data, and design for the local St. Lucie County beach and dune restoration project.

1.7 FEDERAL PROJECTS NEAR THE STUDY AREA

Fort Pierce Federal Navigation Project

Fort Pierce Inlet is located in central St. Lucie County and serves as the northern terminus of the Fort Pierce Shore Protection Project. Fort Pierce Inlet is a manmade inlet initially cut in 1921. The existing north and south jetties were built in 1926, 900 feet apart and 1,800 and 1,200 feet long. The Federal government assumed responsibility for maintaining the inlet and jetties in 1935. The St. Lucie County Port and Airport Authority is the non-federal sponsor for authorized modifications to the existing Federal Navigation Project at Fort Pierce Harbor. Fort Pierce Harbor was last modified between June 1995 and April 1996.

Maintenance-dredged beach quality material from the Federal Navigation Project at Fort Pierce Harbor has been placed on the shoreline south of Fort Pierce Inlet since 1973 between R-34 to R-37; the northern 3,000 feet of the Federal Fort Pierce Shore Protection Project (SPP).

Fort Pierce Shore Protection Project

The Rivers and Harbors Act of 1965 (PL 89-298, 79 Stat. 1089, 1092) in accordance with the recommendations of the Chief of Engineers in House Document (HD) 84, 89th Congress, authorized the Fort Pierce, Florida Shore Protection Project in St. Lucie County⁸. The authorization provided for the restoration of 1.3 miles of shoreline (R-34-R-41) south of Fort Pierce Inlet and for periodic nourishment as needed. Initially constructed in 1970, the current period of Federal participation extends until 2020.

⁸ This document was also an authorization for the St. Lucie County study.

Initial construction occurred in 1970 with 718,000 cubic yards of fill placed along the 1.3-mile project shoreline. A Limited Reevaluation Report (LRR), completed in 2006, resulted in a change of the periodic nourishment interval and updated cost-sharing to include results of a Section 111 Study for Fort Pierce, approved in 1982. The current draft General Reevaluation Report (GRR), being completed by the local sponsor, evaluates alternatives over a new 50-year period.

Martin County Beach Erosion Control Project

The Martin County Beach Erosion Control Project was authorized by the Water Resource Development Act (WRDA) of 1990 (Public Law 101-640) in accordance with the Chief of Engineers Report dated 20 November 1989. The project is 4 miles long, extending southward from the St. Lucie County line to near the limit of Stuart Public Park; Florida Department of Environmental Protection, FDEP, monuments R-1 to R-25. The initial project periodic nourishment interval was 11 years, but was later revised to a periodic nourishment interval, for full beach nourishment, of 13 years. Initial construction was completed in 1996. During the summer of 2000, 6 acres of nearshore artificial reef was created to mitigate for impacts to nearshore hardbottom in the project area. Partial nourishments were constructed in 2001 and 2002. The project was fully nourished in 2005 using Flood Control and Coastal Emergencies (FCCE) funds in response to 2004 hurricane impacts. Finally, the last renourishment was completed in 2013 using a new OCS borrow area.

1.8 OTHER NON-FEDERAL STUDIES AND PROJECTS ADJACENT OR NEAR TO STUDY AREA

In the past decade several Beach Erosion Control activities have been undertaken by St. Lucie County and other private interests, including the following:

- From November 1999 through February 2000 an FDEP field permit was issued for temporary placement of sand bags along the shoreline 400 feet north and south of R-099.
- In February 2002, an FDEP field permit was issued for beach scarping from approximately R-099 to R-101.
- In February 2004, an FDEP field permit for dune restoration by truck haul was issued, permitting placement of approximately 4,000 cubic yards of sand from an upland sand source to the beaches between approximately R-099 and R-101.

Following Hurricanes Frances and Jeanne in 2004, a regional emergency dune restoration project was permitted:

- Initial dune restoration was conducted from March to May 2005 by St. Lucie County. This material was hauled in by truck and included placement of about 162,000 cubic yards of sand along the dune from R-098.4 to R-101.5, and from R-103.3 to the Martin County line (PBS&J, 2005). This dune restoration provided over 15,500 feet of dune, corresponding to a fill density of about 10 cubic yards/foot.

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- A February through March 2006 dune remediation event required removal of approximately 80,000 cubic yards of previously placed material. This material was replaced with dune overwash material that was removed and screened from Blind Creek, a coastal wetland extending from R-075.5 to -R079.
- Another dune segment, previously untouched, was restored by truck haul in February 2007 with approximately 11,000 cubic yards of material trucked in from an upland borrow area. This event nourished dunes from R-088.5 to R-090.3.
- In April 2011 the St. Lucie County Mosquito Control and Coastal Management Services Department initiated an emergency dune fill project which added 60,000 cubic yards of sand (100 feet of beach width) to 1,700 feet of shoreline immediately south of Ft. Pierce Inlet.
- In 2012/2013, in a response to Hurricane Sandy in 2012, as well as damage from the 4 hurricanes in 2004/2005, St. Lucie County constructed a local beach one-time fill and dune restoration project, placing a total of approximately 658,654 cubic yards of fill on approximately 3.4 miles of shoreline from R-98 to the St. Lucie/Martin County line at R-115+1000 feet. More details on this effort is described in Chapter 2, existing conditions.



2

Existing and Future Conditions

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

2.1 GENERAL SETTING*

 Please refer to informational foldout REF-1 and REF-2 throughout Chapter 2.

ASSUMPTIONS

In a letter of response to the Sponsor, signed by the Deputy Director of Civil Works dated 12 October 2006 (**Appendix H**) it was agreed that a reasonable eroded shoreline would define the “without-project” condition for the Feasibility study. In order to ensure that emergency nourishment efforts in response to the 2004 and 2005 hurricane season and local nourishment project (completed in May 2013) did not influence the outcome of the ongoing feasibility study, it was agreed that the “without-project” shoreline for the study would be established using survey data collected in the summer of 2006. However, subsequent analysis of the data showed that the 2006 survey did not provide adequate foreshore and offshore coverage of the project area to complete the Beach-fx analysis. A comparison of the available portions of the 2006 survey and a comprehensive shoreline survey taken in August 2008 showed insignificant difference in shoreline dimensions between the two. Therefore, the 2008 shoreline was determined to be a good representative of the 2006 shoreline and was adopted as the “without-project” condition.

This chapter describes conditions as they currently exist, and as they are projected to exist if a project is not implemented, within the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida. Information gathered in this step helps to describe the problems and opportunities and forecast future conditions. The future without-project (FWOP) condition is the most likely condition of the study area without construction of a Federal project over the next 50 years. The future without-project (FWOP) condition is also the no-action alternative for the purposes of the National Environmental Policy Act (NEPA) process, and this report uses both terms interchangeably.

The St. Lucie County, South Hutchinson Island study area, totals approximately 7.4 miles, spanning 4 island segments. The islands are separated from the mainland by the southern Indian River Lagoon and the Atlantic Intracoastal Waterway (IWW).

The Coastal Barrier Resource System (CBRS) unit P11 comprises about 46% of the study area. Of the approximate 7.4 miles of shoreline within the study area, roughly 3.4 miles of shoreline are in the CBRS. The 3 excluded areas have a total length of about 1.4 miles of shoreline. The non-CBRS shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R-103.5 to the St. Lucie/Martin County line at R-115+1000 feet (approximately R-001).

The study area shoreline consists of a naturally narrow sandy beach, bounded along the landward side by a thin line of dunes. The natural beach berm width along the majority of the study area is relatively thin. The natural beach slope is fairly steep, typically about 1 vertical to 8 horizontal, sloping directly from the sand dunes downward to the waterline with very little flat berm width. This type of beach is common along southeast Florida and has relatively coarse grained, carbonate rich, beaches. Several areas of

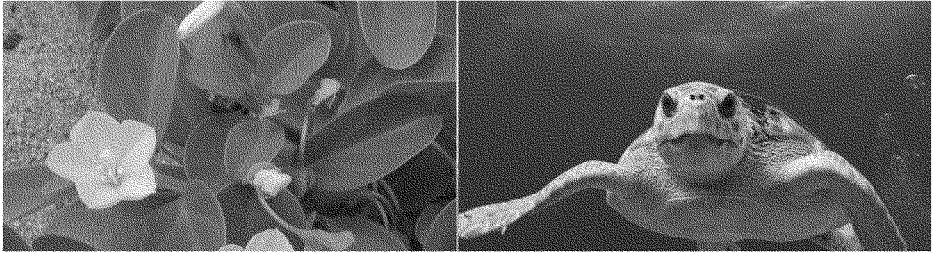
environmentally sensitive nearshore limestone and worm rock formations exist within the littoral zone throughout the study area, and in various densities.

Existing ground elevations along Hutchinson Island are generally less than 10 feet mean low water (MLW), and the width of the island varies from over a mile in the vicinity of the Florida Power and Light (FPL) power plant (R-082) to less than 500 feet along the central portion of the study area (The Narrows of Hutchinson Island, R-095).

There is no coastal armoring in the study area, with the exception of revetment in front of the FPL power plant, on the northernmost reach. This is due to the coastal construction control line (CCCL) pursuant to Section 161.053, Florida Statutes, which restrict coastal armoring in St. Lucie County, unless specific triggers are met.

The biological communities found in the general project area are comprised of the sandy beach shoreline and the open waters of the Atlantic Ocean. The sand substrate is dominated by crustaceans, mollusks, and polychaete worms, in relatively low concentrations, typical of nearshore and surf zone sand habitats. Nesting sea turtles and shore/seabirds use the sandy beach shoreline within the project area. The nearshore waters of the project area are composed of sand bottom with mapped hardbottom resources. Additional hardbottom occurs north and south of the project area. Hardbottom habitats identified in the general nearshore project area are differentiated by the amount of relief above the general floor of the ocean and the number and density of flora and fauna inhabitants. This hardbottom habitat may serve as developmental and foraging habitat for juvenile sea turtles and essential fish habitat (EFH) for coral/hardbottom biota and reef fishes. The offshore project area is unvegetated sand bottom at the southwest end of the St. Lucie Shoal complex. Typical inhabitants include relatively low densities of polychaete worms, bivalves, and nematodes, with some echinoids and small crustaceans.

There are currently 7 suitable parking and access points within the study area of R-77 to R-115+1000 feet to R-001. From north to south: Walton Rocks, Ocean Bay, Herman's Bay Beach, Normandy Beach, Dollman Park, Waveland Beach and Glascock Beach, which is located on the Martin County line (approximately R-001).



2.2 NATURAL (GENERAL) ENVIRONMENT*

2.2.1 VEGETATION

EXISTING CONDITIONS

Vegetation consisting of beach morning glory (*Ipomoea imperati*), railroad vine (*Ipomoea pes-capre*), sea grapes (*Coccoloba uvifera*), sea oats (*Uniola paniculata*), sea purslane (*Sesuvium sp.*), and beach elder (*Iva imbricata*) typically dominate the dune area. Due to the severe impact of Hurricanes Frances and Jeanne in 2004, St. Lucie County implemented a dune restoration/revegetation project in the southern portion of the county (Coastal Tech 2009). The dune system from R-98 to R-101.4 and from R-103.3 to the St. Lucie/Martin County line was revegetated primarily with sea oats with occasional railroad vine, sea grapes, and sea purslane interspersed.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The no-action alternative could affect vegetation within the project area. Continued erosion of the beach would result in loss of vegetated beach and dune habitats. Additionally, continued erosion could cause landowners to implement alternative armoring measures such as revetments to protect their property. These measures could result in negative impacts to the dune system by altering the beach profile and displacing vegetation.

2.2.2 FISH AND WILDLIFE RESOURCES (OTHER THAN THREATENED AND ENDANGERED SPECIES)

EXISTING CONDITIONS

2.2.2.1 NEARSHORE SOFT BOTTOM COMMUNITIES

Soft bottom macrobenthic and infaunal communities located within the nearshore portion of the project area experience highly dynamic conditions due to the high energy wave action in the intertidal surf zone. A portion of this environment comprises hardbottom (worm rock and exposed Anastasia rock formations). The remainder of the nearshore environment consists of medium to coarse quartz sand and shell hash

coarse carbonate/quartz sand bottom with the assemblages of plants and animals that use these soft bottom habitats.

The project area also includes three large shore-parallel sand gaps that lack nearshore hardbottom structures or feature only very small patches of exposed hard substrate. These areas are located between FDEP reference monuments R-98 to R-99, R-107 to R-109, and R-112 to R-2 and consist of primarily fine, unconsolidated sand substrate. In tropical and subtropical areas, the ghost crab genus *Ocypode* typically dominates the upper beach area. Mole crabs (*Emerita*), haustoriid amphipods, and bivalves (*Donax*) are numerical dominants in the intertidal area, while polychaetes, other amphipod species, and bivalves increase in abundance in the subtidal nearshore areas (Pearse et al. 1942, Dahl 1952, Spring 1981).

Gorzelay and Nelson (1987) studied the effects of beach nourishment on intertidal and subtidal infaunal communities in the Indian Atlantic and Melbourne Beach area. The study listed 99 taxa with *Donax* spp. as the numerically dominant group followed by the polychaete *Haploscoloplos fragilis*, the amphipods *Parahaustorius longimerus* and *Bathyporeia parkeri*, and the polychaete *Paraonis fulgens*. Species richness and density decreased in winter, increased in spring and summer, and decreased in fall. These population shifts did not seem attributable to beach nourishment effects, but rather to natural seasonal variations.

2.2.2.2 OFFSHORE BORROW AREA SOFT BOTTOM COMMUNITIES

Infaunal organisms present in the soft bottoms offshore central east Florida are predominantly common invertebrates including crustaceans, echinoderms, mollusks, polychaetous annelids, and interstitial bryozoans. Infaunal populations exhibit both seasonal and spatial variability in distribution and abundance, due to temperature, sediment topography, bathymetry, and sediment composition, including particle size and organic content (Hammer et al. 2005).

Epifaunal invertebrates commonly occurring on the soft bottoms offshore central east Florida include lady crabs (*Ovalipes* spp.), calico scallop (*Argopecten gibbus*), calico box crab (*Hepatus epheliticus*), iridescent swimming crab (*Portunus gibbesii*), brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), striped sea star (*Luidia clathrata*), and arrowhead sand dollar (*Encope michelini*). The distribution on the epifaunal invertebrates listed above exhibit distributions that are depth-, temperature-, and sediment type-related (Hammer et al. 2005).

Distribution of interstitial bryozoans has recently been studied at shoals located offshore St. Lucie County, including the St. Lucie Shoal. In a study conducted for the U.S. Army Corps of Engineers, Brostoff (2002) identified an average of 19 different species located within the samples from the St. Lucie Shoal, with *Cupuladria doma* the exceedingly dominant species collected. Previous studies of Capron Shoal (north of St. Lucie Shoal) by Winston and Håkansson (1986) described the bryozoan population as adapting to varying interstitial conditions. Such adaptations include small size, simplified colony structure, and very early reproduction. The distribution of encrusting bryozoans extends along sandy continental shelves, providing a food source for crustaceans, echinoderms, and mollusks (Winston and Håkansson 1986).

2.2.2.3 NEARSHORE HARDBOTTOM FISH ASSEMBLAGES

An investigation conducted during 2009 documented the fish assemblage associated with the nearshore hardbottom of the project area. The extant assemblage comprised primarily reef-associated species

generally expected for the region (Gilmore et al. 1981, CSA International 2009b). Although the assemblage consisted of 70 species, numerical dominants included black margate (*Anisotremus surinamensis*), silver porgy (*Diplodus argenteus*), newly settled grunts (*Haemulon* spp.), sailors choice (*H. parra*), hairy blenny (*Labrisomus nuchipinnis*), and porkfish (*A. virginicus*). The grunt family (Haemulidae), represented by nine taxa, dominated taxonomically in the project area.

CSA International identified 24 federally managed species during 2009 surveys of the nearshore hardbottom. Represented primarily by the grunt and jack families, many of these managed species also occurred as newly settled or juvenile stage individuals, indicating that the area serves as effective juvenile habitat for most of the managed species recorded. The South Atlantic Fishery Management Council (SAFMC 1998) includes most of the 24 managed species reported in as members of the snapper-grouper complex. The CSA survey also reported two other managed species, a coastal pelagic species (Spanish mackerel, *Scomberomorus maculatus*) and a coastal shark (nurse shark, *Ginglymostoma cirratum*). Other economically important or notable species observed near or over hardbottom, but not formally recorded during timed swims or in strip transects during the survey include snook (*Centropomus undecimalis*), bonnethead shark (*Sphyrna tiburo*), tarpon (*Megalops atlanticus*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), and Florida pompano (*Trachinotus carolinus*). Although not a federally managed fishery species, the striped croaker (*Bairdiella sanctaeluciae*), a federally designated species of special concern (Gilmore and Snelson 1992) was recorded at five of the survey transects.

2.2.2.4 COASTAL PELAGIC FISH

The major coastal pelagic families occurring in inshore and coastal waters of the project area include ladyfish, anchovies, herrings, mackerels, jacks, mullets, bluefish, and cobia. Coastal pelagic species migrate over the region's shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel), while others (e.g., cobia) travel alone or in smaller groups. Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al., 1981; Peters and Nelson 1987). Commonly occurring species in the project area include anchovies (*Anchoa* spp.), menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*), and Florida pompano (*Trachinotus carolinus*). Concentrations of anchovies, herrings, and mullets in nearshore areas may attract larger predatory species, particularly bluefish, blue runner, jack crevalle, sharks, and Spanish mackerel. The presence and density of most coastal pelagic fish species depend on water temperature and quality, which vary spatially and seasonally.

2.2.2.5 SEABIRDS AND SHOREBIRDS

A number of seabirds and shorebirds may occur along the beach and offshore the project area, including a number of species considered birds of conservation concern by the Migratory Bird Treaty Act of 1918 (MBTA). These species are likely to become candidates for listing under the Endangered Species Act. According to the Florida Natural Areas Inventory (FNAI 2010), all of the migratory species listed in the MBTA, except for the Audubon's shearwater, marbled godwit, and the semipalmated sandpiper, have been observed within St. Lucie County. These species all use sandy beaches for foraging and/or nesting and, therefore, could occur along the project area both onshore and offshore.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Species that utilize the beach environment may decrease in number due to continued erosion of the beach and dune system in the future without-project condition. No changes to fish and wildlife resources that reside below the swash zone would occur in the future without-project condition.

2.2.3 THREATENED AND ENDANGERED SPECIES

The project area lies within the coastal area of St. Lucie County, Florida. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have identified the threatened and endangered species listed in **Table 2-1** as potentially occurring in St. Lucie County. Of the species listed in **Table 2-1**, the species most likely to occur within the project vicinity are the following: the five species of sea turtles, manatees, humpback and right whales, smalltooth sawfish, piping plover, rufa red knot, and beach jacquemontia.

Table 2-1. Federally Listed Threatened and Endangered Species that May Occur in St. Lucie County, Florida, or marine environments.

Common Name	Scientific Name	Listing Status	
		USFWS	NMFS
PLANTS			
Fragrant prickly-apple	<i>Cereus eriophorus</i> var. <i>fragrans</i>	Endangered	-
Lakela's mint	<i>Dicerandra immaculata</i>	Endangered	-
Tiny polygala	<i>Polygala smallii</i>	Endangered	-
Beach jacquemontia	<i>Jacquemontia reclinata</i>	Endangered	
BIRDS			
Audubon's crested caracara	<i>Polyborus plancus audubonii</i>	Threatened	-
Everglade snail kite	<i>Rostrhamus sociabilis plumbeus</i>	Endangered	-
Florida scrub-jay	<i>Aphelocoma coerulescens</i>	Threatened	-
Kirtland's Warbler	<i>Dendroica kirtlandii</i>	Endangered	-
Piping plover	<i>Charadrius melodus</i>	Threatened	-
Rufa Red knot	<i>Calidris canutus rufa</i>	Threatened	
Red-cockaded woodpecker	<i>Picoides borealis</i>	Endangered	-
Wood stork	<i>Mycteria americana</i>	Endangered	-
MAMMALS			
Florida panther	<i>Puma concolor coryi</i>	Endangered	
Southeastern beach mouse	<i>Peromyscus polionotus niveiventris</i>	Threatened	
West Indian manatee	<i>Trichechus manatus</i>	Endangered	
Blue whale	<i>Balaenoptera musculus</i>	-	Endangered

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Finback whale	<i>Balaenoptera physalus</i>	-	Endangered
Sei whale	<i>Balaenoptera borealis</i>	-	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	-	Endangered
North Atlantic right whale	<i>Eubalaena glacialis</i>	-	Endangered
REPTILES			
American alligator	<i>Alligator mississippiensis</i>	Threatened/SA*	-
American crocodile	<i>Crocodylus acutus</i>	Threatened	-
Eastern indigo snake	<i>Drymarchon corais couperi</i>	Threatened	-
Green sea turtle	<i>Chelonia mydas</i>	Threatened	Threatened
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	Endangered	Endangered
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered	Endangered
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened	Threatened
FISH			
Smalltooth sawfish	<i>Pristis pectinata</i>	-	Endangered

2.2.3.1 SEA TURTLES

EXISTING CONDITIONS

St. Lucie County is within the normal nesting areas of three species of sea turtles: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and leatherback sea turtle (*Dermochelys coriacea*). The loggerhead and green are listed as threatened species, while the leatherback is listed as endangered under the U.S. Endangered Species Act of 1973. In St. Lucie County, the Florida Fish and Wildlife Conservation Commission defines 1 March through 31 October as the official nesting season for all species of sea turtles.

NESTING HABITAT

Sea turtle nesting occurs in south St. Lucie County within the project area. Loggerhead, green, and leatherback turtles currently account for all nests in the project area (EAI 2007, 2008, 2009a; personal communication, Beth Brost, FWC, March 2016).

Between 2011 and 2015, approximately 89.6% of the total sea turtle nests in the study area were loggerhead, followed by 9% green, and 1.4 % leatherback. During this time period, there were a total of 17,368 loggerhead, 1,745 green, and 280 leatherback sea turtle nests recorded in the study area for a grand total of 19,393 nests. The data are only for the survey period of 15 May - 31 August, and nesting does occur outside those dates (personal communication, Beth Brost, FWC, March 2016).

The study area has been delineated into four reaches, and these reaches overlap with the Index Nesting Beach Survey (INBS). Sea turtle nesting for each of these reaches is provided in **Figures 2-1, 2-2, 2-3 and 2-4**.

Figure 2-1. Sea turtle nesting data for North Hutchinson Island (R77 to R80, INBS Zones 13-14) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. The data are only for the survey period of 15 May - 31 August, and nesting does occur outside those dates. Source Florida Fish and Wildlife Conservation Commission.

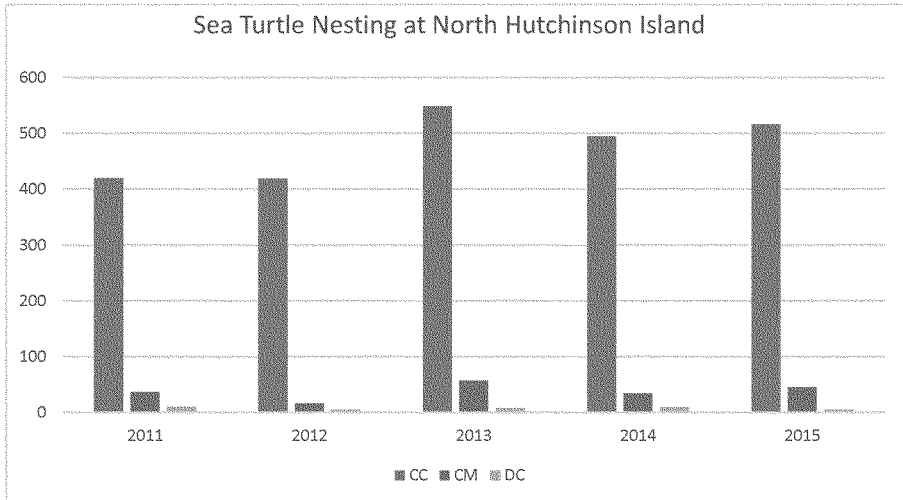


Figure 2-2. Sea turtle nesting data for Power Plant Area (R-80 to R-90, INBS Zones 15-17) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. Source Florida Fish and Wildlife Conservation Commission.

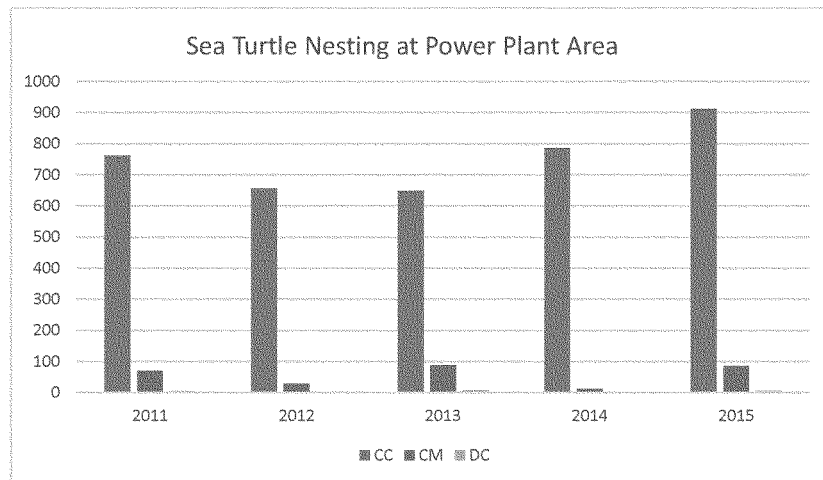


Figure 2-3. Sea turtle nesting data for Narrows of Hutchinson Island (R-90 to R-98, INBS Zones 18-20) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. Source Florida Fish and Wildlife Conservation Commission.

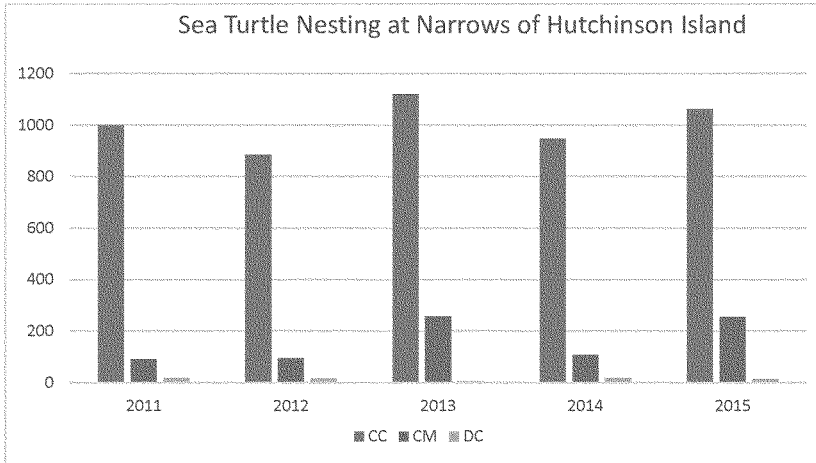
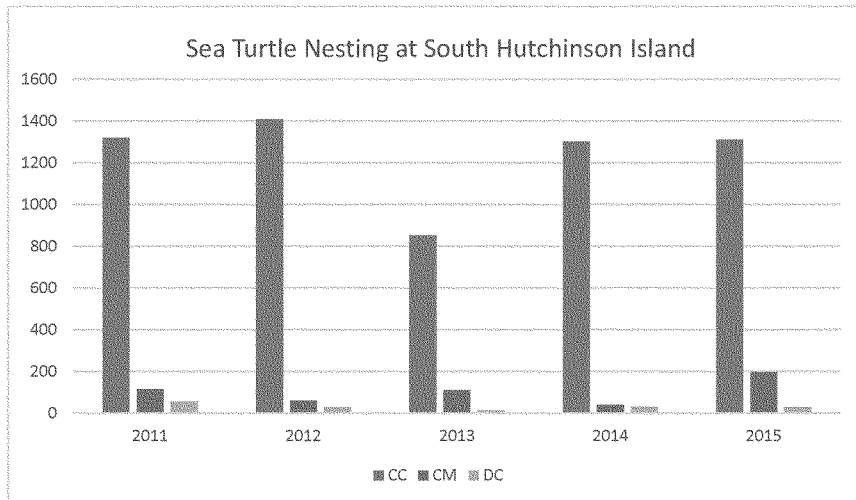


Figure 2-4. Sea turtle nesting data for South Hutchinson Island (R-98 to R-115 plus 1,000 feet, INBS Zones 20-25) for loggerheads (CC), greens (CM), and leatherbacks (DC) from 2011 to 2015. Source Florida Fish and Wildlife Conservation Commission.



INNER SHELF HABITAT

Five sea turtle species occur on the eastern Florida inner shelf; shoreline to the 20-meter isobath. In order of abundance, based on results of sea turtle monitoring conducted in the project area, these species are the loggerhead, green, leatherback, hawksbill, and Kemp's ridley turtles (**Table 2-2**). The table orders several species from highest to lowest abundance.

Table 2-2. Sea Turtle Species Potentially occurring on the Eastern Florida Inner Shelf (Adapted from: NMFS and USFWS, 1991a, b; 1992a, b; 1993; EAI, 2007, 2008, 2009a).

Common and Scientific Names	Status ¹	Life Stages Present	Abundance Within the Project Area	Seasonal Presence	Nesting Season
Loggerhead turtle (<i>Caretta caretta</i>)	T	Adults, subadults, juveniles, and hatchlings	Abundant	Year-round (most abundant during spring and fall migrations)	April to September
Green turtle (<i>Chelonia mydas</i>)	T	Adults, subadults, juveniles, and hatchlings	Common	Year-round	July to August
Leatherback turtle (<i>Dermochelys coriacea</i>)	E	Adults, subadults, juveniles, and hatchlings	Rare	March to October	March to July
Hawksbill turtle (<i>Eretmochelys imbricata</i>)	E	Adults, subadults, juveniles, and hatchlings	Rare	Year-round	June to September
Kemp's ridley turtle (<i>Lepidochelys kempi</i>)	E	Juveniles and subadults	Rare	Year-round (most abundant during spring and fall migrations)	(no nesting in area)

¹ Status: E = endangered, T = threatened under the Endangered Species Act of 1973.

LOGGERHEAD TURTLE

Loggerhead turtles (*Caretta caretta*) are present year-round in Florida waters, with peak abundance occurring during spring and fall migrations. Data suggest that nesting adult females are short-term residents that migrate into east Florida waters at 2 to 3-year intervals and reside elsewhere during non-nesting years (Henwood 1987; Schroeder and Thompson 1987). Adult males do not seem to migrate with adult females but may reside in the vicinity of nesting beaches throughout the year. Following nesting activities, many adult loggerheads disperse to the seas around islands in the Caribbean Sea, waters off southern Florida, and the Gulf of Mexico (Meylan and Bjorndal 1983; Nelson 1988). Subadult loggerheads forage opportunistically along the Atlantic seaboard, although evidence suggests that a resident population of subadults overwinter in the Canaveral area each year (Henwood 1987). In Brevard, Indian River, and St. Lucie Counties, juvenile and subadult loggerheads occur throughout the year in estuarine habitats (Ehrhart 1983, 1992; Henwood 1987; Ehrhart and Redfoot 1996; Bresette et al. 2000; Ehrhart et al. 2001; Holloway-Adkins 2005; Provanca et al. 2005).

Juvenile loggerheads, which researchers believe overwinter along the eastern Florida inner shelf, depart in the spring (March – April) when adult males that migrate into the area to mate (Ryder et al. 1994)

replace them. The adult loggerhead population (males and females) in Florida waters increases during the nesting season (Magnuson et al. 1990). In general, the eastern coast of Florida appears to provide an important year-round habitat for loggerhead sea turtles along both the inner shelf (0 to 20 meters) and middle shelf (20 to 40 meters) depths. The nearshore rock resources in these areas appear to represent a travel corridor to nesting sites rather than a main foraging or developmental habitat (Ryder et al. 1994). Juvenile loggerhead turtles generally feed on insects and invertebrates from within *Sargassum* mats (not present in the project area), while subadult and adult loggerheads primarily feed on bottom dwelling invertebrates (crabs, mollusks, shrimp) and macroalgae (Ryder et al. 1994). The study area beach lies within designated critical habitat unit LOGG-T-FL-09. Marine waters adjacent to the beach lie within designated nearshore reproductive and migratory critical habitat unit LOGG-N-18.

On project beaches, hatchling turtles normally emerge between July and September during the night and swim offshore to begin a pelagic existence within *Sargassum* rafts, drifting in current gyres and convergence zones for several years (Carr 1987; Marine Turtle Expert Working Group 1996a; Witherington 2002). Post-hatchlings from the Florida coast eventually enter currents of the North Atlantic Gyre. At a carapace length of approximately 40 to 60 centimeters, they leave the pelagic environment and move into nearshore habitats (Carr 1987; Bowen et al. 1993).

GREEN TURTLE

The USFWS considers the green turtle (*Chelonia mydas*) as common within the inner shelf waters off the project area. All life stages of green turtles occur during different times of the year in and around the project area. Ecological Associates, Inc. [EAI], (2009a, b, c, d, e, f, g) consistently observed all life stages adjacent to the southern portion of the project area during all seasons, with the most observations in June. Juvenile green turtles (approximately 2 to 5 years of age) also may move into shallow coastal and estuarine waters along the entire east coast of Florida (CSA International 2009b; Schmid 1995; Hirth 1997).

Florida comprises the major feeding grounds for green turtles in U.S. waters, where the turtles forage mainly on algae and the seagrass *Thalassia testudinum* (Burke et al. 1992). The nearshore waters of the project area include no seagrass. There is no designated critical habitat for this species within the project area.

Subadult green turtle habitats on the east coast of Florida include shallow estuarine environments such as the Indian River Lagoon (Ehrhart et al. 1996; Provancha et al. 1998; Bresette et al. 2000), deeper coral and limestone reefs in South Florida (Wershoven and Wershoven 1992; Makowski et al. 2002; Makowski 2004), and shallow nearshore habitats in Brevard, Indian River, and St. Lucie counties (Bresette et al. 1998; Ehrhart et al. 2001; Holloway-Adkins et al. 2002). Subadults also inhabit manmade environments such as shipping channels and turning basins (Henwood 1987; Redfoot 1997).

Several researchers have found juvenile green turtles over nearshore hardbottom habitats in the project area foraging on species of red algae (Ehrhart et al. 1996; Holloway-Adkins 2001; Holloway-Adkins 2005). The most frequently-consumed species were *Gelidium* spp., *Bryothamnion seaforthii*, *Hypnea* spp., *Gracilaria* spp., *Laurencia* spp., and *Bryocladia cuspidata*. The same reports also described juvenile green turtle consumption of a variety of small invertebrates and occasional portions of jellyfish. However, the overall results indicate juvenile green turtles in nearshore hardbottom habitats feed as herbivores (Holloway-Adkins 2001; Gilbert 2005, Holloway-Adkins and Provancha 2005). Sand, pieces of rock, and shell debris found in foraging samples indicate green turtles forage close to the substrate and, either

incidentally or selectively, ingest these non-nutritional items for unknown reasons. Stranding events and foraging studies indicate that sea turtles at all life stages are susceptible to ingesting anthropogenic debris (Balazs 1985; Carr 1987; Witherington 2002).

LEATHERBACK TURTLE

Adult leatherback (*Dermochelys coriacea*) turtles reportedly occur in east Florida waters primarily during summer; aerial surveys also have sighted leatherback turtles off northeast Florida from October through April (Schroeder and Thompson 1987, Knowlton and Weigle 1989, CSA 2002). During these surveys, leatherbacks occurred on the mid-shelf and inner shelf but not usually near shore (CSA 2002). However, historical data suggest that leatherbacks also may use inner shelf waters during periods of local thermal fronts that concentrate food resources (Thompson and Huang, 1993). The cryptic behavior of hatchling and/or juvenile leatherback turtles has resulted in little knowledge of their pelagic distribution. Leatherback turtles occur very rarely in the nearshore waters of the project area. There is no designated critical habitat for this species within the project area.

HAWKSBILL TURTLE

Hawksbill turtles (*Eretmochelys imbricata*) occur in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans. In the western Atlantic, hawksbill turtles generally inhabit clear tropical waters near coral reefs, including the southeast Florida coast, Florida Keys, the Bahamas, Caribbean Sea, and southwestern Gulf of Mexico (NMFS and USFWS 1993).

Pelagic hatchling hawksbills drift with *Sargassum* rafts. Available data suggest they are herbivorous during this period but become more omnivorous as they age (Ernst et al. 1994). Juveniles shift to a benthic foraging existence in shallow waters, progressively moving to deep waters as they grow and become capable of deeper dives for sponges (Meylan 1988, Ernst et al. 1994). Adult hawksbills typically associate with coral reefs and similar hardbottom areas where they forage on invertebrates, primarily sponges. No nesting or boat survey performed during 2006, 2007, and 2008 observed any hawksbill nests or animals in the project area (EAI 2007, 2008, 2009a, b, c, d, e, f, and g). There is no designated critical habitat for this species within the project area.

KEMP'S RIDLEY TURTLE

The Kemp's ridley (*Lepidochelys kempi*) is the smallest and most endangered of the sea turtles. Its distribution includes the Gulf of Mexico and southeast U.S. coast, although some individuals have ventured as far north along the eastern seaboard as Nova Scotia and Newfoundland (Marine Turtle Expert Working Group, 1996b). Adult Kemp's ridley turtles occur almost exclusively in the Gulf of Mexico, primarily on the inner shelf (Bytes 1988). Kemp's ridley hatchlings inhabit offshore *Sargassum* mats and drift lines associated with convergences, eddies, and rings. Gulf and Atlantic surface currents widely disperse the hatchlings. After reaching a size of about 20 to 60 centimeters carapace length, juveniles enter shallow coastal waters (Marine Turtle Expert Working Group 2000).

Post-pelagic (juvenile, subadult, and adult) Kemp's ridley turtles feed primarily on portunid crabs, but also occasionally eat mollusks, shrimp, dead fishes, and vegetation (Mortimer 1982, Lutcavage and Musick 1985, Shaver 1991, NMFS and USFWS 1992a, Burke et al. 1993, Werner and Landry 1994). The Kemp's ridley is considered very rare in nearshore waters of the project area. No nesting or boat survey

performed during 2006, 2007, and 2008 observed any Kemp's ridley nests or animals in the project area (EAI 2007, 2008, 2009 a, b, c, d, e, f, and g). Critical habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the Future Without-Project Condition, the beach is predicted to continue to erode. This will reduce the shoreline area available for nesting sea turtles. It will also increase turtle nest vulnerability to storm washout, as nests would be located closer to the mean high water line. As adjacent shorelines are currently available for nesting, it is unknown whether the overall nesting would be affected. In addition to increased erosion, it is likely that the length of shoreline hardened by structures would increase. This could further decrease the area available for nesting sea turtles due to the fact that the hard structures constructed would likely be seawalls and revetments (where permitted) that could negatively impact the width of beach available for nesting if not constructed in conjunction with beach nourishment.

2.2.3.2 MARINE MAMMALS

Three federally-listed species of marine mammals occur on the inner shelf (shoreline to the 20-meter isobath) of the project area (Table 2-3). The table orders the several species by relative abundance (highest to lowest).

Table 2-3. Endangered Marine Mammal Species Potentially Occurring on the Eastern Florida Inner Shelf. (Wiley et al. 1995, USFWS 2001, <http://www.neaq.org>)

Common and Scientific Names	Status ¹	Life Stages Present	Abundance within the Project Area	Seasonal Presence
Florida manatee (<i>Trichechus manatus latirostris</i>)	E	Adults, subadults, and juveniles	Common	Year-round (most abundant during winter)
North Atlantic right whale (<i>Eubalaena glacialis</i>)	E	Adults, subadults, and juveniles	Rare	December to March

¹ Status: E = endangered.

FLORIDA MANATEE

EXISTING CONDITIONS

The West Indian manatee is one of the most endangered marine mammals in coastal waters of the U.S. In the southeastern U.S., manatees are limited primarily to Florida and Georgia. This group constitutes a separate subspecies called the Florida manatee (*Trichechus manatus latirostris*) that comprises four recognized populations or management stocks (Atlantic Coast, Southwest, Upper St. John's River, and Northwest), based on regional manatee wintering sites (<http://www.nefsc.noaa.gov/nefsc/publications/tm/tm213/F2009App6.pdf>; USFWS, 2001). Adult Florida manatees average about 3.0 m (9.8 ft.) in length and 1,000 kg (2,200 lbs.) in weight. Their maximum lifespan is approximately 59 years. Age of first pregnancy is 3 to 4 years, and their gestation period for a single calf is 11 to 14 months, with an average interbirth interval of 2.5 years (USFWS 2001).

Manatees are seen mostly as solitary individuals or in groups of up to six individuals. Some larger aggregations may occur, such as feeding groups that may number up to approximately 20 individuals and winter aggregations near sources of warm water (such as power plant outfalls) that may contain hundreds of individuals (Jefferson et al. 2008).

Most manatees in the southeastern U.S. migrate between a summer range and a winter range, determined by water temperature changes. During winter months, the Florida manatee population confines itself to coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeastern Georgia (USFWS 2001). As water temperatures rise in spring, individuals disperse from these winter aggregation areas, some migrating as far north as coastal Virginia (USFWS 2001). Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range. They are usually found in canals, rivers, estuarine habitats, and saltwater bays, but on occasion have swum as far as 3.7 miles off the Florida coast (USFWS 2001). Within St. Lucie County, manatees are most frequently observed in the Indian River Lagoon and other inland waters. Individual and small groups of manatees are regularly sighted within shallow nearshore waters off St. Lucie County, including the Ft. Pierce Inlet (personal communication, non-federal sponsor's consultant, August 2010) and may graze on the algae present on the intermittent nearshore exposed hardbottom present in the project area.

In 1976, the USFWS designated critical habitat for this species. All of the critical habitat areas are located in peninsular Florida, predominantly along the inland waters of the southwest and southeast coasts (USFWS 2001). However, the project area is not designated as critical habitat.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the Florida manatee are not expected to be different from the Existing Conditions described above.

HUMPBACK WHALE

EXISTING CONDITIONS

On September 8th 2016 NMFS published a final rule to divide the globally-listed humpback whale into 14 Distinct Population Segments (DPSs) and list 4 DPSs as endangered and 1 as threatened. The West Indies DPS for humpback whales (*Megaptera novaeangliae*) was one of nine DPSs not warranted for listing. The humpback whale is a large baleen whale with a maximum length of about 52 feet (16 meters). Humpback whales range from the Arctic to the West Indies. During summer, at least five geographically distinct feeding aggregations occur in the northern Atlantic (Blaylock et al., 1995). During fall, humpbacks migrate south to the Caribbean where calving and breeding occurs from January to March (Blaylock et al. 1995). Aerial surveys during the Cetacean and Turtle Assessment Program (CETAP) detected only a few humpback whale sightings from New Jersey southward during any season (Winn 1982). However, subsequently there have been numerous sightings and strandings off the mid-Atlantic and southeastern U.S. coast, particularly during winter and spring (Swingle et al. 1993, Wiley et al. 1995). Most of the stranded animals were juveniles, suggesting that the area may provide an important developmental habitat (Wiley et al., 1995). Humpbacks feed largely on euphausiids and small fishes such as herring, capelin, and sand lance, and Blaylock et al. (1995) correlated their distribution largely to prey species

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distribution and abundance. Calving and breeding occurs in the Caribbean from January to March (Tove 2000).

The humpback whale is rarely sighted within the vicinity of St. Lucie County during its spring/fall migration. Critical habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the humpback whale are not expected to be different from the Existing Conditions described above.

NORTH ATLANTIC RIGHT WHALE

EXISTING CONDITIONS

The North Atlantic right whale (*Eubalaena glacialis*) is one of the most endangered whales in the world. The New England Aquarium's Atlantic right whale research and conservation initiative estimates a total world population of about only 400 (New England Aquarium 2010). North Atlantic right whales range from Iceland to eastern Florida, primarily in coastal waters. This species uses the waters around Cape Cod and Great South Channel to feed, nurse, and mate during summer (Kraus et al. 1988, Schaeff et al. 1993). From June to September, most animals feed north of Cape Cod. Southward migration occurs offshore from mid-October to early January (Kraus et al. 1993). Coastal waters of the southeastern U.S. (off Georgia and northeastern Florida) are important wintering and calving grounds for North Atlantic right whales. Migration northward along the North Carolina coast may begin as early as January but primarily occurs during March and April (Firestone et al 2008, Minerals Management Service [MMS] 1990).

Designated critical habitat for the North Atlantic right whale includes portions of Cape Cod Bay and Stellwagen Bank and the Great South Channel (off Massachusetts) and a strip of near coastal waters extending from southern Georgia to Sebastian Inlet, Florida; therefore, the project area lies south of the critical right whale habitat. The southern critical habitat area widens near the Georgia-Florida boundary where the highest concentrations of individual whales gather during their winter calving season (typically December through March, with peak calving in December and January). During this time, the population consists primarily of mothers and newborn calves, some juveniles, and occasionally some adult males and noncalving adult females (<http://www.neaq.org>). Sightings of North Atlantic right whales within waters off Florida are limited to late fall to early spring months. Sightings are concentrated near northeastern Florida and southeastern Georgia; however, sightings of individual whales have been reported as far south as Palm Beach County, Florida.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the right whale are not expected to be different from the Existing Conditions described above.

2.2.3.3 SMALLTOOTH SAWFISH

EXISTING CONDITIONS

The smalltooth sawfish (*Pristis pectinata*), currently listed as endangered by NMFS, rarely occurs within the project area. This species has become rare along the southeastern Atlantic and northern Gulf of Mexico coasts of the U.S. during the past 30 years, with its known primary range now reduced to the coastal waters of Everglades National Park in extreme southern Florida. Fishing and habitat degradation have extirpated the smalltooth sawfish from much of this former range. There is no designated critical habitat for this species within the project area.

The smalltooth sawfish, distributed in tropical and subtropical waters worldwide, normally inhabits shallow waters (10 m or less), often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters (20 m) of the continental shelf. Shallow water less than 1 m deep appears an important nursery area for young smalltooth sawfish. Maintenance and protection of habitat is an important component of the smalltooth sawfish recovery plan (NMFS, 2006). Recent studies indicate that key habitat features (particularly for immature individuals) nominally consist of shallow water, proximity to mangroves, and estuarine conditions. Smalltooth sawfish grow slowly and mature at about 10 years of age. Females bear live young, and the litters reportedly range from 15 to 20 embryos requiring a year of gestation (NMFS 2006a). Their diet consists of macroinvertebrates and fishes such as herrings and mullets. The smalltooth sawfish reportedly uses its saw to rake surficial sediments in search of crustaceans and benthic fishes or to slash through schools of herrings and mullets (NMFS 2006a).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions for the sawfish are not expected to be different from the Existing Conditions described above.

2.2.3.4 PIPING PLOVER

EXISTING CONDITIONS

The piping plover (*Charadrius melodus*) is a rare to uncommon winter resident that can occur along both the Gulf and Atlantic coasts between September and April. Although found on both coasts, they are more common along the Gulf of Mexico. The piping plover is listed as endangered in Canada and the inland United States, and is threatened along the coast. This small shorebird can occur inland but prefers sandy beaches and tidal mudflats where it forages along the waterline or high up the beach along the wrack line. Piping plovers eat a variety of insects and aquatic invertebrates. Declines have resulted from direct and unintentional harassment by people, dogs, and vehicles; destruction of beach habitat for development; and changes in water level regulation (Haig 1992).

A winter census stated that approximately 20 – 30 piping plovers occur along the Atlantic coast from Duval County south to Brevard, St. Lucie, and Miami-Dade Counties (Florida Natural Areas Inventory [FNAI] 2001). Ecological Associates, Inc. (EAI) conducted a piping plover survey in the vicinity of the project area (St. Lucie Inlet) from January to May 2009 in support of permitting planned dune restoration project at

Bathtub Beach Park on Hutchinson Island. According to Robert Ernest, EAI documented one sighting of a piping plover in or near the project area, but its occurrence there is very rare, given the high amount of human use and associated disturbances. Only one solitary bird has been observed on the Atlantic beaches of Hutchinson Island, located a considerable distance from the inlet (personal communication, Robert Ernest, EAI August 2009). Designated critical habitat for wintering piping plovers occurs south of the project area on Jupiter Island, Martin County, Florida. No critical habitat is designated within the project area.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The continued erosion of the shoreline in the proposed placement area may reduce some habitat that could potentially be utilized by the plover; however, the infrequent usage of this area by this species suggests that the Future Without-Project Conditions would be similar to the Existing Conditions with respect to the plover.

2.2.3.5 RUFA RED KNOT

EXISTING CONDITIONS

The rufa subspecies of the red knot (*Calidris canutus rufa*), listed as threatened, is a small shorebird that can occur along the Atlantic and Gulf coasts during migration. It is also known to overwinter in low numbers along both coasts. Florida is home to the largest concentration of wintering rufa in the United States, with the main concentration occurring in the greater Tampa Bay region (A.C. Schwarzer et al. 2012). In migration and winter, it prefers coastal mudflats, tidal zones, and sometimes open sandy beaches where it feeds on small invertebrates such as small mollusks, marine worms, and crustaceans (Kaufman 1996). The knot population has declined primarily due to reduced food availability from increased harvests of horseshoe crabs (USFWS 2015). Their numbers appear to have stabilized in the past few years, but they remain at low levels relative to earlier decades (USFWS 2015). Critical Habitat has not been designated for this species.

Red knots have been observed at Fort Pierce Jetty Park in St. Lucie County (St. Lucie Audubon 2014), and have also been known to occur in St. Lucie Inlet Preserve State Park (FDEP 2014). They may occasionally occur within the study area.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The continued erosion of the shoreline in the proposed placement area may reduce some habitat that could potentially be utilized by the knot; however, the infrequent usage of this area by this species suggests that the Future Without-Project Conditions would be similar to the Existing Conditions with respect to the knot.

2.2.3.6 BEACH JACQUEMONTIA

EXISTING CONDITIONS

Beach jacquemontia (*Jacquemontia reclinata*), or beach clustervine, is an endangered coastal dune plant endemic to the southeastern coast of Florida. This low-growing, creeping vine typically inhabits the lee side of stable, vegetated dunes, disturbed openings in maritime hammocks, coastal strand, and coastal scrub. The species produces somewhat fleshy leaves up to 3 cm long and white, star-shaped flowers. Currently, only a few populations remain along the east coast of Florida from Martin County south to Dade County. The primary threats to its continued existence include habitat loss and fragmentation from coastal development and erosion, and displacement from non-native, invasive species such as Brazilian pepper (*Schinus terebinthifolius*).

In its letter dated 14 December 2011, the USFWS indicated that based on observations made in January 2010, the endangered beach jacquemontia may occur within the project area. The potential location(s), quantity, and current vegetative state are unknown for beach jacquemontia specimens that may occur within the project area. Critical Habitat has not been designated for this species.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the Future Without-Project Condition, the upper beach and dune may continue to erode. This may reduce the habitat for jacquemontia.

2.2.4 HARDBOTTOM HABITAT

EXISTING CONDITIONS

Nearshore hardbottom features along the project area comprise marine components of the Anastasia formation, including lithified shell fragments (especially coquina clam), quartz sand, and calcium carbonate (Cooke and Mossom 1929, Cooke 1945). These features parallel the shoreline, extend through the intertidal and subtidal zones, and range from relatively wide expanses of pavement-like platforms with ledges to isolated patches of rocks. The ledges typically have exposed vertical faces and overhangs along the shoreward edges. Nearshore hardbottom in this area is ephemeral in nature due to high wave energy and a dynamic sedimentary environment. The majority of hardbottom observed in the project area includes partially exposed rock with sand veneers of varying depths.

The sabellariid tubeworm *Phragmatopoma lapidosa* (also known as *P. caudata*) colonizes nearshore hardbottom in portions of the project area. This colonial species settles in intertidal and subtidal hardbottom areas and uses sand particles in concert with a mucoproteinaceous cement to construct dwelling tubes resulting in construction of reef-like structures (Gore et al. 1978, Nelson and Demetriades 1992; Kirtley 1994; Drake et al. 2007). This “worm rock” is somewhat ephemeral, as storm waves and burial by sediments may destroy the structures (CSA International 2009b) and the species typically constructs the worm rock only from early summer through fall. Although *P. lapidosa* is capable of spawning year-round (Eckelbarger, 1976; McCarthy et al. 2003), spawning peaks in summer and fall (McCarthy et al., 2003). Sabellariid worms have an opportunistic life history typified by fast-growth, short time to sexual maturity, and hardness regarding physical disturbance (McCarthy et al. 2003). Although

P. lapidosa is quite resilient to turbidity (Main and Nelson 1988), studies evaluating sediment burial tolerance of *P. lapidosa* colonies within St. Lucie and Brevard counties found increased mortality linked to both depth of sediment cover and duration of burial (Main and Nelson 1988, Sloan and Irlandi 2008).

Off the east coast of Florida, the structure provided by nearshore hardbottom and associated worm rock supports locally moderate to high diversities and abundances of algae, fishes, and invertebrate groups including sponges, hydroids, mollusks, crustaceans, bryozoans, ascidians, and cnidarians (Kirtley 1966, Gore et al. 1978, Nelson 1989, Lindeman and Snyder 1999, Coastal Planning and Engineering 2006a). Considered important nursery habitat for juvenile fishes (Sloan and Irlandi 2008), nearshore hardbottom also provides shelter and/or foraging grounds for sea turtles (Ehrhart et al. 1996, Wershoven and Wershoven 1992, Holloway-Adkins 2001, CSA International 2009b). Corals and/or octocorals occur only rarely in the project area due to seasonal changes (decreases) in water temperature; however, hardbottom areas in deeper water further offshore support octocorals and several genera of scleractinian corals including *Oculina*, *Siderastrea*, and *Phylangia*.

Substantial geological evidence suggests that nearshore hardbottom and/or worm rock are also important in the maintenance and persistence of beaches and barrier islands by dissipating wave energy and retaining sediments, and thus increasing the volume of standing sand on beaches adjacent to large worm rock habitat (Gram 1965; Kirtley 1966, 1967; Multer and Milliman 1967; Kirtley and Tanner 1968; Mehta 1973; Kirtley 1974).

In the northern section of the project area, between reference monuments R-87.7 and R-90.3, hardbottom includes an often discontinuous, low- to medium-relief landward edge with a significant worm rock component. The landward edge of hardbottom is relatively close to shore (within 10 to 20 meters of the mean high water line – MHWL). Hardbottom continues seaward as a series of well-exposed, shore-parallel ledges with vertical relief of 0.5 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Generally, hardbottom covers the nearshore area in a relatively continuous distribution.

Data from the first 50 meters seaward of the shore along each of two monitoring transects surveyed (located at reference monuments R-88.7 and R-90.4) during summer 2009 provided detailed estimates of biological benthos. Percent cover of macroalgae ranged from 10% to 70% at individual sampling locations (*in situ* 0.5 square meter quadrats), with an average cover of 35.8%. Red algae dominated the algal community with an average cover of 20.3%, followed by turf algae at 9.5%. Dominant species of red algae included *Laurencia* sp., *Bryothamnion seaforthii*, *Chondria* sp., and *Hypnea musciformes*. Cover of sessile macroinvertebrates ranged from 0% to 15% at individual sampling locations, with an average cover of 1.3%. *P. lapidosa* dominated the invertebrate community, although other observed invertebrates included hydroids, solitary (*Cinachyra* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks.

In the southern section of the project area, between reference monuments R-99.5 and R-107, hardbottom occurs as a discontinuous landward edge. The landward edge of hardbottom in this region generally occurs as an undercut coquina rock ledge with low relief (of 0.25 to 1.0 meter or 9-39 inches vertical rise) and relatively less biotic cover than the northern section.

Between monuments R-98.5 to just north of R-104, the landward edge of hardbottom is located approximately 40 meters from the MHWL, whereas from just south of monument R-104 to R-107, the landward edge of hardbottom lies approximately 17 to 40 meters from the MHWL. Hardbottom continues seaward as a series of low-relief ledges with a vertical relief of 0.25 to 1.0 meters, alternating with partially-exposed, pavement-like platforms. Worm rock occurs in the intertidal zone near monuments R101, R-104.5, and R-105.9; hardbottom (including worm rock) in this section showed more evidence of sand-scouring and a dynamic sedimentary environment with minimal to moderate algal cover dominated by turf algae.

Data from the first 50 meters seaward of the shore along each of the six monitoring transects (located at monuments R-100, R-101, R-102, R-103.2, R-104.5, and R-105.9) surveyed during summer 2009 provided more detailed estimates of biological benthos. Cover of macroalgae ranged from 0% to 60% at individual sampling locations, with an average cover of 25%. Turf algae dominated the vegetative community with an average cover of 18.5%, followed by green algae at 4.7%. *Caulerpa prolifera* almost completely dominated the green algae component present along the transects. This species commonly occurs on hardbottom outcrops in the intertidal zone in St. Lucie and Indian River counties (CSA International 2009c). Sessile macroinvertebrates on transects located between monuments R-100 and R-103.2 provided only a small fraction of total cover (0% to 3% at individual sampling locations) and included no worm rock.

Cover of sessile macroinvertebrates at monuments R-104.5 and R-105.9 ranged from 0% to 100% due to localized abundance of worm rock in the intertidal zone. Other invertebrates observed along these transects included barnacles, hydroids, solitary (*Cinachya* sp.) and encrusting sponges, encrusting tunicates, holothuroids (*Holothuria grisea*), and various small crabs and other mollusks. **Table 2-4** provides a synopsis of dominant hardbottom community components, ordered by relative abundance.

Table 2-4. Taxa on Nearshore Hardbottom Habitat in Eastern Central Florida. (CSA International 2010a)

Common and Scientific Names	Life Stages Present	Abundance Within the Project Area	Seasonal Presence
Macroalgae	Spores and adults	Common	Year-round (perennial species) and May-October (annual species)
Invertebrates (crustaceans, echinoderms, and mollusks)	Larvae, juveniles, and adults	Common	Year-round
Sponges	Larvae, recruits, and adults	Common	Year-round
Sabellariid worm rock (<i>Phragmatopoma lapidosa</i>)	Larvae, recruits, and adults	Common to Occasional	Year-round
Scleractinian Corals (e.g. <i>Phylangia americana</i> , <i>Siderastrea</i> spp., <i>Oculina</i> spp.)	Larvae, recruits, and adults	Rare	Year-round
Octocorals	Larvae, recruits, and adults	Rare	Year-round

An additional hardbottom community consists of faunal species that were not observed in the more nearshore hardbottom areas including spiny lobster (*Panulirus argus*), octocorals (*Leptogorgia sp.*), holothuroids, and a variety of encrusting sponges. The hardbottom is characterized by large (1 to 3 m diameter), flat rock structures found in deeper (3 to 4 m) water farther from the shoreline than the communities previously described. Octocorals were observed in this hardbottom community, which is located further offshore and would not be impacted by the implementation of the project.

During the 2010 monitoring event, three scleractinian coral polyps were observed in one quadrat on one transect (R-104.5). No scleractinian corals were observed in any quantitative or qualitative video transects. One octocoral was observed during the point count analysis of one transect (R-78.7). Octocorals constituted less than 1% mean coverage along transect R-78.7, which is outside the project area. One stony coral species (*Phyllangia americana*, cup coral) also constituted less than 1% mean coverage along transect R-110.5, a transect that starts 188 m from the mean high water line and would not be affected by the project.

2.2.5 REEF/HARDBOTTOM MITIGATION

St. Lucie County constructed the South Beach Project (local project) between March 30 and April 29, 2013. The work was authorized by USACE permit (No. SAI-2009-03448) and Florida Department of Environmental Protection (FDEP) permit (No. 0154626-001-JC), and entailed placement of 645,164 cubic yards of beach quality sand on 3.4 miles of beach between FDEP Range Monument R-98 in St. Lucie County south to the Martin County line (approximately 1,000 m from R-115). The placement material was dredged from a sand source located within the St. Lucie Shoal complex and within state waters. Sand placement impacted approximately 0.57 acres of hardbottom.

The permits required 1.89 acres of artificial reef be constructed to mitigate for the impacts to the naturally occurring hardbottom. As reflected in the August 2015 “as-built survey (see Appendix G, Attachment 3)” and as cited in the corresponding September 18, 2015 “Mitigation Reef Certification Report (see Attachment 3)”, a total of 1.93 acres of mitigation reef were constructed in 2013 & 2015 – in excess of the 1.89 acres required by the permits. Adjustments to specific reef cell locations were made to comply with water depth requirements prescribed by USACE and FDEP. At low tide these areas are expected to have ambient water depths between 9.37 and 12.37 feet. The monitoring report “Year One Post-Construction Mitigation Artificial Reef Monitoring Survey for the St. Lucie County South Beach Project” dated January 2017 indicates that in 2016 the artificial reef was providing suitable habitat for benthic faunal communities at or above the level provided by the nearshore hardbottom impacted by the County’s project. USACE Regulatory Division has determined that the constructed mitigation and monitoring have been performed in compliance with the County’s permit SAI-2009-03448, and this determination has been coordinated with NMFS, BOEM, and St. Lucie County. The compliance letter dated 3 April 2017, monitoring reports, and other relevant documents can be found in Appendix G, Attachment 3.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The quality of hardbottom habitat in the study area is not likely to be different from the existing conditions if the project were not constructed.

2.2.6 ESSENTIAL FISH HABITAT (EFH)

EXISTING CONDITIONS

The Magnuson-Stevens Fishery Conservation and Management Act requires identification of habitats needed to create sustainable fisheries and comprehensive fishery management plans with habitat inclusions. The act also requires preparation of an EFH assessment and coordination with NMFS when EFH impacts occur.

EFH is defined as “those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity” [16 U.S.C. § 1801(10)]. Waters are defined as aquatic areas and their associated physical, chemical, and biological properties that fish use during each stage of their cycle. Substrate includes “sediment, hardbottom, structures underlying the waters, and associated biological communities”. Necessary is defined as “the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.” Fish includes finfishes, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds, whereas “spawning, breeding, feeding, or growth to maturity” covers the complete life cycle of species of interest.

The SAFMC (South Atlantic Fisheries Management Council) holds responsibility for managing fisheries and habitat in the waters of the project area and has produced several Fisheries Management Plans (FMPs) for single and mixed groups of species. All of these FMPs — including those for penaeid shrimp, spiny lobster, red drum, snapper-grouper (reef fishes) and coastal migratory pelagics — were amended in a single document (SAFMC 1998) to address EFH within the South Atlantic region. In addition to the FMPs prepared by the SAFMC, highly migratory species (e.g., tunas, billfishes, sharks, and swordfish) are managed by the Highly Migratory Species Management Unit, Office of Sustainable Fisheries, NMFS. This Office prepared an FMP for highly migratory species that includes descriptions of EFH for sharks, swordfish, and tunas (NMFS 1999). The SAFMC recently prepared a Fishery Ecosystem Plan (SAFMC 2009) that expands many of the EFH descriptions provided in the Habitat Plan (SAFMC, 1998). Note that some of the species managed by SAFMC and NMFS also fall under the jurisdiction of the Atlantic States Marine Fisheries Commission (ASMFC) in order to further coordinate the conservation and management of the states' shared fishery resources.

Of the species or species groups managed by the SAFMC and NMFS, the following may occur within the project area for at least a portion of their life history:

- *Sargassum*
- Coral, coral reefs, and live/hardbottom habitats
- Penaeid shrimp
- Spiny lobster
- Coastal pelagic fishes
- Reef fishes (snapper-grouper complex)
- Dolphin and wahoo
- Highly migratory species

The following subsections accounts briefly describe the EFH for these species and their respective life stages.

2.2.6.1 SARGASSUM

Sargassum, a seaweed that permanently drifts at the surface in warm waters of the Atlantic Ocean (SAFMC 2002), normally occurs in scattered individual clumps ranging from 10 to 50 centimeters (4 to 20 inches) in diameter. Accumulation of *Sargassum* and other flotsam in lines often indicates a convergence zone between water masses. Convergence zones are sites of considerable biological activity; many species (including juvenile sea turtles and pelagic fishes) gather along these zones regardless of whether *Sargassum* or other flotsam is present (Carr 1986).

Floating *Sargassum* provides habitat for as many as 100 fish species at some point in their life cycle, but only two spend their entire lives there: the sargassum fish and the sargassum pipefish (Adams 1960, Dooley 1972, Bortone et al. 1977, SAFMC 2002). Most fishes associated with *Sargassum* are temporary residents (e.g., juveniles of jacks, triggerfishes, flying fishes, and filefishes). Adults of these species reside in shelf or coastal waters (McKenney et al. 1958, Dooley 1972, Bortone et al. 1977, Moser et al. 1998, Comyns et al. 2002). In addition, several larger species of recreational or commercial importance, including dolphin, yellowfin tuna, blackfin tuna, skipjack tuna, little tunny, and wahoo, feed on the small fishes and invertebrates attracted to *Sargassum* (Morgan et al. 1985). *Sargassum* is considered a Habitat of Particular Concern (HAPC) for dolphin and wahoo (SAFMC 2003).

2.2.6.2 CORAL, CORAL REEFS, AND LIVE/HARDBOTTOM HABITATS

The FMP for coral, coral reefs, and live/hardbottom habitats covers a range of organisms and structural features including reef-building stony corals, black corals, octocorals, sea pens, sea pansies, and live/hardbottom.

The regional distributions and ecological requirements of sea pens and sea pansies are not well known, but their recognized EFH includes muddy, silty bottoms in subtidal to outer shelf depths within a range of salinity and light penetration that includes the offshore borrow site proposed for this project.

The live/hardbottom FMP category also includes nearshore hardbottom. On a broad scale, nearshore hardbottom occurs in patches along the east coast of Florida. Considered EFH for coastal pelagic and reef fish management units (SAFMC 1998, 2009), these patches provide important ecological functions for plants, invertebrates, marine turtles, and fishes of the region (CSA International 2009b). The reef-building polychaete *Phragmatopoma lapidosa* augments the structural complexity of nearshore hardbottom.

The only HAPC for coral, coral reefs, and live/hardbottom within the project area is the *P. lapidosa* worm reefs found on nearshore hardbottom in water depths of 0 to 4 m.

2.2.6.3 PENAEID SHRIMP

Penaeid shrimp managed by the SAFMC and found in the project area include brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*).

EFH for penaeid shrimp encompasses the series of habitats used during their life history, which has two basic phases: the adult/juvenile benthic phase and the planktonic larval/post-larval phase (SAFMC 1998).

Benthic adults aggregate to spawn in shelf waters over coarse, calcareous sediments. Eggs attached to the females' abdomen hatch into planktonic larvae. These larvae and subsequent post-larval shrimp feed on zooplankton in the water column and make their way into inshore waters. For the inshore phase of the life history, post-larval shrimp settle to the bottom and resume a benthic existence in estuaries that provide rich food sources as well as shelter from predation. Young penaeid shrimp prefer shallow-water habitats with nearby sources of organic detritus such as estuarine emergent wetlands or mangrove fringe.

2.2.6.4 SPINY LOBSTER

EFH for spiny lobster (*Panulirus argus*) consists of hardbottom, coral reefs, crevices, cracks, and other structured bottom in shelf waters. Juvenile habitat, located in nearshore waters, ranges from massive sponges, mangrove roots, and seagrass meadows to soft bottom with macroalgal clumps. Spiny lobster has a complex series of planktonic larvae transported by small-scale currents as well as the Gulf Stream (SAFMC 1998). At least two life stages (adults and planktonic larvae) occur in the project area. Adult spiny lobster frequently occur in holes, crevices, and under ledges provided by regional nearshore and offshore hardbottom habitats. On occasion these adults migrate, walking in groups or single file lines along the open seafloor. Thus, this species would likely occur in the project area, including the borrow site and nearshore hardbottom habitat.

2.2.6.5 COASTAL PELAGIC FISHES

The major coastal pelagic families occurring in nearshore waters of the project area are ladyfish (*Elops saurus*), anchovies (*Anchoa* spp.), herrings (*Harengula* spp., *Opisthonema oglinum*, and *Sardinella aurita*), mackerels (*Scomberomorus* spp.), jacks (*Caranx* spp., *Trachinotus* spp), mullets (*Mugil* spp.), bluefish (*Pomatomus saltatrix*), and cobia (*Rachycentron canadum*). Coastal pelagic species migrate over the region's shelf waters throughout the year. Some species form large schools (e.g., Spanish mackerel [*Scomberomorus maculatus*]), while others travel alone or in smaller groups (e.g., cobia). Many coastal pelagic species inhabit the nearshore environment along beaches and barrier islands of eastern Florida (Gilmore et al. 1981, Peters and Nelson 1987). Commonly occurring species in the project area include anchovies, menhaden (*Brevoortia* spp.), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), hardhead catfish (*Ariopsis felis*), and Florida pompano (*Trachinotus carolinus*). Larger concentrations of anchovies, herrings, and mullets that aggregate in nearshore soft or hardbottom areas may attract larger predatory species particularly bluefish, blue runner (*Caranx crysos*), jack crevalle (*Caranx hippos*), requiem sharks (*Carcharhinus* spp., *Negaprion brevirostris*, and *Galeocerdo cuvier*) and Spanish and king mackerel (*Scomberomorus cavalla*). The distribution of most species depends on water temperature and quality, which vary spatially and seasonally.

Coastal pelagic species managed by the SAFMC include cobia, Spanish mackerel, king mackerel, cero (*Scomberomorus regalis*), and little tunny (*Euthynnus alletteratus*) (SAFMC 1998). Various life stages of all these species may occur in the project area.

EFH for coastal pelagic species includes *Phragmatopoma* reefs (worm reefs) off the central coast of Florida; ocean high-salinity surf zone; and nearshore hardbottom located south of Cape Canaveral. This EFH also includes sandy shoals of capes and offshore bars and high-profile rocky bottom and barrier island ocean-side waters from the surf zone to the shelf break zone from the Gulf Stream shoreward (including *Sargassum*). In addition, EFH for coastal migratory pelagic species includes all coastal inlets and state-designated nursery habitats (SAFMC 1998).

2.2.6.6 REEF FISHES (SNAPPER-GROUPER COMPLEX)

The Reef Fish Management Unit comprises 73 species from 10 families. Although the fisheries and adult habitat of most of these species exist well offshore of the project area, the young stages of several reef fishes use nearshore hardbottom (e.g., Gilmore et al. 1981, SAFMC 1998, Lindeman and Snyder 1999, Lindeman et al. 2000). SAFMC (1998) identified the following habitats as EFH for early life stages of reef fishes: attached macroalgae, seagrasses, salt marshes, tidal creeks, mangrove fringe, oyster reefs and shell banks, soft sediments, artificial reefs, coral reefs, and hard/live bottom. The project and surrounding areas include soft bottom and hard/live bottom. Nearshore hardbottom has been identified as an important habitat for many of the 73 members of the Reef Fish Management Unit (SAFMC 1998).

Generally, reef fishes spawn offshore and then release eggs and larvae into the water column. Reef fishes such as lane snapper (*L. synagris*) and grunts (*Haemulon* spp., *Anisotremus surinamensis*, and *A. virginicus*) have similar life cycles, and their early life stages also occur in the inshore waters of the project area (CSA International 2009b, Lindeman et al. 2000). Nearshore hardbottom provides an important connection to the cross-shelf developmental pathways undertaken by many reef species (Lindeman et al. 2000).

2.2.6.7 DOLPHIN AND WAHOO

Dolphin (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) are oceanic species associated with the western edge of the Gulf Stream. Dolphin and wahoo travel near this edge as they migrate through the project area near the offshore borrow site. Closely associated with the Gulf Stream, all life stages (eggs, larvae, juveniles, and adults) of these species could occur in the project vicinity near the offshore borrow site. Dolphin, tunas, and wahoo feed on small fishes and invertebrates associated with drifting *Sargassum* and other flotsam (Manooch et al. 1983, Manooch and Mason 1984, Morgan et al. 1985). HAPC for dolphin and wahoo is *Sargassum*.

2.2.6.8 HIGHLY MIGRATORY SPECIES

Worm et al. (2003) identified eastern Florida as an area supporting a high diversity of oceanic predators, such as sharks, billfishes (Istiophoridae), and tunas (*Thunnus* spp. and *Katsuwonus pelamis*), considered under the Highly Migratory Species Management Unit.

Many species, including tunas, swordfish (*Xiphias gladius*), and billfishes, may occur in the project area near the offshore borrow site because of its proximity to the Gulf Stream current. Swordfish and bluefin tuna (*Thunnus thynnus*) migrate through the Florida Straits and into the eastern Gulf of Mexico to spawn (NMFS 1999, 2009). *Sargassum* is important habitat for various life stages of the swordfish, billfishes, and tunas. Sailfish (*Istiophorus platypterus*), blue marlin (*Makaira nigricans*), and white marlin (*Tetrapturus albidus*) regularly occur offshore east Florida.

Coastal sharks are managed under the highly migratory species group. These species commonly occur during various life stages in inland and nearshore shelf waters of east Florida. In the project area, several managed shark species occur, including nurse (*Ginglymostoma cirratum*), hammerheads (*Sphyrna* spp.), and requiem sharks (Gilmore et al. 1981, CSA International 2009b, Gilmore 2009). Some of these species are very wide-ranging and loosely associated with a variety of habitats (e.g., soft bottom, hardbottom, and the water column). Others, particularly the nurse shark, are associated closely with hardbottom habitats.

The reef-building activities of the sabellariid polychaete *P. lapidosa* augment the nearshore hardbottom features in the project area. This species, defined as a foundational or structural species, forms large colonies commonly referred to as worm rock (Kirtley and Tanner 1968, McCarthy 2001). In addition to fish species, worm rock supports associated assemblages of organisms, such as decapod crustaceans (Gore et al. 1978).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The quality of EFH in the study area is not likely to be different from the existing conditions if the project were not constructed.

2.2.7 OFFSHORE SAND SOURCES

EXISTING CONDITIONS

St. Lucie Shoal, the proposed sand source, is a sandy shoal occurring 3-5 miles offshore of the project area in Federal and State waters with water depths of about -40 feet NAVD88. The shoal is a well-developed shore-face connected and isolated linear shoals oriented north-to-south. These features, depositional in nature, exhibit varying degrees of morphological change in response to local hydrodynamic conditions. Sand shoals form as an irregularity on the seafloor and then grow in response to local coastal processes such as waves, tides, and currents.

Surveys (CPE 2006b) of the proposed borrow area identified clean sand layers from 4 to 20 feet thick. Side-scan and magnetometer investigations conducted during the surveys indicated no hardbottom habitats near the borrow area (CPE 2006b).

Hammer et al. (2005) performed a study to examine the implications of sand removal from potential borrow areas off the east central Florida coastal shelf. The study, focused on Federal waters seaward of the current St. Lucie Shoal borrow area, found that waves passing over the shoals turned toward the shoreline sooner than in other areas the same distance offshore. The study concluded that waves refracting over the shoals within the entire investigation area produced area region of increased wave heights landward of each shoal and a corresponding region of decreased wave heights immediately south of the sites. However, the wave refraction over the entire St. Lucie Shoal (Federal waters and state waters portion) is potentially more significant than the impact to waves from the other shoals located farther offshore because the St. Lucie shoal area of influence is more focused along the shoreline (Hammer et al. 2005).

Sedimentary habitats such as sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifaunal species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Demersal feeding fishes prey on most of these species. A number of sand shoal studies conducted along the eastern coast of the U.S. have documented the use of sand shoals as fish habitat (Able and Hagan 1995, Slacum et al. 2006, Walsh et al. 2006, Vassilides and Able 2008, Gimore 2009). CSA International et al. 2009a) generally characterized use of sand shoals by fishes at several spatial scales. At broad scales (1 to 100 square kilometers), fishes may use shoal features as guideposts during migrations, local movements, or spawning. At intermediate scales

(tens to hundreds of square meters), different parts of individual shoals may represent different foraging areas or shelter from predators or waves and currents. At smaller scales (e.g., meters to centimeters), sediment texture (fine sand to shell fragments), variable bedform structures, and biogenic structures may provide important predator refuge or foraging areas. Considering this spatial framework, most fundamental ecological functions of shoals for fishes fall into the categories of spawning, shelter, or foraging.

Gilmore (2009) synthesized unpublished information and data and interviewed local anglers to determine the importance of the east Florida sand shoals, including the St. Lucie Shoal, to fishes. The report inferred from the various data sources that more than 200 species potentially use shoals for orientation, refuge, spawning, and feeding sites. Interviews with anglers confirmed that shoals served as aggregating points for small pelagic fishes such as menhaden, Spanish sardine, thread herring, and false pilchard. These species are important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups. Additional information on St. Lucie Shoal can be found in Appendix D, Geotechnical.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions of the offshore borrow area resources are not expected to be different from the Existing Conditions described above. However, the borrow area may be used for other projects.

2.2.8 COASTAL BARRIER RESOURCES

EXISTING CONDITIONS

In 1982, Congress signed the Coastal Barrier Resources Act (CBRA) prohibiting Federal expenditures (direct or indirect) for development of designated undeveloped coastal barriers and their associated aquatic habitat, including wetlands, estuaries, and inlets. The three primary goals of the CBRA include

- Minimize loss of human life by discouraging development in high risk areas
- Reduce wasteful expenditure of Federal resources
- Protect the natural resources associated with coastal barriers

One Coastal Barrier Resource System (CBRS) map unit, P11 (Hutchinson Island), lies partially within and adjacent to the project area (**see REF-1**).

The May 27, 2009 FWS CBRA Consistency Determination letter (**Appendix H**) describes the project area CBRS Unit P11 as follows:

This area supports suitable habitat for species listed under the Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 153 1 *et seq.*), including the threatened piping plover (*Charadrius melodus*), threatened loggerhead sea turtle (*Caretta caretta*), endangered green sea turtle (*Chelonia mydas*), endangered leatherback sea turtle (*Dermochelys coriacea*), and endangered hawksbill sea turtle (*Eretmochelys imbricata*). The beaches of St. Lucie County support the fifth highest nesting density of sea turtles in Florida.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Future Without-Project Conditions of the CBRS unit are not expected to be different from the Existing Conditions described above.

2.2.9 WATER QUALITYEXISTING CONDITIONS

The State of Florida classifies the waters offshore of the project area as Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The predominant issue that affects water quality in offshore waters in south Florida is turbidity, considered a good measure of water quality. Turbidity is a measure of the loss in transparency of water due to the presence of suspended particulates — the more total suspended solids in the water, the cloudier it appears and the higher the turbidity. Turbidity is measured in nephelometric turbidity units (NTUs), which is measured by the intensity of light scattered passing through the water sample.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The water quality in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTEEXISTING CONDITIONS

The coastline within the project area is located adjacent to predominantly residential, commercial, and recreational areas. No known industrial activities produce hazardous, toxic, and/or radioactive wastes adjacent to the project site; no known industrial activities discharge effluents near the shoreline; and no known records of such past activities exist. Sediments within the littoral zones of the project area, as well as sediments from the borrow areas, comprise particles of a large grain-size. Normally, contaminants do not adhere to materials with such properties. Sediments in the potential borrow sites are sufficiently removed from shipping lanes or other potential contaminant sources. Hence, pollutants are unlikely to have contaminated them.

The closest Formerly Used Defense Site to the project area was the Fort Pierce Naval Amphibious Training Base. Heavy ordnance activities associated with this base took place to the north of the project area, on North Hutchinson Island in Indian River County. There were no offshore activities as far south as the project area. Unexploded ordnance has not been observed in previous dredging events within St. Lucie Shoals or during beach placement activities.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The absence of hazardous or toxic wastes in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.11 AIR QUALITY

EXISTING CONDITIONS

St. Lucie County lies within the Southeast Florida Intrastate Air Quality Region, as established by 40 CFR Part 81.49. The U.S. Environmental Protection Agency (EPA) (40 CFR Part 81.310) designates St. Lucie County as being in attainment with National Ambient Air Quality Standards for ozone, nitrogen dioxide, carbon monoxide, particulate matter, and sulfur dioxide. Air quality in St. Lucie County exceeds national standards. The EPA has not made a designation for lead in southeastern Florida.

Ambient air quality along coastal St. Lucie County is generally good due to prevalent ocean breezes from the northeast through the southeast. Coastal development and the popularity of the beaches area all contribute to the presence of motorized vehicles and vessels in the project area at any given time. The usually present sea breezes along the Ft. Pierce shore readily disperse airborne pollutants. This project, regardless of the alternative implemented, would not require air quality permits.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The air quality in the study area is not likely to change from the Existing Conditions in the Future Without-Project Conditions.

2.2.12 NOISE

EXISTING CONDITIONS

Ambient sources of noise within the project area include beach and nearshore recreational activities, breaking surf, boat and vehicular traffic, and noise from adjacent residences. Because St. Lucie County has many seasonal residents and tourists, many more residents are present in the homes and condominiums located along the project area during the winter months. Their presence results in more ambient noise along the beach front as well as more boating traffic during the winter tourist season.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

While the area may experience a slight decrease in tourist activity, noise levels in the study area are not likely to change significantly from the Existing Conditions in the Future Without-Project Conditions.

2.2.13 AESTHETIC RESOURCES

EXISTING CONDITIONS

An aesthetic or visual resource is a broad term used to identify the particular scenic qualities that define a place or landscape. The sandy beaches and blue waters of the Atlantic Ocean found along South Hutchinson Island define the aesthetic resources within the project area. Upland development consisting of high and low rise commercial and residential development, vacant lands, and recreational beach access areas backs the coastline. Vacant lands and beach access areas are generally vegetated with low lying shrubby dune plants such as sea oats (*Uniola paniculata*), with occasional interspersed railroad vine

(*Ipomoea pescapre*), sea grapes (*Coccoloba uvifera*), and sea purslane (*Sesuvium* sp.). Residents and guests of the numerous condominiums, resorts, and hotels within the project area enjoy the aesthetically pleasing panoramas of the Atlantic Ocean. However, the general project area does not include sites designated under 40 CFR 81.407 as a Class I Federal Area, where visibility is an important value.

Erosional processes currently occurring within the project area distract from the aesthetics and will continue to reduce the width of the beach area and related aesthetic value. According to the Conditions Assessment Report (Coastal Tech 2009: Attachment P), an average 60 feet of dune separated the buildings and the sandy beach. The analysis found project area beaches generally eroded and the shoreline generally in retreat, with the greatest volumetric loss occurring between reference monuments R-90 and R-100. From R-103 to R-109, the slightly accreted beaches advanced slightly seaward.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The aesthetics of the study area are anticipated to decline in the Future Without-Project Condition due to increased erosion and the continued narrowing of the beach.

2.2.14 RECREATION RESOURCES

EXISTING CONDITIONS

Beaches within the project area are somewhat less congested than other nearby beaches due to limited public beach access points (there are 7 throughout the study area from R-77 to the Martin County line) and distance from the heavily populated areas of Ft. Pierce, Port St. Lucie, and Stuart. Project area beaches provide an appealing and relaxing South Florida atmosphere.

Recreational usage along the beaches within the project area includes shore-based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, visitors use area beaches for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, lobstering, scuba diving, and snorkeling often start from boats in nearshore hardbottom areas. Offshore angling may occur near the proposed borrow site despite the absence of known, identified fish havens near the borrow area. Numerous boat ramps and marinas in Ft. Pierce, Jensen Beach, and Stuart provide access to the Atlantic Ocean through the Ft. Pierce Inlet located approximately 10 miles north and the St. Lucie Inlet located 7.5 miles south of the project area.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The recreational usage of the study area is anticipated to decline in the Future Without-Project Condition due to increased erosion and the continued narrowing of the beach, which will make it less suitable for recreating.

2.2.15 CULTURAL RESOURCES AND HISTORIC PROPERTIES

EXISTING CONDITIONS

All portions of the proposed project area, including the offshore borrow area and the sand placement template have been subjected to cultural resource surveys. New South Associates conducted a Phase I cultural resources survey of the sand placement area in October 2007 (Smith et al. 2008). The survey extended from the Martin/St. Lucie County line to approximately 0.5 miles north of the Florida Power and Light (FPL) Nuclear Power Plant and included the area currently under review. The Phase I survey consisted of background research, surface reconnaissance, systematic shovel testing, metal detection in areas adjacent to recorded locations of historic shipwrecks, artifact identification and analysis, and report preparation. Background research indicated that all previously recorded historic and prehistoric sites are located outside of the current project area — on or west of the back dune along or west of U.S. A1A. No cultural resources were identified as a result of the surface and sub-surface testing.

The study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. The report recommended a finding of no effect on cultural resources listed or eligible for listing in the National Register of Historic Properties (NRHP), and recommended no further investigation of the project area. The State Historic Preservation Office (SHPO) reviewed the survey report and concurred with the final report findings and recommendations in a letter to USACE dated 27 July 2010 (DHR File No. 2008-02141-B) (**Appendix H**).

A remote sensing survey of the proposed offshore borrow location was conducted by SEARCH between October 2007 and June 2008 (Krivor 2008). An additional remote sensing survey of a portion of the proposed shoal borrow area not previously investigated was also conducted by SEARCH in December 2010 (Krivor 2010). These surveys utilized a magnetometer, side scan sonar, and sub bottom profiler to identify any potentially significant submerged cultural resources. In addition to the remote sensing surveys, SEARCH conducted a refinement survey of reported wreck sites near the project area, including the *America* (8SL28) and the *Halsey* (8SL30).

As a result of the 2007-2008 survey, SEARCH identified one cluster of magnetic anomalies associated with side scan sonar imaging within the project area. The cluster of magnetic targets were not evaluated by a diver; however, the magnetic signature suggests these targets may represent a potentially significant submerged cultural resource (Krivor 2008). The *Halsey* was relocated outside of the current borrow area; however, the *America* was not relocated as a result of the remote sensing survey, and is believed to be south of the coordinates provided by the Florida Master Site File. No potentially significant submerged cultural resources were identified as a result of the 2010 SEARCH survey.

The 2007-2008 remote sensing survey recommended that the project avoid submerged cultural resources during dredging by utilizing a 500-foot buffer zone around the cluster of magnetic anomalies and recommended no further investigation of the area. Based on these recommendations, the proposed project was determined to have no effect on cultural resources listed or eligible for listing in the NRHP. The SHPO reviewed both reports and issued letters dated 20 January 2011 concurring with the report findings and recommendations (DHR File No. 2011-00114 and 2011-00231) (**Appendix H**).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of cultural resources are similar to the existing conditions described above. Selection of the No-action alternative would have no effect on cultural resources listed or eligible for listing in the NRHP.

2.2.16 NATIVE AMERICANSEXISTING CONDITIONS

No portion of the proposed project area exists within or adjacent to known Native American-owned lands, reservation lands, or Traditional Cultural Properties. However, Native American groups have lived throughout this region in the past, and their decedents continue to live within the State of Florida and throughout the United States. Pursuant to Section 106 of the National Historic Preservation Act (16 USC 470), obligations regarding USACE Trust Responsibilities to federally-recognized Native American Tribes, and in consideration of the Burial Resources Agreement between USACE and the Seminole Tribe of Florida, prior consultation on the project has not indicated any historic use of the project area.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of Native American groups are similar to the existing conditions described above. Selection of the No-action alternative would have no effect on Native American groups.

2.2.17 PUBLIC SAFETYEXISTING CONDITIONS

Issues of public safety along the beach placement area principally include those typically associated with beach- and water-related recreation, including sun exposure and injuries or drowning from high surf or run-outs. The submerged rock outcrops in shallow water along the shoreline can also result in injuries to bathers. Most public beach parks are staffed by County or municipal lifeguards during periods of normal to high beach use. Crime and related activities are of a low to moderate nature and are not considered to be of a significant nature.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The public safety of the study area is not anticipated to significantly change in the Future Without-Project Condition; however, due to increased erosion and the continued narrowing of the beach, the number of people recreating on the beach is expected to decline and this may affect public safety statistics for this area.



2.3 PHYSICAL ENVIRONMENT (Conditions)

The study area consists of an open sandy coast subject to frequent storm events. Adjacent properties to the shoreline can be categorized as urban and include residential, commercial, and recreational properties. Many factors influence the coastal processes characteristic to the St. Lucie County, Florida shoreline. Factors include winds, tides, currents, waves, storm effects, and sea level rise. Human-related factors include other coastal storm risk management projects, navigation projects, and development. The role of each of these factors and their contribution to beach erosion in St. Lucie County are briefly described in the following paragraphs.

2.3.1 STUDY REACHES

EXISTING CONDITIONS

The area has been delineated into four reaches. The Florida Department of Environmental Protection (FDEP) has designated four erosion reaches in St. Lucie County. The FDEP defines a critically eroded area as “a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost”. The reaches are discussed below:

- North Hutchinson Island (R-77 to R-80): This reach is approximately .57 miles long, with an average erosion rate of -1.8 feet per year. There is no development in this reach and it is entirely within the CBRS unit. This reach is designated as non-critically eroded by FDEP.
- Power Plant Area (R-80 to R-90.3): This reach is approximately 1.9 miles long, with an average shoreline change rate of +0.06 feet per year (slightly accretional). The only structure in the reach is the Florida Power and Light (FPL) Nuclear Power Plant. With the exception of the power plant, the remainder of the reach is entirely within the CBRS unit. This reach is designated as critically eroded by FDEP.
- Narrows of Hutchinson Island (R-90 to R-98): This reach is approximately 1.5 miles long and the average erosion rate is -1.0 feet per year. The area consists of low development within the CBRS unit, with the exception of one excluded area with one condominium development. This reach is designated as non-critically eroded by FDEP.

- South Hutchinson Island (R-98 to R-115 plus 1000 feet): This reach is approximately 3.4 miles long and the average erosion rate is -.4 feet per year. There is a small CBRS unit which ends 600 feet south of R-98, begins again at roughly R-101.5 to R-103.5 (Dollman Park), and then ends for the remainder of the reach. This reach is designated as critically eroded by FDEP.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The reaches will generally remain the same in the future without-project condition.

2.3.2 GEOLOGY

EXISTING CONDITIONS

South Hutchinson Island is part of a chain of sandy barrier islands separated by narrow inlets from Cape Canaveral to Palm Beach. These barrier islands rarely exceed one mile in width or 20 feet in elevation. Separating South Hutchinson Island from the mainland is the Indian River, a shallow lagoon, approximately 2 miles in width. During high seas and storms, the island may be overwashed by the sea, which spreads the sands into the lagoon, forming a fan or delta shape.

Offshore of the beaches and modern barrier islands is the continental shelf. It is a broad, shallow, low relief shelf that extends from 80 miles offshore near Jacksonville, to only a few miles offshore near Miami. The shelf contains relic Pleistocene and Holocene terraces and submerged beach sand ridges. The wave climate and sediment transportation system creates a linear sandy coastline.

The east coast of Florida, from the state line at the Georgia border to Miami Beach (350 miles), consists of a series of sandy barrier islands broken occasionally by inlets. The barrier islands are characterized by dunes and shore parallel beach ridges. Many of the islands display relic beach ridges formed during higher stands of sea level. The barrier islands often have a distinctive drumstick-shape with an accreting bulbous end and a slender eroding end. These barrier islands were formed from waves and longshore currents reworking marine and fluvial sediments. Lagoons and marshes are typically located between the barrier islands and the mainland.

The quartz component of the modern barrier island sand was deposited from sand migrating southward along the Atlantic coast, from the reworking of the Pamlico Sand that was previously deposited over the entire region. The remaining component of coastal sediments are typically carbonates, locally produced by calcite-producing plants and animals. Additional carbonate materials are from reworked materials from outcropping Pleistocene formations offshore (Duane and Meisburger, 1969).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The geology in the future without-project condition would be expected to function and/or change according to the conditions described above.

2.3.3 NATIVE BEACH

EXISTING CONDITIONS

The native beach on South Hutchinson Island was sampled by Coastal Tech in February 2007 to characterize the recent native beach sediments and assess compatibility with the potential sand source material. The project beach area has not previously been nourished. Sixty (60) native beach sediment samples were obtained from R-77, R-80, R-85, R-90, R-95, R-98, R-100, R-105, R-110, and R-115. Samples were collected from the toe of dune, mid-berm, mean high water, mean low water and near the -3-foot contour. Samples were obtained from approximately 5" below the surface (Coastal Tech, 2010). More details can be found in the **Geotechnical Appendix**.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of the native beach are similar to the existing conditions described above.

2.3.4 SAND SOURCES

EXISTING CONDITIONS

Several offshore sand sources were investigated in 2006 by Coastal Planning & Engineering. However, St. Lucie Shoal (designated SL4-R98 during the Sediment Assessment and Needs Determination (SAND) study, 2014) is the main area of focus for this report (see **REF-4**). The shoal is located in Federal water, approximately three to seven miles offshore of the study area, and is comprised of two main parts: the North St. Lucie Shoal and the South St. Lucie Shoal. The North St. Lucie Shoal covers an area of approximately 2 square miles and contains approximately 8.3 million cubic yards of beach-quality material. The South St. Lucie Shoal sand source covers an area of approximately 1.2 square miles. The South St. Lucie Shoal contains approximately 2.3 million cubic yards of beach-quality material.

In general, the beach-quality material encountered within the St. Lucie Shoal consists of olive brown to olive gray, fine to medium-grained skeletal sand with few to some fine-grained quartz and few to some gravel-size shell. More details can be found in the **Geotechnical Appendix**.

Other nearby sand sources have been investigated in recent studies or used in past projects. The "Dade County, FL, Beach Erosion Control and Hurricane Protection Project, Limited Reevaluation Report" investigated SL10-T41 and M4-R105, located about 10 miles from the St. Lucie Shoal. The Martin County Federal project uses sand source SL7-R104. The local St. Lucie County one-time nourishment used SL3-R107 (a portion of St. Lucie Shoals, which is located in State Water).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future, it is possible that this sand source could be mined for sand by another agency or for another Federal project. However, at this time, there are no construction plans by any agency to use it.

2.3.5 SHORELINE CHANGE AND EROSION RATES

EXISTING CONDITIONS

Due to a combination of geographic and natural factors, the St. Lucie County shoreline experiences regions of both erosion and accretion. Based on all available survey data (January 1970 to August 2008), the northern (less developed) portion of the project (R-77 to R-99) experiences an annual erosion rate of -0.31 feet per year, while the southern (significantly developed) portion of the study (R-100 to R-115+1000 feet) experiences an annual erosion rate of -0.18 feet per year. The most developed, southernmost portion of the study which is not in the CBRS unit (R-104 to R-115) has experienced an average annual erosion rate of -0.12 feet per year during this time period. Overall, the study area (R-77 to R-115+1000 feet), has fairly uniform erosion as a whole with an annual erosion rate of -0.26 feet per year.

Prior to the 2004 hurricane season, the northern and southern portions of the project experienced an average annual shoreline change rates of +0.18 feet per year and -0.36 feet per year, respectively. The southernmost portion of the project had an annual shoreline change rate of -0.38 feet per year for the same time period. The overall average annual erosion rate for the same time period was -0.04 feet per year. This indicates that prior to the impact of severe storms, the northern portion of the project experienced mild accretion while the southern portions of the project have been historically erosional.

Both the north and south portions of the project experienced dramatic erosion due to the 2004 and 2005 storm seasons. This has been followed by significant post-storm recovery.

Shoreline erosion is detailed further in the **Engineering Appendix**.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project shoreline profile is assumed to be the 2008 profile (see explanation earlier in this chapter), with erosion until the base year of 2020, and forecasted out to 2070⁹. The shoreline should experience similar rates of erosion and accretion in the future without-project condition as described in the existing conditions section above.

2.3.6 WINDS

EXISTING CONDITIONS

Local winds in the project area are the primary means of generating the small-amplitude, short period waves which are the primary mechanisms of daily (non-storm related) sand transport along the south-central Florida shoreline.

Predominant winds from the east-southeast quadrant are generally mild in nature and occur in the spring and summer months. Elevated wind speeds from the north-northeast quadrant in fall and winter months occur during passage of northeasters which can cause extensive beach erosion and shorefront damage.

⁹ Technically the modeling year started at 2020 as year 1, and therefore 2069 is 50 years is the end of the period of the analysis. However, for planning purposes of this report, 2070 will be the end of Federal participation.

Occasionally the area is impacted by the passage of tropical storms that can generate devastating winds, waves, and storm surge, which can cause direct damage to coastal structures and infrastructure. The **Engineering Appendix** provides additional detail on winds.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of winds are similar to the existing conditions described above.

2.3.7 WAVES

EXISTING CONDITIONS

The wave energy dissipation that occurs as waves enter the nearshore zone and break is the principle driver for sediment transport. Wave height, period, and direction, in combination with tides and storm surge, are the most important factors influencing the behavior of the beach and dune system.

The St. Lucie County study area is exposed to the open ocean toward the northeast. This orientation makes the coastline vulnerable to wave attack from distant storms as well seasonal conditions. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast will produce large swells which are capable of causing erosion along the St. Lucie County shoreline.

Open-ocean swells originating from south of due east are blocked by two large shoals north and west of the Bahamas known as the Little Bahama Bank and the Great Bahama Bank, respectively. Water depths across the Bahama Banks average about 30 feet, so longer-period swells are reduced or eliminated by bottom friction or the presence of land masses as they traverse the Bank. The minimum fetch between the western edge of the Banks and the St. Lucie County study area is about 65 miles, which allows ample distance for the generation of shorter-period wind waves in the deep waters of the Florida Straits. During severe storm events such as hurricanes and tropical storms, high wind velocities can generate large, damaging waves over the relatively short distance between the Bahamas and Florida.

The study area experiences daily (non-storm related) sediment transport due to typical seasonal wave conditions. This results in variable, generally low level, rates of erosion and accretion dependent on incident wave direction and intensity. Prolonged periods of daily erosion can lead to the undermining of structures and roads over time. However, the main cause of damage to the St. Lucie County shoreline and upland development are produced primarily by tropical and extra tropical disturbances, as described above.

The **Engineering Appendix** provides additional detail on waves.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of waves are similar to the existing conditions described above.

2.3.8 ASTRONOMICAL TIDES

EXISTING CONDITIONS

Astronomical tides are created by the gravitational pull of the moon and sun and are well understood and predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for selected locations along the coastlines of the United States and selected locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in the St. Lucie County area are semidiurnal: two high tides and two low tides per tidal day (24 hours 50 minutes). Two measures of tidal range are commonly used: the mean tide range is defined as the difference between Mean High Water (MHW) and Mean Low Water (MLW), and represents an average range during the entire lunar cycle (27.3 days). The range of tidal elevations between successive high and low tides is typically greater at any location during periods of a new or full moon. The spring tide range is the average semidiurnal range which occurs semimonthly when the moon is new or full.

Tide ranges are relatively low along the St. Lucie County region of Florida's east coast. The nearest tide station to the study area is NOAA Tide Station #8722212, located at the Ft. Pierce Inlet south jetty, about 12 miles north of the center of the study area. The mean tide range at this station is found to be 2.56 feet and the spring tide range is 3.59 feet (based on 2010 averages).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of tides are similar to the existing conditions described above.

2.3.9 CURRENTS

EXISTING CONDITIONS

The primary ocean current in the project area is the Florida Gulf Stream. With the exception of intermittent local reversals, it flows northward. The average annual current velocity is approximately 28 miles per day, varying from an average monthly low of 17 miles per day in November to an average monthly high of approximately 37 miles per day in July. The Gulf Stream lies approximately 25 miles offshore of the project area.

The near-shore currents in the project vicinity are not directly influenced by the Gulf Stream, but may be influenced indirectly via interaction with incident waves. Littoral currents affect the supply and distribution of sediment on the sandy beaches of St. Lucie County. Longshore currents, induced by oblique wave energy, generally determine the long-term direction and magnitude of littoral transport. Cross-shore currents may have a more short term impact, but can result in both temporary and permanent erosion. The magnitude of these currents is determined by the wave characteristics, angle of waves from offshore, local tides, configuration of the beach and the nearshore profile. For St. Lucie County beaches, the net sediment transport is from north to south.

Influence of Ft. Pierce Inlet and St. Lucie Inlet ebb and flood currents on local currents is negligible. In both cases the distance between the inlet and the project area (8 miles and 7 miles, respectively) places the study area outside the influence of inlet tidal fluctuations.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

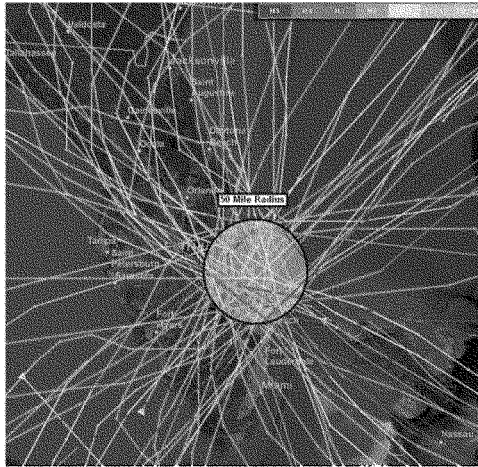
The future without-project conditions of currents are similar to the existing conditions described above.

2.3.10 STORM EFFECTS

EXISTING CONDITIONS

The study area is located in a region of considerable hurricane activity, resulting in relatively frequent hurricane impacts. **Figure 2-5** shows historic tracks of hurricanes and tropical storms from 1851 to 2010, as recorded by the National Hurricane Center (NHC) and available from the NOAA website. The circle in the center of this figure indicates a 50 mile radius from the center of the study area. Based on NHC records, 55 hurricanes and tropical storms have passed within this 50-mile radius over the 159-year period of record, averaging one storm every 2.8 years.

The 50-mile radius was chosen for display purposes because any tropical disturbance passing within this distance, even a weak tropical storm, would be likely to produce some damage along the shoreline. Stronger storms are capable of producing significant damage to the coastline from far greater distances. For example, Hurricane Andrew made landfall in southern Dade County in 1992 as a Category 5 storm. This storm produced significant coastal erosion along St. Lucie County, over 120 miles north of the storm track.

Figure 2-5. Hurricanes within 50 miles radius of St. Lucie over 159-year period.

In recent years, a number of named storms have significantly impacted the project area, including hurricanes Mitch (1998), Irene (1999), and Tropical Depression #4 (2000). However, the most severe storm events in recent years are due to the multiple storms of the 2004 and 2005 hurricane seasons. In August 2004 the study area was impacted by hurricane Charley, followed by Hurricanes Frances, Jeanne, Ivan, and a strong northeaster in September 2004. Of these storms, Hurricanes Frances and Jeanne were considered to be 100-year storm events, and caused considerable erosion along this coastline. Hurricanes Frances and Jeanne made landfall only three weeks apart and within 2 miles of each other. This season marked the first time that Florida (or any individual state) has been impacted by four hurricanes in one tropical season since weather records began in 1851. In 2005 the St. Lucie County area was again impacted, by Hurricanes Dennis (July), Katrina (August), Ophelia (September), Rita (September), and Wilma (October).

Damages to coastal storm risk management projects from these combinations of storms in 2004 and 2005 included substantial erosion and damage from wind, wave, and water action beyond that which would ordinarily be expected by an individual storm. This is due, in part, to the fact that protective beach fill initially moved offshore by a storm did not have ample time to return onshore before the beach was impacted by the next storm. The large size of these hurricanes also contributed to damage levels along the St. Lucie County coastline as several storms inflicted damages far from their landfall points.

Since the study area is exposed to the open ocean toward the northeast, the coastline is vulnerable to wave attack from distant storms as well. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast are capable of producing large swells which are capable of causing erosion along the study area, within the St. Lucie County shoreline.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of storm effects are similar to the existing conditions described above.

2.3.11 STORM SURGEEXISTING CONDITIONS

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure which accompanies storms also contributes to a rise in water surface elevation. The combination of extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong northeasters) can produce very high, damaging water levels. In addition to wind speed, direction and duration, storm surge is also influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An estimate of storm surge is required for a complete assessment of shoreline response and coastal storm risk. An increase in water depth may increase the potential for coastal flooding and allow larger waves to attack the shore.

The study area is a low, flat barrier island and is particularly susceptible to overtopping from storm surges. Topographic surveys show that much of the island is less than 5 feet in elevation. Maximum elevations of 10-15 feet occur, but are almost exclusively along the oceanfront dune line. A series of existing hurricane storm-surge maps have been produced by the Florida Division of Emergency Management of all of Florida's coastal counties.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of storm effects are similar to the existing conditions described above.

2.3.12 SEA LEVEL CHANGEEXISTING CONDITIONS

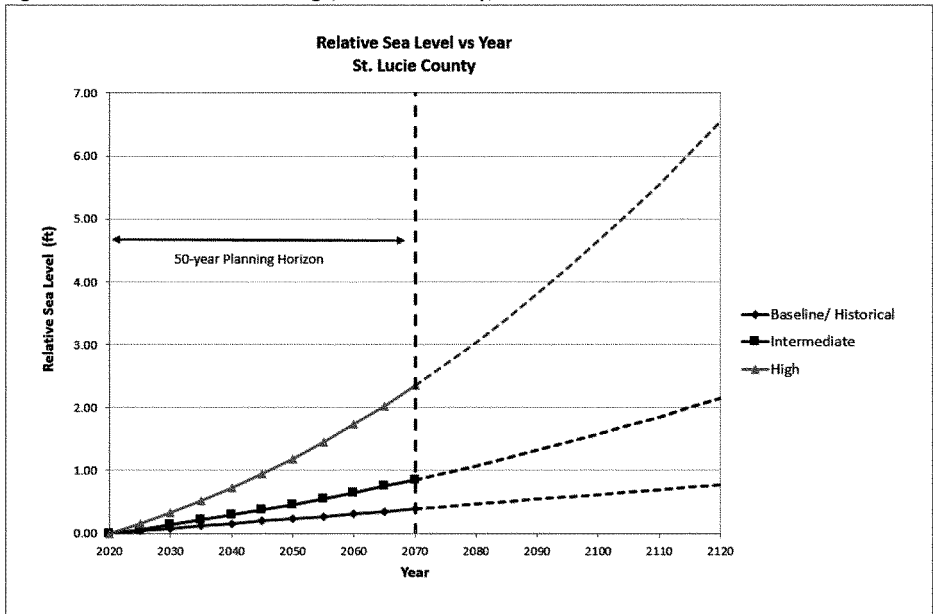
It is anticipated that the global mean sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of Engineering Regulation, ER 1100-2-8162 and Engineering Technical Letter (ETL) 1100-2-1. Three estimates are required by the guidance, a Baseline (or "Low") estimate, which is based on historic sea level rise and represents the minimum expected sea level change; an Intermediate estimate; and a High estimate representing the maximum expected sea level change.

The study area is located approximately 101 miles from the NOS gage #8723170 at Miami Beach, Florida, and approximately 132 miles from NOS gage #8721120 at Daytona Beach Shores, Florida. Due to the distance, the historic sea level change at St. Lucie was approximated by a linear interpolation between the Miami and Daytona gages. The resulting averaged historical sea level change rate for St. Lucie County then equals 2.36 mm/yr. Given a project base year of 2020 a table of sea level change rates was produced for each of the three required scenarios through the 50-year period of analysis and up to the year 2120. Additional detail on sea level change is provided in the Engineering Appendix.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Figure 2-6 provides a graphic representation of the three levels of projected future sea level change over a 100-year period. The project area can expect to see sea level rise .4 to 2.2 feet above its current position within the 50-year period of analysis as predicted by the low and high sea level change rates, respectively.

Figure 2-6. Relative sea level change, St. Lucie County, FL.



2.3.12.1 SHORELINE CHANGE RESULTING FROM SEA LEVEL RISE

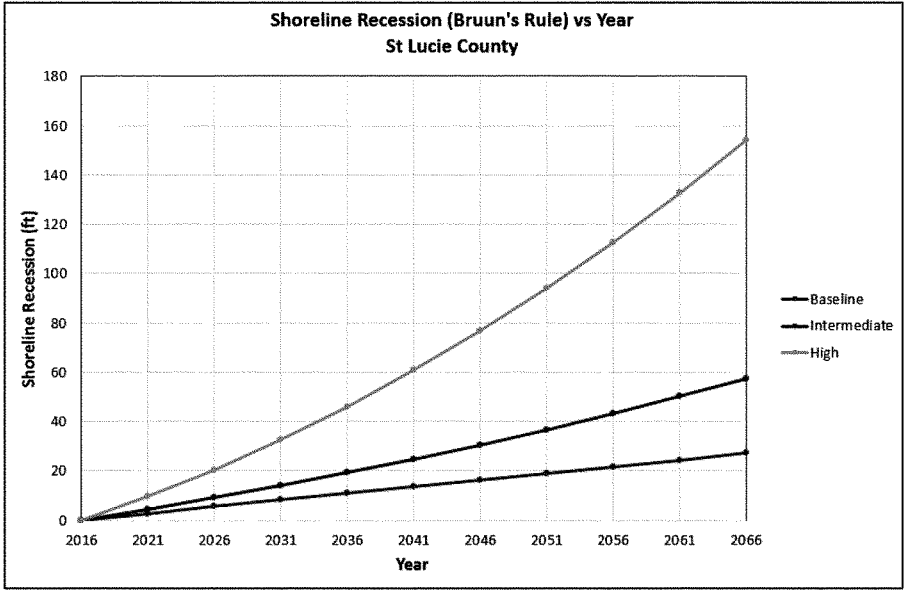
An estimate of the rate of shoreline recession can be based on the local rate of sea level change in some cases. With a change in sea level, the beach profile will attempt to reestablish the same bottom depths relative to the surface of the sea that existed prior to sea level change. That is, the natural profile will be translated upward and shoreward to maintain equilibrium. If the longshore littoral transport in and out

of a given shoreline is equal, then the quantity of material required to re-establish the nearshore slope must be derived from erosion of the shore.

The above estimation is applicable to long straight sandy beaches with an uninterrupted supply of sand and should only be used for estimating long-term changes. Additional detail is given in the **Engineering Appendix**.

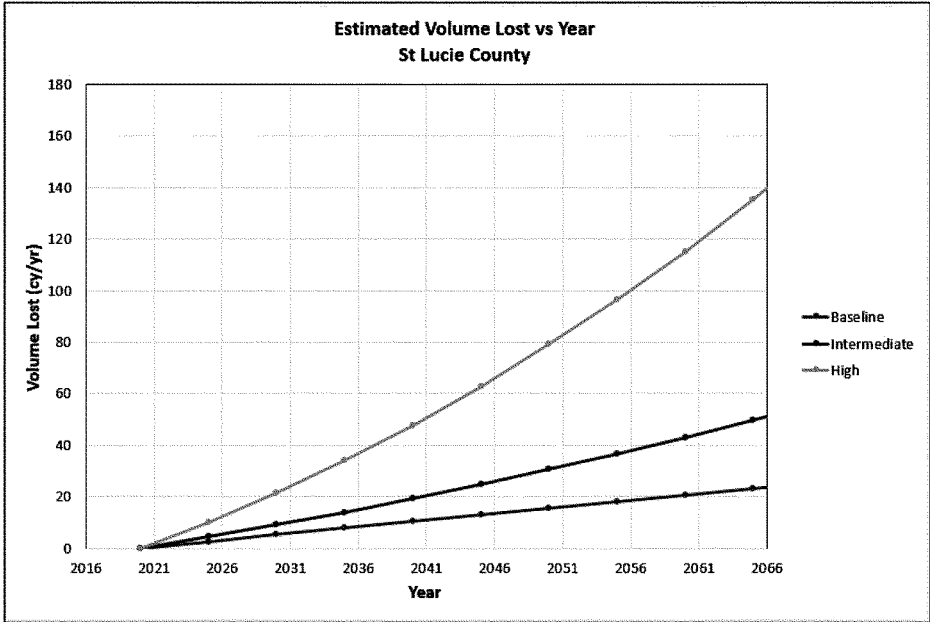
Figure 2-7 provides an estimate of the potential shoreline changes within the project area attributable to projected changes in sea level.

Figure 2-7. Estimated shoreline recession rate due to sea level rise.



2.3.12.2 VOLUMETRIC CHANGE RESULTING FROM SEA LEVEL RISE

Engineering Manual (EM) 1110-2-3301 (USACE, 1995) gives guidance on how to calculate beach volume based on berm height, depth of closure, and translation of the shoreline (in this case, shoreline recession). Figure 2-8 provides an estimate of the shoreline volume loss as a result of the three Sea Level Rise scenarios.

Figure 2-8. Estimated volume lost per year due to sea level rise.

2.3.12.3 INCORPORATION OF ER 1100-2-8162 AND ETL 1100-2-1: GUIDANCE FOR SEA LEVEL CHANGE

The Sea-Level Change (SLC) Engineering Technical Letter (ETL) 1100-2-1 supporting ER 1100-2-8162, suggests a tiered analysis to determine the risk of potential SLC and resulting incorporation into the plan formulation process. Incorporation of potential SLC into the USACE Planning process will require active focus on risk-based scoping to define pertinent needs, opportunities, and the appropriate level of detail for conducting investigations. In particular, close attention is needed at the beginning of each study in order to screen planning/scoping decisions. The tiered analysis for SLC is incorporated into the 6-step planning process used in this report. Mean Sea Level (MSL) is used as an elevation reference in this section of the report as it is generally more intuitive for readers when describing changes to existing water elevations.

In order to evaluate SLC impacts to infrastructure, critical resources, and the population residing in the study area, a qualitative matrix was developed in **Table 2-5**, which evaluates the resources on which the study area depends. Resources evaluated in the matrix were based on those identified by the USACE Coastal Systems Portfolio Initiative (CSPI). CSPI describes the resource risk in a project area relative to the density of the resource, the population density that the resource serves, or in the case of environment/habitat and recreation, the value placed on the resource. See <http://navigation.usace.army.mil/CSPI> for more information. The evaluation criteria shown in the table

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is from, *Technical Review of Coastal Projects: Storm Risk Management, Navigation and Ecosystem Restoration for Nation's Coastlines* (USACE, Spring 2012.)

In addition to the CSPI evaluation criteria, **Table 2-5** evaluates the vulnerability to resources from potential SLC, or Sea Level Rise (SLR) in the case of the study area. Averaging the “Vulnerability from SLR” to resources gives an average of 1.7, equating to a low to medium overall resource vulnerability within the 50 year period of analysis.

Table 2-5. Qualitative Matrix describing vulnerability of resources from potential accelerations in SLC (50 year period of analysis, base, intermediate, and high SLC scenarios).

Resource	Risk Rating from CSPI - Value or density of resource or dependent population (3=high, 2=med, 1=low, x=none present)	Description	Vulnerability from SLR (3=high, 2=medium, 1=low, x=none present)	Description
Residential/Commercial Structures	2	Mostly residential (condominiums). Most ground floor elevations of structures are built on the existing ground level elevation, roughly 4.5 feet NAVD88. Most ground floor elevations with the Tentatively Selected Plan (TSP) area are approximately 4.5 feet NAVD88.	2	Projected high SLC would place Mean Sea Level (MSL) near infrastructure within the 50 year year planning horizon. Typical storm tide expected in the 50 year planning horizon was reported to be +8.6 feet NAVD88 (FDOT, 2003). This indicates that the high SLR scenario combined with the potential 8.6 foot of storm tide could reach the top of the dune.
Environmental and Habitat	3	Beach/dune habitat. Fairly narrow steep beach backed by dune which averages 11.5 feet high NAVD88.	2	Beach berm and dune system is located between 5 and 11.5 feet NAVD88 throughout the study area. Sub aerial habitat is located throughout this system.
Infrastructure (roads, water/sewer lines, boardwalks, navigation structures)	2	Water/sewer lines, septic tanks, and dune walkovers exist. State Road A1A is located at an average of 5 feet NAVD88 throughout the study area and TSP area. Most other infrastructure would not be impacted until water level, including storm surge, reached above this point.	1	See explanation for State Road A1A in Evacuation routes. Other infrastructure is located at or above this elevation is also adequately elevated. Wooden boardwalks have portions lower than this elevation and are more subject to damage. However, they are not high value or critical infrastructure.
Critical Facilities (police, fire, schools, hospitals, and nursing homes)	3	FPL Power Plant is located in northern portion of study area; however, it is not within the TSP area.	2	The most critical facility (FPL) is elevated 20 feet and would remain above MSL under any SLC scenario. Additionally, the power plant is not in the TSP area.
Evacuation routes	3	State Road A1A is the main north/south evacuation route, located approximately 5 feet NAVD88 within the TSP area.	2	State road A1A is set back from the shoreline by a minimum of approx. 350 feet. In the TSP area, in some locations it is roughly midway between the ocean side and marsh side; in other areas, it is buffered by both the offset to the shoreline and marsh. It could be potentially affected under the high SLC scenario past the 50 year horizon, or as a result of the high storm tide plus high SLC on the ocean side towards the end of the 50 year planning horizon.
Recreation	3	Reasonable recreational use of beaches.	1	Beach berm is between 5 and 11.5 feet NAVD88 throughout the study area. Recreational use of beach is high around public access points.
Average =			1.7	Low to Medium Vulnerability

PROJECT VULNERABILITY TO SLC

Upland elevations within the study area (Atlantic Ocean side of the island) average approximately 4.5 ft-NAVD88. These uplands are fronted by a dune system with an average elevation of 11 ft-NAVD88 over a majority of the project area (R-98 to R-111). South of R-111 (R-112 to the county line), however, the average dune elevation rises to 13 ft-NAVD88. Elevations on the marsh side of the island also average approximately 4.5 ft-NAVD88. Although the marsh side of the island is not within the current study area, stakeholders should be aware of increased risk to infrastructure as sea level rises. Based on lidar topographic survey data, contoured over the barrier island between R-77 and R-115, key cross-island ground elevations were identified. **Table 2-6** provides the key ground elevations according to R-

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monument and grouped by similar shoreline dimensions (see the **Engineering Appendix** for details on profile groupings).

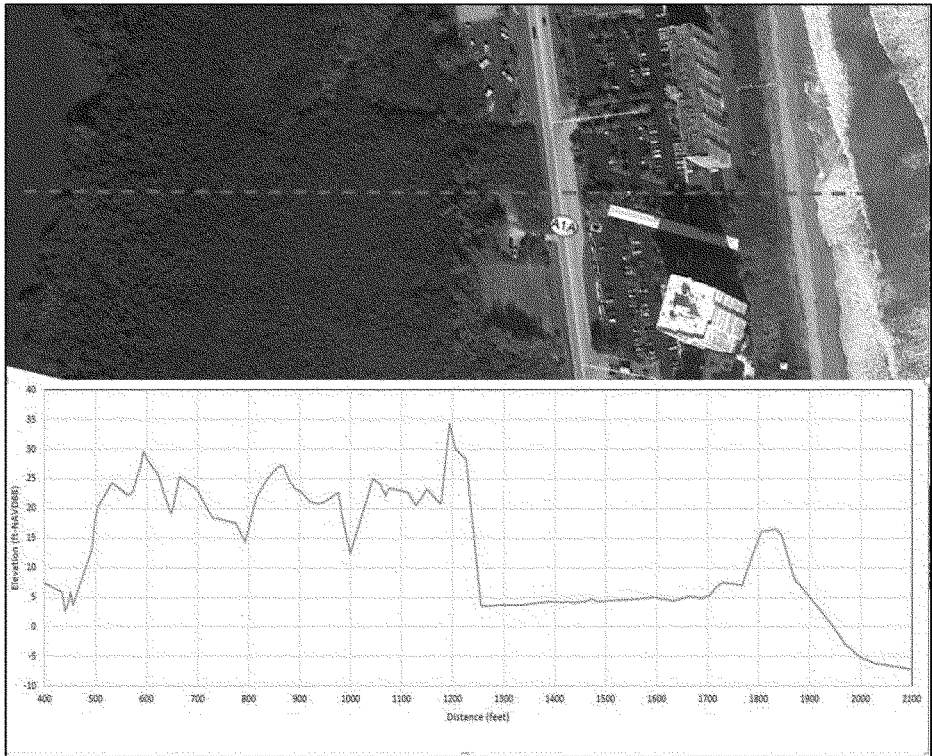
Table 2-6. Key Elevations Along Cross-Island Profiles.

R-Monument	Ground Elevations (feet-NAVD88)			
	Average Dune Elevation	State Road A1A	Atlantic Side Structures	Marsh Side Structures
77-80, 84-102	11	4.5	4.5	4.5
81-83	13	4.5	5	4.5
103-104	11	5	5	5
105-106	11	5	3	5
107-110	11	5	3	5
111	11	5	6	4.5
112	14	5	5	5
113-115	13	5	5	5
Average for Study Area (R-98 to R-115)	11.5	5.0	4.5	4.5

A representative island profile, taken in the vicinity of R-107, is shown in **Figure 2-9**. Note that the topographic survey from which the profile was drawn was not “bare earth”. Therefore elevations include vegetation and structures. The profile was positioned to avoid structures, but vegetation is evident, particularly on the marsh side. The ground elevations in **Table 2-6**, determined from full contour plots, are the most representative of the project area.

The width of the barrier island varies over the length of the project. Typically the marsh side of the island is fronted by an expanse of heavy vegetation. In some regions, however, development extends from seaside to marsh side.

A key question when assessing the vulnerability of the study area to SLC is when critical elevation based thresholds related to flooding or other project objectives will be reached and exceeded. Throughout the study area, the dune crest height represents a critical elevation threshold. The average dune height from **Table 2-6** is 11.5 ft-NAVD88. SR A1A and other infrastructure are located at a lower elevation, approximately 4.5- to 5.0 ft-NAVD88. Since the dune lies between the ocean and infrastructure, the dune height will be the ocean side critical elevation.

Figure 2-9. Cross-island Profile in the Vicinity of R-107.

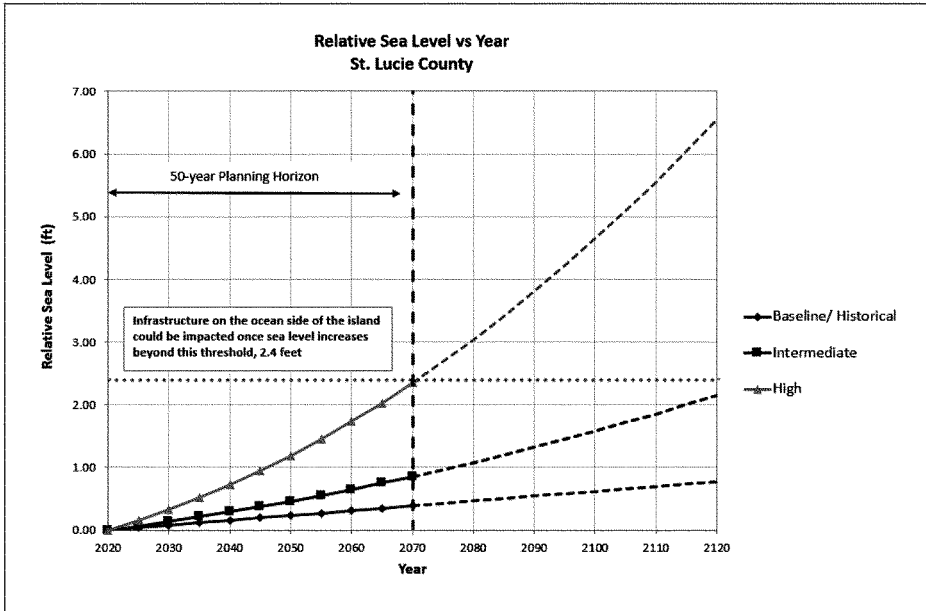
The 50-year storm tide elevation for the study area has been determined to be +8.6 ft-NAVD88 (FDOT, 2003). Water elevations during such storm events will reach the top of the dunes once sea level increases by 2.4 feet (8.6 feet of storm tide + 2.4 feet of SLC = 11 feet) (between R-98 to R-111). Because overtopping of the dune north of R-111 would cause flooding over the full extent of the project, the higher dune crests (R-112 to county line) are not considered to have any preventative significance against inundation due to SLC (although they still contribute to reducing damages due to wave attack and erosion).

The average dune crest critical elevation has been defined in terms of a relative sea level rise target of 2.4 feet for comparison to multiple scenarios.

Figure 2-10 shows the elevation-time trajectories developed for the three SLC scenarios as net change in sea level, versus the project performance target of 2.4 feet. The plot shows that the 2.4-foot sea level change threshold is only exceeded with the High SLC scenario in year 50. Adaptive measures designed to

maintain performance above 2.4 feet of sea level rise may be triggered should relative sea level increase approaches 2.4 feet.

Figure 2-10. Threshold Vulnerability on the Ocean Side of the Island.



Reference: Florida Department of Transportation (FDOT), 2003. "Design Storm Surge Hydrographs for the Florida Coast", University of Florida, Gainesville, Florida.

PROJECT ADAPTABILITY

General

Sea level change is a growing concern in coastal regions of the United States. It is therefore necessary to ensure that coastal projects are adaptable to changing conditions. Constructing or elevating shoreline structures (seawalls, revetments, groins, etc.), raising dunes, floodproofing infrastructure, and implementing storm warning and evacuation plans are some types of coastal adaptation methods.

Assessing adaptation requirements of the project most often requires considering SLC impacts to the project beyond the 50 year period of analysis (as shown previously in **Table 2-8**). **Table 2-7** provides an alternative qualitative view of project vulnerability by updating **Table 2-5** for an extended 100 year Horizon.

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Table 2-7. Qualitative Matrix describing vulnerability of resources from potential accelerations in SLC (100 year period of analysis, base, intermediate, and high SLC scenarios).

Resource	Risk Rating from CSPI-Value or density of resource or dependent population (3=high, 2=med, 1=low, x=none present)	Description	Vulnerability from SLR (3=high, 2=medium, 1=low, x=none present)	Description
Residential/Commercial Structures	2	Mostly residential (condominiums). Most ground floor elevations of structures are built on the existing ground level elevation, roughly 4.5 feet NAVD88. Most ground floor elevations with the TSP area are approximately 4.5 feet NAVD88.	2	No change from 50 year Planning Horizon: Although High SLC is projected to reach the top of the dune near the end of the 50 year planning horizon and exceeds the elevation of the average dune from the first 50 year period to the end of 100 year horizon, the dune can be raised with the addition of material or with the introduction of elevated "hard" structures such as revetments or seawalls. Due to the adaptability of the dune (raised or armored), the vulnerability from SLC remains unchanged over the full 100 years. The likelihood that the structures themselves will require direct adaptation is low.
Environmental and Habitat	3	Beach/dune habitat. Fairly narrow steep beach backed by dune which averages 11.5 feet NAVD88 high.	3	Increased vulnerability: The existing dune system will become submerged near the 50 year mark of the 100 year horizon for the high SLC scenario. While the berm will elevate naturally in response to rising seas and the dune may be raised with the placement of additional of material, it may become cost prohibitive to maintain a "natural" shoreline favorable as habitat under increasing adverse conditions (rising water levels, increased wave energy, more frequent storms). The increasingly adverse conditions along with the introduction of "hard" structures such as revetments and seawalls in response to SLC will have a dramatic impact to shoreline habitat.
Infrastructure (roads, water/sewer lines, boardwalks, navigation structures)	2	Water/sewer lines, septic tanks, and dune walkovers exist. State Road A1A is located at an average of 5 feet NAVD88 throughout the study area and TSP area. Most other infrastructure would not be impacted until water level, including storm surge reached above this point.	3	Increased vulnerability: Currently water/sewer lines are susceptible to storm surge on a short term basis (the duration of the surge). Outflows and sub-surface water levels are not protected by the elevation of the dune (i.e. raising the dune will offer little mitigation from impacts of SLC). Short term flooding due to storm surge will increase throughout the 100 year horizon. Additionally as projected SLC elevations exceed these infrastructure independent of storm activity, flooding will become chronic without significant structural changes. A1A and other infrastructure are less susceptible as SLC impacts can be mitigated by raising the dune rather than by adapting the structures directly.
Critical Facilities (police, fire, schools, hospitals, and nursing homes)	3	FPL Power Plant is located in northern portion of study area; however, it is not within the TSP area.	2	No change from 50 year Planning Horizon (due primarily to existing elevation)
Evacuation Routes	3	State Road A1A is the main north/south evacuation route, located approximately 5 feet NAVD88 within the TSP area.	2	No change from 50 year Planning Horizon. The vulnerability of A1A remains tied to the elevation of the dune. It is assumed that the dune will be raised or a seawall with adequate elevation will be placed in order to protect critical infrastructure. The likelihood that A1A itself will require adaptation does not change between the 50 year mark and the end of the 100 year Planning Horizon.
Recreation	3	Reasonable recreational use of beaches.	2	Increased vulnerability: Similar to Environment and Habitat, natural elevating of the berm in response to rising seas and raising of the dune may become prohibitively costly under increasing adverse conditions (rising water levels, increased wave energy, more frequent storms). In the event that "hard" structures such as seawalls and revetments are introduced, natural erosion exacerbated by wave reflection will remove a significant portion of what would be recreational beach. Recreational use of the beach would be reduced.

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Dune Raising

For the St Lucie CSR project, the most efficient and (currently) environmentally acceptable means of adapting the project is to raise the crest elevation of the existing dune. The active portion of the shoreline profile, the berm and foreshore, will adjust naturally with rising tide levels. The dune, however, will require additional material to raise its elevation.

Based on the high sea level change curve, a 50-year storm surge will begin to exceed the St Lucie lowest project dune crest elevation near the year 2070 (the end of the 50-year period of analysis). By the end of the 100-year period of analysis, the high sea level curve predicts that existing dune crest will be overtopped by approximately 4.1 feet. Within the 100-year period of analysis, a 100-year storm surge might be considered. The 100-year surge, +9.6 ft-NAVD88 would exceed the existing dune crest by 5.1 feet by the end of 100-year period of analysis.

While the existing dune elevation is adequate to prevent overtopping from a 50-year storm surge through the 50-year period of analysis, to adapt the project to resist overtopping from the same surge through the 100-year period of analysis, it would be necessary to raise the crest to a minimum elevation of 15.1 ft-NAVD88. To resist overtopping from the 100-year surge, the crest would need to be raised to a minimum of 16.1 ft-NAVD88. Due to construction tolerances these elevations would be rounded up to the nearest half of a foot or 15.5 ft-NAVD88 and 16.5 ft-NAVD88, respectively.

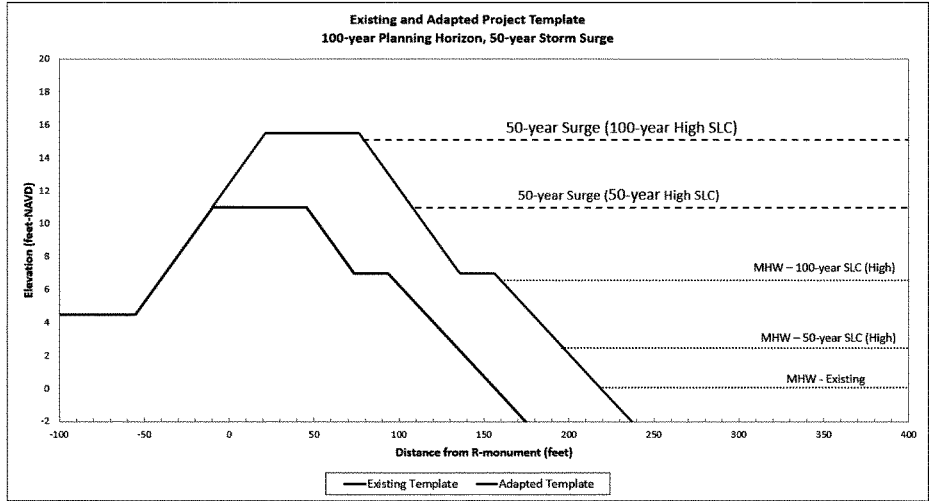
Although dune raising is outside of the current project authority, with an approved decision document this adaption is physically feasible within the planning period and may be assessed in the future if sea level rise approaches the critical elevation threshold of 2.4 feet. Dune raising extends the dune's footprint seaward, rather than landward, ensuring that there is sufficient land/real estate to make the adaptation without interfering with upland infrastructure (**Figure 2-11**). Based on design profiles, it is estimated that raising the dune to 15.5 feet would require approximately 700,000 cubic yards of material. Raising the dune to 16.5 feet would require approximately 1,000,000 cubic yards. While dunes of this elevation occur throughout the coastal regions of eastern Florida, dune elevations directly adjacent to the project have elevations nearer to the existing dunes. Therefore, while raising the dune over the length of the project would provide increased protection from wave and erosion damage, infrastructure behind the dunes would still be vulnerable to indirect flooding from adjacent areas.

Hard Structures

Presently hard structures such as seawalls and revetments are prohibited in St Lucie County. This is due to the fact that such structures can lead to increased erosion of the berm and foreshore due to wave reflection and have an adverse impact to sea turtle and shore bird habitat. However, if sea level change follows the high sea level curve, environmental and aesthetic concerns may become secondary to the protection of upland infrastructure and the increased risk to human life.

If hard structures are permitted in the future, it is feasible that previously screened out alternatives would become viable and possibly cost effective.

Figure 2-11. Existing and Adapted Project Profile.



Floodproofing

Dune raising and/or the introduction of revetments or seawalls are adaptations that deal directly with the shoreline feature (dune system) that provides the maximum level of protection from inundation, erosion, and wave damage. Much like an inland levee, the dune system provides a single continuous barrier between the water and the land.

Flood proofing also consists of a type of barrier. However, floodproofing solutions apply localized barriers (new construction, sealing/waterproofing existing structural elements, and/or raising lower elevation structures) to individual structures. Depending on the density of infrastructure in the upland, floodproofing can be logistically challenging and expensive. Different structure types would require different floodproofing solutions. Because it is assumed that sea levels would be allowed to overtop the dune and flood the general project site, each solution would also require a design that resists failure due to erosive undermining and from direct wave attack. Projects where the density of upland structures is low would have less logistical and cost concerns, but would still require individual specialized design.

In addition to logistics and cost, peripheral damages must also be considered. If the general project site is allowed to be inundated by seas overtopping the dune some “structures” would likely remain highly vulnerable despite floodproofing. These include roads, walkways, boardwalks, utility posts/boxes/outlets, and other structural features that would be difficult or not cost effective to floodproof individually. Peripheral damages would also include landscaping, park lands, open habitat, and other non-structural, but important community upland features.

It should also be noted that floodproofing predominantly safeguards against direct physical damage to structures. This alternative does not consider potential risks to human life due to flooding in the vicinity of the protected structures. It is recommended that this alternative be combined with a storm warning and evacuation system specifically designed for expected SLC.

Storm Warning and Evacuation Plans

Development or improvement of storm warning and evacuation plans is not a standalone alternative. While the development and implementation of site specific storm warning systems and evacuation plans can be costly, there are no traditional benefits by which to offset those costs. Note that traditional benefits depend predominantly on physical damages to property. However, the development and implementation of such storm warning and evacuation plans could have a significant impact on safeguarding human life. Combined with an alternative that produces traditional benefits, this alternative could be justified for a Federal project.

Assessment of Potential Adaptation Paths

As discussed in previous sections, not all methods of adaptation are equal when applied to combating the impacts sea level change (SLC). Some are more effective than others and are more complete or acceptable. **Table 2-8** provides a qualitative assessment to the potential adaptation paths that could be applied to the St Lucie CSRM Project.

Table 2-8. Qualitative Assessment of Adaptation Paths.

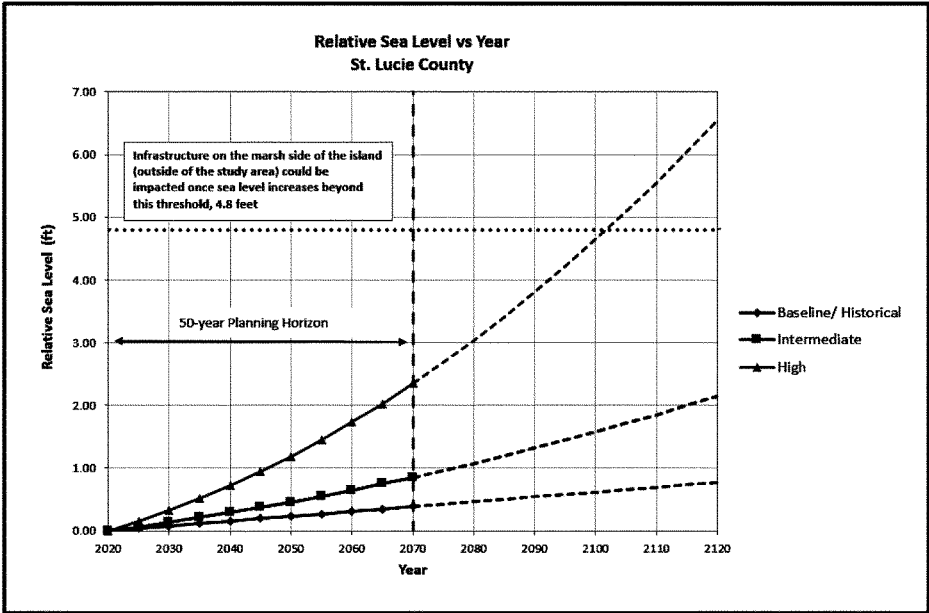
Measure	Effectiveness	Efficiency	Completeness	Acceptability
Dune Raising	High	High	High	High
Hard Structures	High	High (Medium, if the structure is non-continuous with gaps)	High (Medium, if the structure is non-continuous with gaps)	Low (may change if damages outweigh environmental concerns)
Flood Proofing	Medium (limited to certain structure types and only effective for inundation)	Medium (limited to specific structures)	Low (Vulnerable to wave attack and erosion, peripheral damages)	Low (limited benefit, peripheral damages, prohibited in high hazard flood zones)
Storm Warning and Evacuation Plans	Low (When applied only to traditional damages; rating does not include risk to human life)	Low (does not address inundation, wave attack, or erosion)	Low (does not affect traditional damages)	Low (limited benefit unless combined with another alternative)

EXTERNAL VULNERABILITY

ETL 1100-2-1 recommends that systems related to, but existing outside, the study area should also be evaluated for vulnerability to SLC. The marsh side of the island does not contain any critical infrastructure on which the study area depends, such as hospitals or emergency services. This analysis only brings attention to the vulnerability of the marsh side of the island for stakeholder knowledge.

Infrastructure on the marsh side is generally built at approximately 4.5 ft-NAVD88. Tidal range on the marsh side of the island is smaller than the ocean side. Mean Higher High Water (extreme high tide) is -0.28 ft-NAVD88 on the marsh side (+0.28 ft-NAVD88 on the ocean side). For comparison, a critical elevation threshold is defined in terms of potential sea level change over the 100 year planning period. Factoring in extreme high tide, infrastructure could be periodically impacted once sea level increases by about 4.8 feet (-0.28 feet + 4.8 feet = 4.5 feet). At the end of 50 years, sea level is not expected to rise as much as 4.5 feet for any of the SLC scenarios (Figure 2-12). Projected out 100 years, only the High SLC scenario predicts levels exceeding 4.8 feet (between the years 2100 and 2105). In such a case, infrastructure on the back side of the island would be impacted during higher high tide events, dependent on current and future construction to protect against elevated water levels such as seawalls and bulkheads. The marsh side of the barrier is not within the project area. Any adaptation to mitigate SLC will be under the authority of local governments.

Figure 2-12. Relative SLC Critical Elevation Threshold versus SLC scenarios on Marsh Side of the Island.
Reference: Florida Department of Transportation (FDOT), 2003. “Design Storm Surge Hydrographs for the Florida Coast”, University of Florida, Gainesville, Florida.



2.3.13 EFFECTS OF OTHER COASTAL STORM RISK MANAGEMENT (CSRM) AND NAVIGATION PROJECTS

EXISTING CONDITIONS

OTHER CSRM PROJECTS

To date, no Federal large-scale beach projects have been constructed along the study area (R-77 to R-115). However, several Federal beach fill placements have been made on either side of the study area.

To the north of the study area, several large-scale placements of material have been made under the authority of the Federal coastal storm risk management projects at Ft. Pierce, with the Ft. Pierce Shore Protection Project (SPP). Additionally, numerous placements of smaller volumes of material dredged from the Federal navigation project at Ft. Pierce Inlet have been made along this same reach of shoreline over the past 26 years. These two Federal projects result in the periodic placement of large volumes of material along the shoreline about 12 miles north of the study area of this report. Due to the predominant southward littoral transport of material along this region of coast, these fill placements may provide indirect nourishment of the study area.

South of the study area, the Martin County Shore Protection project extends from Stuart Public Beach Park (R-25) northward to the Martin County/St. Lucie County line (R-1), which is the southern limit of this study. Material placed along northern Martin County near the county line can be transported northward from the fill area by diffusion (end) losses, and may provide a source of nourishment along the southernmost reach of the St. Lucie County study area.

In addition to the large-scale Federal projects at Ft. Pierce and Martin County, several small-scale shore protection projects have been implemented along the study area. In 1990, a beach-scraping project was performed along the southern reach of the project. Several privately-funded shore protection measures have also been constructed in front of individual properties.

Each of the various projects as mentioned above is described in more detail in the **Engineering Appendix**.

OTHER NAVIGATION PROJECTS

Ft. Pierce Inlet is a Federal navigation project located in northern St. Lucie County in the proximity of R-33 and R-34. Following completion of the initial dredging of the Ft. Pierce navigation project by local interests in 1930, severe scouring occurred along the channel across the Indian River, leading to an increase in the volume of littoral material and a resulting pattern of accretion along most of the shoreline adjacent to the inlet. After the inlet channel stabilized (1930-1935), erosion began to occur along the shoreline south of the inlet. Research conducted in support of the Ft. Pierce SPP has determined that there is no evidence that the inlet has significantly affected sediment transport processes further south of the inlet than 14,000 feet (R-48) (USACE, 2000).

St. Lucie Inlet is a Federal navigation project located in northern Martin County (just south of St. Lucie County) in the proximity of R-44 and R-45. Initially excavated in 1892, St. Lucie Inlet separates Hutchinson Island to the north and Jupiter Island to the south. The introduction of a north jetty in the late 1920 worsened erosional patterns already present due to construction of the inlet. The north jetty trapped

south moving sand, stabilizing the northern shoreline (southern Hutchinson Island) while causing shoreline erosion on Jupiter Island. Due to the predominantly southern transport of material, inlet impacts are to the south of the inlet channel, along approximately 5.8 miles of Jupiter Island shoreline (FDEP, 1995).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The future without-project conditions of other CSRM and navigation projects are similar to the existing conditions described above.



2.4 BUILT ENVIRONMENT

2.4.1 HURRICANE EVACUATION ROUTES AND ZONES

EXISTING CONDITIONS

National Scenic Highway, Florida State Road A1A (SR A1A), is the only evacuation route for the region and a major north-south thoroughfare for the area.

For the 4 reaches in study area, this highway is a major evacuation route, but is set back from the shoreline to avoid damages in most instances. The Florida Department of Transportation (FDOT) maintains this road and has not expressed interest or need for a Federal project.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future without-project condition the FDOT would continue to operate and maintain A1A.

2.4.2 PAST LOCAL PROJECT

EXISTING CONDITIONS

The St. Lucie County Erosion District completed a one-time local nourishment in 2012/2013 due to 4 severe storms which impacted the area in 2004/2005, as well as 2012. The project from R-87.7 to R-90.3 and R-98 to the St. Lucie/Martin County line at R-115+1000 feet, consisting of a beach fill and dune

restoration, for a total of 658,654 cubic yards of material (initially 485,900 cubic yards and modified to include an additional 172,754 cubic yards due to severe storm erosion near the time of construction). The EIS found that the project would impact .57 acres of hardbottom habitat.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Although the sponsor has built a one-time project in this location in the past, there is a need for the Federal government to construct a project over a 50 year period of Federal participation. Based on conversations with the non-federal sponsor, the future without-project condition is that the sponsor would not build another large fill project, as was performed in 2012/2013. The local project in 2012/2013 was constructed due to extraordinary hurricane events, as well as an opportunity in cost sharing with state funding, with the knowledge that it was a one-time project and that a project with Federal partnership was in progress. The letter sent in 2006 from USACE, Deputy Director of Civil Works, confirms the sponsor's intent. The information below supports the future without-project assumptions.

1. Funding Constraints: Funding for this one-time non-federal local beach and dune project included three funding sources: State funding at 43%, Erosion District Zone E reserve funding at 23% and Special Assessment District (property owners) funding at 34%. The large contribution by the state was crucial and is unlikely to occur again in the future. Additionally, St. Lucie County has other competing Federal project funding commitments (Ft. Pierce), and it is very unlikely that local contributions could occur in this capacity again.

2. Federal commitment: The Feasibility study began 2000, with Feasibility Cost Sharing Agreement (FCSA) signed in 2004, signaling Federal involvement. The area was hit by Francis and Jeanne in 2004, followed by Wilma in 2005, and the level of protection within the study area was severely compromised. There was an urgent need to do one-time project, with the knowledge that the Federal process would be time intensive.

3. Coordination, Effort and Timeframe: The planning for the local project was initiated in 2006. After numerous meetings, workshops and public hearings, the Board approved several actions on October 2, 2012, including the award of a construction contract for the project. Construction was complete in April 2013.

2.4.3 PUBLIC ACCESS AND PARKING

EXISTING CONDITIONS

Federal participation in CSRM projects involving placement of sand is limited to shorelines open to public use. Guidance is provided in Engineering Regulation (ER) 1105-2-100 and ER 1165-2-130. Cost sharing for any recommended plan is based on shoreline ownership, use, and the availability of public access.

There are currently 7 suitable parking and access points within the study area of R-77 to R-115+1000 feet to R-001, with three new access points created by St. Lucie County which use existing parking. From north to south: Walton Rocks, Ocean Bay, Herman's Bay Beach, Normandy Beach, Dollman Park (which now includes not only the previous access point in the central portion of the park but also two new access points on the northern and southern boundary), Waveland Beach (which now includes not only the

previous access point but also one on the northern boundary) and Glascock Beach, which is located on the Martin County line (approximately R-001).

USACE policy in ER-1105-2-100 states: “Lack of sufficient parking facilities for the general public (including nonresident users) located reasonably near and accessible to the project beaches may constitute a restriction on public access and use, thereby precluding eligibility for USACE participation...Generally, parking on free or reasonable terms should be available within a reasonable walking distance of the beach...Reasonable access is access approximately every one-half mile or less.”

Based on existing information, there are gaps larger than ¼ mile between the existing parking/access. The non-federal sponsor, St. Lucie County, is willing to create additional public access/parking as needed to qualify for maximum Federal cost-sharing. More information can be found in Chapter 4 The Recommended Plan.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future without-project condition, in absence of a Federal project, there is sufficient access and parking (particularly in the large Dollman Park public access area) for recreational use and St. Lucie County would generally not have a need to create additional public access.



2.5 ECONOMIC ENVIRONMENT

EXISTING CONDITIONS

Information on the existing economic conditions along the St. Lucie County coastline was collected for economic modeling purposes. The information on the coastal assets detailed in this section was collected from St. Lucie County mapping resources, site visits, and contractors.

2.5.1 DAMAGE ELEMENTS – STRUCTURE AND CONTENTS VALUE

Beach-fx is an event-driven life-cycle model that estimates damages and associated costs over a period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Damages to developed shorelines include damages to buildings, pools, patios, parking lots, roads, utilities, seawalls, revetments, bulkheads, replacement of lost backfill, etc., all classified as “damage elements.”

Economists, real estate specialists, and engineers have collected and compiled detailed information on damage elements within the study area¹⁰ including:

- 1 single family residence
- 1 multi-family residence
- 52 commercial structures (including traditional commercial structures, as well condominiums and hotels)
- 35 dune walks
- Several parking lots, gazebos, garages, pools, tennis courts, and bath houses

In total, attribute information for 241 separate damage elements was populated for economic modeling using Beach-fx. The proximity of these damage elements to the beach makes them potentially vulnerable to erosion, wave attack, and inundation.

Beach-fx handles economic considerations at the damage element level. These considerations include extent of damage, cost to rebuild, and time to rebuild. Real Estate professionals from SAJ provided updated depreciated replacement costs for all of the damage elements in April 2015. An uncertainty of +/- 15% was assigned to these costs. The value of contents was assumed to be 50% of the structure value for all habitable structures per ER 1105-2-100. Non-habitable structures (dune walks, bathhouses, pools, etc...) had zero contents value.

2.5.2 STRUCTURE INVENTORY

The economic value of the existing structure inventory represents the depreciated replacement costs of damageable structures and their associated contents within the study area along the coastline. The damage element inventory includes 236 damageable structures with an overall estimated value of \$669,000,000, with structure and content valuations of \$579,000,000 and \$91,000,000 respectively. **Table 2-14** provides the distribution of structure and content values broken down by Beach-fx Reach.

Table 2-14. Distribution of Structures and Structure Value by Reach.

Reach	Structure Value	Content Value	% Total Value	# Damage Elements	% Total Damage Elements
Reach	Structure Value	Content Value	% Total Value	# Damage Elements	% Total Damage Elements
R-099	\$ 70,328,170	\$ 11,335,909	12.2%	18	7.6%
R-100	\$ 65,393,015	\$ 8,938,156	11.1%	7	3.0%
R-101	\$ 33,292,909	\$ 4,583,021	5.7%	12	5.1%
R-102	\$ 510,685	\$ 0	0.1%	2	0.8%
R-103	\$ 382,169	\$ 0	0.1%	1	0.4%

¹⁰ This references South Hutchinson Island reach only, which is the only reach where damage elements were collected, due to screening of the upper 3 reaches during plan formulation. More information can be found in Chapter 3.

R-104	\$	59,638,936	\$	8,233,070	10.1%	16	6.8%
R-105	\$	50,671,441	\$	6,935,733	8.6%	12	5.1%
R-106	\$	38,827,604	\$	5,262,028	6.6%	10	4.2%
R-107	\$	23,131,259	\$	3,342,885	4.0%	14	5.9%
R-108	\$	67,674,190	\$	9,683,231	11.6%	16	6.8%
R-109	\$	36,383,413	\$	5,941,502	6.3%	18	7.6%
R-110	\$	23,862,725	\$	3,165,472	4.0%	11	4.7%
R-111	\$	26,672,082	\$	4,018,670	4.6%	20	8.5%
R-112	\$	31,434,922	\$	4,406,246	5.4%	12	5.1%
R-113	\$	26,669,670	\$	6,969,432	5.0%	19	8.1%
R-114	\$	1,393,215	\$	217,112	0.2%	17	7.2%
R-115	\$	22,365,140	\$	7,626,235	4.5%	31	13.1%
Total	\$	578,631,545	\$	90,658,701	100%	236	100%

2.5.3 BEACH-FX MODEL SET-UP

FUTURE WITHOUT-PROJECT CONDITIONS

The **Economic Appendix** provides a complete description of the Beach-fx model set-up and use. Data on historic storms, beach survey profiles, and private, commercial and public structures within the project area is used as input to the Beach-fx model. The model is then used to estimate future damages resulting from hurricanes and coastal storms.

The future without-project damages are used as the base condition against which potential alternatives will be compared. The difference between with and without-project damages are used to determine project benefits.

2.5.4 BEACH-FX MODEL ASSUMPTIONS

- **Start Year:** The year in which the simulation begins is 2019
- **Base Year:** The year in which the benefits of a constructed Federal project would be expected to begin accruing is 2020.
- **Period of Analysis:** 50 years (2020 to 2069¹¹)
- **Discount Rate:** 2.875% FY2017 Federal Water Resources Discount Rate

Damage Functions: For the vast majority of structures within this study the damage functions used were those developed by the Institute for Water Resources (IWR), within the Coastal Storm Damage Workshop

¹¹ Technically the modeling year started at 2020 as year 1, and therefore 2069 is 50 years is the end of the period of the analysis. However, for planning purposes of this report, 2070 will be the end of Federal participation.

(CSDW), Coastal Storm Damage Relationships Based on Expert Opinion Elicitation in 2002. However, early review of the model results demonstrated a potential overstatement of damages to high-rise structures from wave attack. Additional research was conducted for these structures to determine the relationship between the structure value, maximum number of floors, and expected damages from wave attack. The research focused on results from FEMA's Mitigation Assessment Team Report (MAT) from Hurricane Sandy and Hurricane Katrina with specific respect to the structural performance of high-rise buildings. After additional model runs were completed, damages to high-rise structures were reviewed and calibrated against the findings from FEMA's MAT and were found to be in line with actual damages experienced. This information is described in more detail in the **Economic Appendix**.

Coastal Armor: There is no existing coastal armor in the project area. In St. Lucie County the use of armoring is generally prohibited under local county ordinances, and was therefore omitted from the model.

Number of Times Rebuilding Allowed: The rebuilding parameter within Beach-fx allows the economic modelers to restrict the amount of monetary investment allocated to structural repair for any specific building type in order to most accurately reflect real-world behavior. Rebuilding does not refer to a total rebuild event (i.e. 100% of structure value), but rather a repair event (i.e. some non-zero percent of value intended to restore the structure). Allowing for an unlimited amount of rebuilding in the period of analysis may be unrealistic for a CSRSM study and can potentially overstate damages in the FWOP. However, issuing emergency permits for rebuilding on lots meeting a minimal setback restriction is generally the rule, not the exception in Florida. Common practice and historical evidence also show that rebuilding lost structures, provided setback restrictions are met, occurs frequently¹². Additionally, county records dating back to 1994 demonstrate that there have been no known rejections to rebuilding requests. As a result, the number of rebuilds within the model has been limited to reflect this behavior as follows:

- Public Access Structures¹³: 124X
- Commercial Recreation Facilities¹⁴: 62X
- Remaining: 31X

Additionally, after long-term erosion has claimed more distance on the oceanfront lot than the building requires the model ceases to reinstate the same property. The model also considers a lot "condemned" once 50%¹⁵ of the total value of that lot is damaged. There is also a control feature that allows an individual damage element to become condemned once 50% of the original structure value has been damaged at which point the damage element undergoes a "time to rebuild" period where no additional damages can accrue. These assumptions will prevent overestimation of the without-project damages. A sensitivity analysis was conducted and the result demonstrates that a change in the number of rebuilds has a negligible effect on the proportion of high-value to low-value rebuilds.

¹² Reference Florida Office of General Counsel order 12-1453 and 12-1264 as examples.

¹³ Examples of public access structures include dunewalks, shelters, guard shacks and roads

¹⁴ Examples of commercial recreation facilities include pools, parking areas, and tennis courts

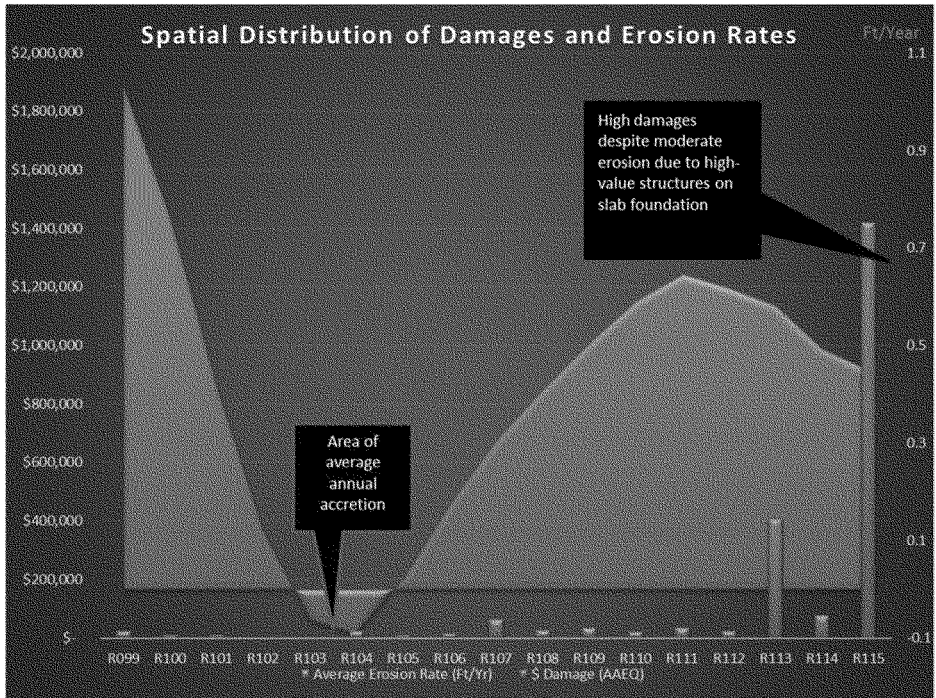
¹⁵ This amount, the lot condemnation ratio, can be manipulated within the model as needed but is set to 50% for this study.

2.5.5 BEACH-FX FUTURE WITHOUT-PROJECT DAMAGE RESULTS

- **Structure Damage:** Economic losses resulting from the structures situated along the coastline being exposed to wave attack, inundation, and erosion damages. Structure damages account for approximately 71% of the damages for the future without-project (FWOP) damages.
- **Contents Damage:** The material items housed within the aforementioned structures (usually air-conditioned and enclosed) that are potentially subject to damage. Content damages are approximately 29% of the total damages.
- **Damage Distribution by Structure Category and Type:** The coastal inventory was categorized as 'Commercial', 'Public Access & Recreation', and 'Residential'.
 - **Commercial:** The St. Lucie shoreline is dotted with various commercial real estate subject to damage. The structures are primarily condominium complexes or large hotels and represent 88% of all the damages in the FWOP. Again, some of these condominiums may be used primarily as permanent residences and thus deemed residential in real estate appendices. However, for purposes of economic damage aggregation the delineation between condominiums was not made and they are deemed commercial.
 - **Residential:** The only type of residential structure in the project area is the three-story single-family residence. The damage incurred to these structures is minimal (<1%) and makes up less than one-percent of overall damages.
 - **Public Access and Recreation Structures:** A public access structure refers to those that provide the general public with safe access to beaches and shorelines throughout St. Lucie County which include, but are not limited to, roads, dune walks, public shower and bathroom facilities, and life-guard stations. This category represents 12% of the damages in the FWOP. A recreation structure refers to items such as pools, patios and tennis courts.

2.5.5.1 SPATIAL DISTRIBUTION OF WITHOUT-PROJECT DAMAGES

Reaches R-113 to R-115 account for around 83% of the damages, while the remainder of the damages are relatively evenly distributed; R-098, R-100 to R-103 are the only reaches that account for less than one-percent of damages. R-115 accounts for 65% of the total damage due in large part to several groups of valuable condominium complexes situated very near the dune that are on slab foundations instead of deep-pile. Structures on slab foundation are far more susceptible to damages from erosion than those with a deep-pile foundation. **Figure 2-13** illustrates the spatial distribution of erosion rate, existing structure value, and FWOP damages and costs by reach.

Figure 2-13. Spatial Distribution of Damages and Erosion Rates by Reach.

2.5.5.2 DAMAGE DISTRIBUTION BY DAMAGE DRIVING PARAMETER

Most of the FWOP damages and costs are attributable to erosion. The distribution of damages by driving parameter is as follows:

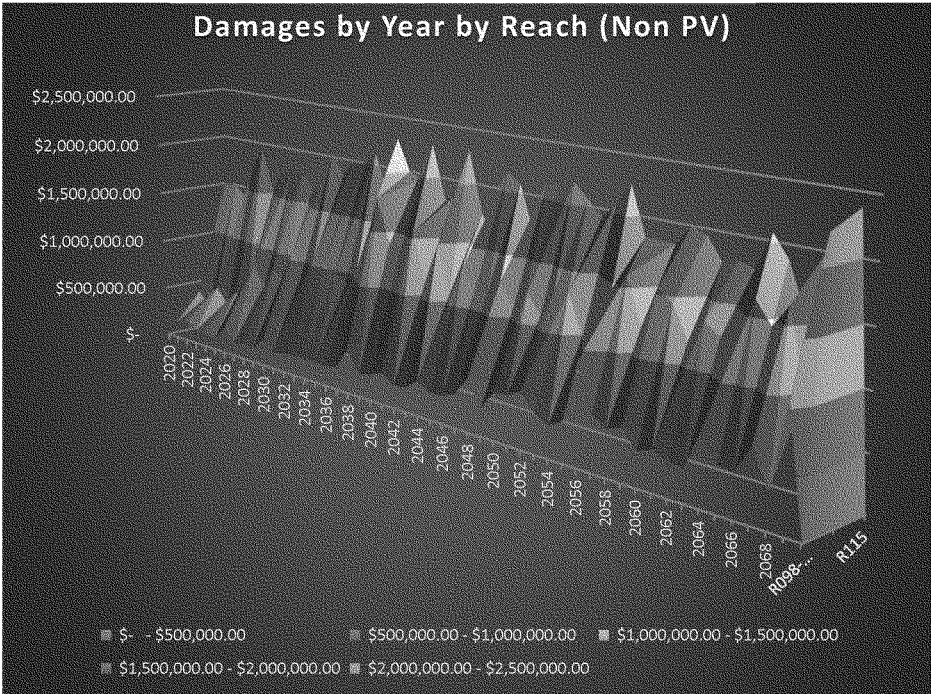
- Erosion: 97.29%
- Inundation: 2.55%
- Wave Attack: .16%

2.5.5.3 TEMPORAL DISTRIBUTION OF DAMAGES

Damages begin to rise steadily from the base year until 2042, beyond which they remain relatively constant on a yearly basis. The pattern is somewhat intuitive as one would expect the cumulative impact of erosion to take a toll on nearshore structures.

Figure 2-14 illustrates the damages over time by condensed reaches¹⁶ in non-present value. In years 2036-2046 there are a series of small spikes in damages and that pattern continues throughout the remaining years culminating in a final peak in 2069. The pattern of damage spikes brings to light the frequent vulnerability of the St. Lucie shoreline to the powerful effects of storms and hurricanes.

Figure 2-14. Damages Over Time by Combined Reaches (Non-PV\$).



2.5.5.4 EVACUATION ROUTE FLOODING

Florida State Road (SR) A1A is South Hutchinson Island’s hurricane evacuation route and provides vital access to critical infrastructure and services. In order to gauge the potential impact of flooding on SR A1A Beach-fx was adjusted to model two different scenarios with the statistics from the National Weather Service (NWS) used as a framework. In the first scenario, 38% of iterations experienced one foot or more of flooding at some point in the 50-year period of analysis. In the second scenario, 31% of iterations experienced two or more feet of flooding.

¹⁶ For graphical display purposes the reaches were grouped as R-099 to R-107, R-108 to R-114, and R-115. R-102 and R-103 were not displayed as damages remain at zero throughout the period of analysis.

This potential flooding could present a hazard to all residents of Hutchinson Island both within and outside of the project area boundaries. Additionally, if the southern portions of SR A1A are impassable, the result is that traffic might be rerouted approximately 16 miles during evacuations.

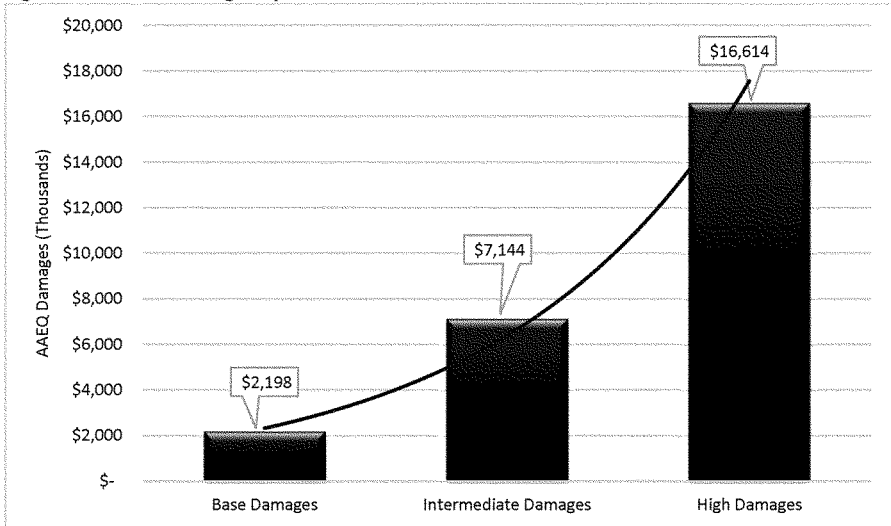
2.5.5.5 FWOP DAMAGES IN ALTERNATIVE SEA LEVEL RISE (SLR) SCENARIOS

The FWOP condition was modeled for three Sea Level Rise (SLR) scenarios. ER 1110-2-8162 provides both a methodology and a procedure for determining a range of sea level rise estimates based on the local historic sea level rise rate, the construction (base) year of the project, and the design life over the 50-year period of Federal participation. The Beach-fx results presented above refer to the baseline scenario, which is based on the historic erosion rate. The results associated with the other two SLR scenarios are presented here.

Figure 2-15 provides an overall summary of FWOP average present value damage in each SLR scenario. The SLR results are intuitive in the sense that one would expect damages to be positively correlated with water levels (i.e. as water levels increase throughout the period of analysis, so do damages). What is important to note, however, is the magnitude of the effect. From the base to intermediate SLR scenario the difference in average SLR was .0086 ft./year, yet resulted in an increase of roughly 225%, or roughly \$5 million AAEQ, worth of damages. From intermediate to high SLR, there was a .0276 ft./year average rise with a corresponding increase of 133%, or \$9.5 million AAEQ, in damages. From base to high SLR, damages increase over 655%.

There is also an interesting shift in what drives the damages in each scenario. It is very common for erosion to be the main cause of damages in Florida CSRM studies. However, as sea levels rise, inundation begins to take on more of the share of damages. In the high SLR scenario, damages caused by erosion fall from 95% to 51% with inundation accounting for most of the difference.

Additional detail on results from the SLR analysis is provided in the **Economics Appendix**.

Figure 2-15. Total Damages by SLR Scenario.

2.5.5.6 FUTURE WITHOUT-PROJECT CONDITION CONCLUSION

The following points summarize the future without-project (FWOP) conditions:

- Damages are largely driven by storm induced erosion events instead of gradual long-term erosion.
- The overwhelming majority of the damage is structural in nature. Commercial structures account for well over half of all damages.
- Proximity to the shoreline, vulnerability of structure type (i.e. slab foundation) and exposure to recurring damages are the most important factors for determining structure damage.
- Damages in the FWOP increase dramatically in the SLR scenarios.



3 Plan Formulation

3 PLAN FORMULATION

3.1 PLAN FORMULATION RATIONALE

 Please refer to informational foldouts REF-2 and REF-3 for Chapter 3.

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the “P&G,” and will be cited throughout the plan formulation sections of this report.

Plan formulation is the process of developing alternative plans to address a given problem. The first step in plan formulation involves identifying all potential management measures for the given problems. A management measure is a structural or nonstructural action that can be implemented at a specific geographic site to address one or more planning objectives.

An alternative plan includes one or more management measures to address the problem. Alternative plans can differ by types of measures, or how measures are combined or defined, including dimensions, quantities, materials, locations or implementation time frames.

Four accounts (P&G 1983) facilitate the evaluation of management measures and display the effects of alternative plans.

- National Economic Development (NED) account: Includes consideration of a measure’s potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and consider project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gauge the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure’s adaptability to such change were considered under the National Economic Development (NED) account.
- Environmental Quality (EQ) account: Considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA).
- Other Social Effects (OSE) account: Includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and, the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the

planning objectives to maintain recreation and maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements.

- **Regional Economic Development (RED) account:** Considers the potential impacts on the local economy including employment, income, and sales volume.

The P&G require the NED plan to be selected as the recommended plan, unless an exception is granted. The NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these four criteria.

Preliminary plans were formulated by combining management measures. Each plan was formulated in consideration of the following four criteria described in the Principles and Guidelines (P&G):

1. **Completeness:** Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
2. **Effectiveness:** Extent to which the plan contributes to achieving the planning objectives
3. **Efficiency:** Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
4. **Acceptability:** Workability and viability of the alternative plan with respect to acceptance by Federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies

3.2 SCOPING*

3.2.1 FEDERAL

An initial scoping period for the project was conducted from May 31 through June 30, 2006. The National Oceanic and Atmospheric Administration (NOAA) responded to the scoping letter with concerns about the proposed dredging of the offshore shoals as a sand source and that the Essential Fish Habitat (EFH) assessment and NEPA documents on this action should be prepared with sufficient detail. This assessment is included in Sections 2.3.4 and 4.1.10 of this report. The Florida Department of Environmental Protection (FDEP) coordinated a review of the scoping letter and the proposed project with the appropriate state agencies. FDEP stated that "based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program." FDEP also stated that "it is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification." Other stakeholders raised concerns regarding the use of St. Lucie Shoal as a borrow site, impacts to hardbottom resources, and cumulative impacts.

All correspondence associated with this NEPA scoping process is included in **Appendix H**.

3.3 PROBLEMS AND OPPORTUNITIES*

A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable.

The purpose of this feasibility study is to develop an implementable and acceptable plan to change the future condition and address specific problems and opportunities in the study area. Problems and opportunities have been identified by the Project Delivery Team (PDT) in several ways, including previous USACE studies, reports completed by private contractors for St. Lucie County, as well as scoping letter comments received from local residents and stakeholders.

3.3.1 PROBLEMS

Existing problems in the study area include:

- Storm damages due to erosion, inundation, and waves threatening infrastructure
- Loss of natural habitat
- Shoreline erosion threatening recreational opportunities

Erosion, mainly storm induced, is the greatest problem in the study area as a negative impact to infrastructure. Additional problems associated with the eroding shoreline include loss of recreational resources and loss of natural habitat. Sea level rise and coastal storms will continue to exacerbate erosion in the study area.

Per the Florida coastal construction control line (CCCL) program and in conjunction with county management ordinances, St. Lucie County is prohibited from installing coastal armoring, unless the situation meets certain triggers. There is no coastal armoring in the area to date, other than the revetment at the FPL power plant described earlier in the report. To combat damages from storms, St. Lucie County has performed small truck fills after large storms, and an overall larger local nourishment in 2012/2013.

3.3.2 OPPORTUNITIES

Opportunities are positive conditions in the study area that may result from implementation of a Federal project such as:

- Reduction of storm damage to residential and commercial properties along the St. Lucie County shoreline
- Restoration of natural dune function, where possible, in the study area

- Protection of habitat for nesting sea turtles, benthic invertebrates, and shore birds
- Protection of the current hurricane evacuation route along Hutchinson Island
- Maintenance of existing recreation and tourism levels

These opportunities may be realized by implementing a single management measure or a combination of management measures which may be structural and/or non-structural. Management measures such as beach nourishment and dune creation/remediation include additional opportunities to protect natural habitat for sea turtles, shore birds, etc. While some natural functions, such as sea turtle nesting, may be disrupted during construction activities, there is an opportunity for long-term benefits in preserving the beach habitat.

3.4 CONSTRAINTS

3.4.1 PLANNING CONSTRAINTS

A constraint is a restriction that limits the extent of the planning process; it is a statement of effects that alternative plans should avoid. Constraints are designed to avoid undesirable changes between without and with-project future conditions. The planning constraint for this study area is to avoid conflict with Federal regulations, as stated in Federal law, USACE regulations, and executive orders.

3.4.2 LOCAL CONSTRAINTS

Local and state laws, such as Florida State statutes, do not constrain NED formulation. However, they may be considered in the selection of a Locally Preferred Plan (LPP).

3.5 OBJECTIVES

3.5.1 FEDERAL OBJECTIVES

The Federal objective, as stated in the P&G, is to contribute to national economic development (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.

The Federal objective is to maximize net benefits to the nation, and as such, it does not seek to identify specific targets within objectives. For example, targeting a pre-defined storm frequency (100-year storm) relative to the storm damage reduction objective would be inappropriate. Rather, the planning process includes formulation of alternative plans to maximize benefits relative to costs. The Federal objective to maximize net benefits would supersede any project-specific target output.

3.5.1.1 PLANNING OBJECTIVES

The overarching goal of this study is to formulate an alternative for coastal study risk management to determine if Federal participation in reduction of the damages caused by erosion and coastal storms to shorefront structures and infrastructure within the study area is warranted and economically justified. Specific study objectives have been developed to provide a means of determining whether individual management measures are capable of solving the study area's problems while taking advantage of the opportunities identified and avoiding the constraints. The following study objectives have been developed based on the St. Lucie County feasibility study area problems, opportunities, goals, and Federal and state objectives and regulations.

1. Objective 1: Reduce storm damages to property and infrastructure, including SR A1A (a major hurricane evacuation route), within the project area over a 50-year period of analysis period of analysis (2020 – 2070).
2. Objective 2: Maintain environmental quality in the project area and adjacent areas, for human and natural use, sea turtle habitat and aesthetics over a 50-year period of analysis period of analysis (2020 – 2070).
3. Objective 3: Maintain recreational use of beach and nearshore areas in the project area including beach going, surfing, fishing, and wildlife viewing over a 50-year period of analysis period of analysis (2020 – 2070).

3.5.1.2 FEDERAL ENVIRONMENTAL OBJECTIVES

USACE strives to balance the environmental and development needs of the nation in full compliance with the National Environmental Policy Act (NEPA) and other authorities provided by Congress and the Executive Branch. Public participation is encouraged early in the planning process to help define problems and environmental concerns relative to the study. Therefore, significant environmental resources and values that would likely be impacted, favorably as well as adversely, by an alternative under consideration are identified early in the planning process. All plans are formulated to avoid to the fullest extent practicable any adverse impact on significant resources. Significant adverse impacts that cannot be avoided are mitigated as required by Section 906(d) of WRDA 1986.

This report is an integrated feasibility study and environmental document. As with a separate NEPA document, it discusses and documents the environmental effects of the recommended plan and summarizes compliance with Federal statutes and regulations.

3.5.1.3 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities. Section 6.6.27 includes a discussion of the USACE Environmental Operating Principles and how the study addresses them.

CHAPTER 3.0: PLAN FORMULATION

3.5.1.4 CAMPAIGN PLAN OF THE U.S. ARMY CORPS OF ENGINEERS (USACE)

USACE Campaign Plan goals and objectives are derived, in part, from the Commander's intent, the Army Campaign Plan, and the Office of Management and Budget. The four campaign plan goals and their associated objectives also build on prior strategic planning efforts. Each campaign plan goal and objective is led by a USACE senior leader who manages and oversees actions to reach the goal and objectives.

The successful achievement of the campaign plan goals and objectives are dependent on actions implemented by the entire USACE team. The implementing actions supporting each goal and objective are contained in the headquarters staff and Major Subordinate Command (MSC) implementation guidance for the Campaign Plan. The four goals of the Campaign Plan are:

Goal 1: Deliver innovative, resilient, and sustainable solutions to the Department of Defense (DoD) and the nation.

Goal 2: Deliver enduring and essential water resource solutions, utilizing effective transformation strategies.

Goal 3: Deliver support that responds to, recovers from, and mitigates disaster impacts to the nation.

Goal 4: Build resilient People, Teams, Systems and Processes to sustain a diverse culture of collaboration, innovation and participation to shape and deliver strategic solutions.

These Campaign Plan goals and associated objectives will be addressed through the course of this feasibility study.

3.5.2 STATE AND LOCAL OBJECTIVES

The State of Florida is empowered by the Federal Coastal Zone Management Act (CZMA) and its implementation of regulations per 15 CFR 930 to review Federal activities within or adjacent to its coastal zone to determine whether the activity is consistent with the requirements of the state's approved management program for its coastal zone. The Federal CZMA requires Federal activities to be consistent with a state's coastal zone program to the maximum extent practicable; it does not require compliance with a state's program. Florida's Coastal Zone Management Program was established under the Coastal Management Act of 1978 (Chapter 380.20, Florida Statutes) and approved by the Federal Coastal Zone Management Office in 1981. Florida does not regulate its coastal zone through one comprehensive law but rather through several state statutes and administrative codes. Through Florida's comprehensive planning act, local governments are also given the opportunity to determine whether these activities are consistent with their coastal goals and policies. The FDEP is the lead state agency for the implementation of the Federal CZMA.

The Beach and Shore Preservation Act (Chapter 161, Florida Statutes) is Florida's primary statute for developing and implementing the state's strategic coastal management plan, regulating coastal

construction seaward of the mean high water line, and regulating activities seaward of the coastal construction control lines. The act, administered by the FDEP, was first passed in 1965 and has since been significantly amended. The objective of the Beach and Shore Preservation Act is to preserve and protect Florida's sandy beaches and adjacent beach and dune systems. The FDEP strives to accomplish this objective with the following programs: Coastal Construction Control Lines, Joint Coastal Permit Program, Erosion Setbacks, Coastal Building Zone, Erosion Control Program, Erosion Control Line, and Inlet Management.

3.5.2.1 LOCAL COMPREHENSIVE PLANNING

The state's Local Government Comprehensive Planning Act of 1985 (Chapter 163) requires that all local governments prepare, adopt, and implement comprehensive plans that address community growth and development needs. It requires that local, regional, and state comprehensive plans be consistent with each other and requires coastal counties and cities to include a "coastal management element" in their local plans. This section of the plan must be based on an inventory of the beach/dune system and existing coastal land uses and an analysis of the effects of future land uses on coastal resources. Local governments must also address disaster mitigation and redevelopment, designation of coastal high-hazard areas, beach protection, and shoreline use.

The St. Lucie County Comprehensive Plan 2015 outlines unique features of the area, key coastal elements and related goals, objectives and policies, as well as existing and future land use.

3.6 SUMMARY OF MANAGEMENT MEASURES

Management measures are specific structural or nonstructural actions that would take place at geographical locations within the project areas. For the first iteration of evaluating measures, the entire project area was split into two geographical locations (REF-2):

- 1) The Power Plant, North Hutchinson Island, and Narrows of Hutchinson Island reaches were grouped together due to their proximity and similarity in physical and built features.
- 2) The South Hutchinson reach was evaluated separately due to its erosive nature and higher development.

3.6.1 IDENTIFICATION OF MANAGEMENT MEASURES

Management measures were selected to accomplish at least one of the planning objectives for the St. Lucie County study. Both nonstructural (NS) measures and structural (S) measures were identified. All possible measures were considered, including those beyond the authority of USACE to implement. The following is a summary of the management measures considered for St. Lucie County.

Non-Structural

NS-1: No-action: The no-action plan represents future conditions without the implementation of a project. Although this measure does not address any specific problems, it provides a comparison for all other measures. Information to describe this measure was collected during the inventory of existing conditions. The rate of shoreline change will be assumed to continue over the 50-year period of analysis. Present structures and replacement costs will be used into the future.

NS-2: Coastal Construction Control Line: A Coastal Construction Control Line (CCCL) that does not prohibit construction, but does provide stringent structural restrictions, was established in 1988 by the State of Florida for all of St. Lucie County. Evaluation of this management measure considers potential changes to the CCCL or building regulations that could be implemented by the State of Florida. Such changes could include moving the CCCL landward, increasing the setback for construction, or increasing the standards for construction to reduce storm damages. Erosion of the shoreline will be considered to continue at the present average rate, unabated by this measure.

NS-3: Moratorium on Construction: This management measure would not permit new construction in the area vulnerable to storm damages adjacent to the study area. As properties are damaged, reconstruction would not be permitted. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

NS-4: Establish a No-Growth Program: This management measure would allow for limited reconstruction of existing structures following storm damage, but would not allow for an increased number of new structures within the area vulnerable to storm damages adjacent to the study area. The erosion of the shoreline would continue at the present rate, unabated by this measure. Although not a congressionally-authorized activity, this measure could be implemented by state or local governments.

NS-5: Relocation of Structures: The relocation of structures measure will assume that shorelines in the study area will continue to erode. Vulnerable structures may be identified within the study which may be moved further landward on their parcels to escape storm damages. This would be accomplished as a Federal partnership with the non-federal sponsor, with the non-federal sponsor acting as the lead agency to oversee the process.

NS-6: Floodproofing of Structures: This management measure considers that various methods for non-structural floodproofing are available which may be implemented by homeowners and/or homeowners associations within the study area in the form of wet or dry floodproofing. Wet floodproofing involves making a series of modifications to a structure to allow an enclosed area below the base flood elevation to flood – it protects the building but not the contents of the building. Dry floodproofing makes building and site modifications to prevent water from entering during a flooding event. In the study area, the majority of affected buildings are condominiums, where dry floodproofing would be the least cost and most practical means to floodproof. Flood shields could be a potential type of dry floodproofing that could apply to condominium structures.

NS-8: Acquisition of Land and Structures:

This measure would allow the shoreline to erode in the study area with a loss of land. Structures within the area vulnerable to storm damage would be identified for acquisition. Structures on the acquired parcels would be demolished and natural areas restored. Such parcels would become public property and would reduce the number of structures vulnerable to storm damages.

Structural

S-1: Seawalls: The construction of concrete seawalls could provide a significant degree of storm damage protection. Seawalls could be constructed at some position seaward of the structures which they are designed to protect.

S-2: Revetments: This measure would involve placement of large rock, designed to withstand the wave environment, seaward of structures which are most vulnerable to storm damages which may result from shoreline erosion. The engineered structure would have a sloped profile designed to dissipate wave energy before it reaches the protected structures. The revetment could be covered by a dune or some degree of beach fill for additional protection and for aesthetic reasons. Construction would be from the beach, with intermittent access from roads. Impacts to the nearshore resources during construction would be avoided.

S-3: Sand Covered Soft Structures: This management measure includes construction of a dune composed of geotextile sand-filled forms (typically tubes or bags) and covered with sand. This forms a sand dune with a structured core. When storm erosion causes the structured geotextile core to become exposed the soft structure acts as armoring to prevent erosion from reaching further inland. Sand depth over the geotextile core would be maintained to an adequate depth to allow the dune to function as habitat and not inhibit sea turtle nesting.

S-4: Beach Nourishment: This management measure includes initial construction of a beach fill and future periodic nourishments at periodic intervals. Periodic nourishment of the beach would be undertaken periodically to maintain the recreational and storm damage reduction features within design dimensions. Dimensions of the beach fill would be based on the degree of protection desired or economically justified, storm damage protection of given widths of beach, and the environmental impact to the nearshore resources. Beach nourishment material (sand) would need to be available in adequate quantities. Geotechnical investigations would be conducted to identify potential offshore sand sources. The potential for use of upland sources, as well as the beneficial use of beach quality dredged material from other sources in the region would also be investigated.

S-5: Groins: A series of groins in the problem area would help hold a beach in front of existing development and prevent further losses of land. The construction of groins would have to be supplemented with beach nourishment so that adjacent beaches would not be starved of sand. For this reason, groins are considered a method to help hold the fill in place and to reduce periodic nourishment requirements. The beach nourishment material would come from the sources discussed in the beach nourishment structural measure, S-4. The groins would be constructed of large rocks, designed to

interlock together, with a foundation designed to avoid subsidence. The groins would be placed perpendicular to the shoreline and would extend from above the mean high water line out into shallow water. The length, orientation, and head of the structure (T-head or not) would be designed based on wave conditions, storms, and sediment transport.

S-6: 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” landward of the reef structure. This measure may reduce initial fill quantities, reduce periodic nourishment requirements and offer mitigation for the environmental impacts of potential nearshore hardbottom burial. The submerged artificial reef may be constructed using one of many various materials, and would sit on top of a foundation-type material to avoid subsidence. The beach fill material would come from the sources discussed in the beach nourishment structural measure, S-4.

S-7: Nearshore Berm Placement: Dredged material would be placed in the nearshore to provide wave attenuation benefits, passive nourishment of the active profile, or a combination of both. This method allows placement in water depths 15 feet and deeper, avoiding direct placement covering any potential nearshore hardbottom. This management measure assumes that a portion of the sand placed in shallow water will move towards the beach under normal wave conditions. Over time following construction, the sand bar will migrate towards the beach through natural sediment transport processes, become transported onto the beach, and shaped into the natural equilibrium profile of the beach, thus adding material and enlarging the beach. The dredged material would come from the sources discussed in the beach nourishment structural measure, S-4.

S-8: Emergent Breakwaters: The construction of breakwaters offshore along the Flagler County study area is considered as a management measure to stabilize the beach. Such structures reduce the amount of wave energy reaching the shoreline. As a result, the rate of annual erosion would decrease. The breakwaters would be constructed of large rock with foundation materials to prevent subsidence. The breakwaters would be trapezoidal in profile and would be placed parallel to the shoreline in shallow water. The breakwater would be constructed in segments, separated from each other, to prevent infilling between the beach and the breakwater. The elevation and length of each breakwater segment and the distance between segments would be designed considering the local wave and sediment transport characteristics.

S-10 - Dunes and Vegetation: The presence of dunes is essential if a beach is to remain stable and able to accommodate the natural forces applied by unpredictable storms and extreme conditions of wind, wave, and elevated sea surface. Dunes maintain a sand repository that, during storms, provides sacrificial sand reserves to the eroding beach profile before upland structures would be damaged. Following large erosional events, dunes are generally replenished by natural forces provided by the calmer weather conditions following a storm. The dune system provides a measure of public safety and property protection. Proper vegetation on dunes increases sand erosion resistance by binding the sand together via extensive root masses penetrating deep into the sand. Further, such vegetation promotes dune growth through its sand trapping action when significant wind action transports substantial quantities of sand. Additionally, healthy dune systems are visually attractive to beach visitors and contribute to the

recreational beach experience and the general appearance of the beach community. This measure would include placement of beach compatible material, from either upland or offshore sources, in a dune feature adjacent to the existing bluff. The top elevation of the dune would tie into the bluff. The front slope of the dune would be a function of the material grain size and construction equipment. Vegetation would be planted after placement of the dune material.

3.7 SCREENING OF MANAGEMENT MEASURES

Screening is the ongoing process of eliminating measures which will no longer be considered, based on planning criteria.

3.7.1 PRELIMINARY SCREENING

Criteria for the St. Lucie Coastal Storm Risk Management (CSRM) Project were derived from the specific project objectives, four P&G accounts, as well as constraints. During this process, the interdependency, as well as the exclusivity of measures, is identified. This process serves to eliminate some measures from further consideration. Costs and benefits are not calculated at this stage.

In order to provide a metric for appraisal of the various management measures, a numeric score was applied by judging a measure's ability to meet planning objectives, avoid constraints, and to contribute to each of the four P&G accounts. The management measures were evaluated and rated in **Table 3-1** as follows: 0 = does not meet criteria, 1 = partially meets criteria, and 2 = fully meets criteria. If the total rating equals a number greater than 8, the measure partially meets, at least, over half of the objectives and constraints and is carried forward for further analysis. If the total rating is equal to or less than 8, the measure is not considered further. The final total rating should not be inferred to be a ranking of measures against one another. A measure's rating is only an indication of how likely it is to meet objectives given constraints and therefore carried forward or not. Conclusions from the matrixes are discussed below.

St. Lucie County - Structural Management Measures for South Hutchinson Island Reach											
Management Measures		Farming Objectives		Constraints		Principles and Guideline Accounts				Total Points	
	Reduce Storm Damages	Maintain Environmental Quality	Multistakeholder Opportunities	Avoid conflict with Federal and State Regulations	National Economic Development (NEP)	Environmental Quality (EQ)	Other Social Benefits (OSB)	Regional Economic Development (RED)			
13a	Seawall	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3
13b	Beach nourishment	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3
13c	Beach covered sand dunes	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3
13d	Beach nourishment	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3
14	Beach nourishment	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3
15	Beach nourishment	This measure could provide storm damage reduction to standard interaction during major hurricanes. Properties would become more vulnerable. Partially meet objective.	In the long term, sea walls, seawalls, and levees would be second priority and would not be a first priority. Partially meet objective.	This measure will likely cause disruption of the local economy. Does not meet objective.	This measure is likely to be inconsistent with the state Coastal Zone Management Act. Partially meet objective.	Cost of this measure is not a concern. Cost of this measure is not a concern. Level Blue (LB) could be a concern. Level Blue (LB) could be a concern.	While this measure would provide a degree of storm damage reduction, it would likely intensify erosion and cause beach erosion. Does not meet objective.	Increased erosion of the shoreline and loss of property. Does not meet objective.	1	0	3

St. Lucie County - Structural Management Measures for South Hutchinson Island Reach									
Management Measures	Planning Objectives			Constraints	Principles and Guideline Accounts				Score Points
	Reduce Storm Damages	Restore and Enhance Commercial and Recreational Opportunities	Nurture Recreation Opportunities		Regional Economic Development (RED)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)	
14 Submerged Artificial Reefs	Could provide storm damage reduction if constructed in conjunction with a beach fill. Fully meet objective.	Could potentially enhance recreation habitat although it already has exposed hard bottom habitat in much of the area. Measure would need to be constructed. Partially meets objective.	May help to maintain the reef. Could have positive and/or negative effect on other nearshore or fishing. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Could positively contribute to RED if economically justified. Level five (5B); Could be affected and could require modifications.	Could enhance nearshore fish and beach habitat. Partially meets objective.	May create a safety hazard for swimmers. The recreational area would be negatively impacted by the measure. Partially meets the objective.	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.	Yes
15 Beaches Storm Protection	This measure could hypothetically reduce storm damage on a beach fill project area. Partially meet objective.	The measure would likely have a significant impact on the beach fill. Does not meet objective.	May help maintain beach recreation but it likely to negatively impact existing recreational opportunities. Partially meet the objective.	Likely to not be permitted by the state and/or federal government due to the beach fill project. Does not meet the objective.	Could positively contribute to RED if economically justified. Level five (5B); Could be affected and could require modifications.	Would have impact on nearshore resources but to a lesser extent than beach fill. Partially meets the objective.	This measure is most likely to have a negative impact on the regional economy. Partially meets the objective.	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.	No
16 Dune and Vegetation	Could provide storm damage reduction if constructed in conjunction with a beach fill. Partially meet objective.	This measure could create some degree of nearshore habitat and could have a positive impact on existing resources. Partially meets objective.	May help maintain beach recreation but it likely to negatively impact existing recreational opportunities. Partially meet the objective.	May not be permitted by the state. Partially meets objective.	Could positively contribute to RED if economically justified. Level five (5B); Could be affected and could require modifications.	Could affect the nearshore resources, but to a lesser extent than beach fill. Partially meets the objective.	May not be economically justified. Could be a potential hazard for localities and swimmers. Not favored by the public of the project. Does not meet objective.	Could possibly have a minor positive impact on the regional economy. Partially meets this objective.	No
19 Dune and Vegetation	This measure could provide a significant reduction in storm damage on a beach alone measure. Fully meet objective.	Dune habitat would be enhanced and exposed. Impact on existing resources. Fully meet objective.	Existing recreational opportunities would be maintained. Fully meet the objective.	Not likely to conflict with any state or federal regulations. Fully meets objective.	This measure is most likely to contribute to RED based on the reduction for effective storm damage reduction. Fully meets objective. (5B); Could be affected and could require modifications.	Dune habitat would be enhanced and exposed, but likely to have any negative impact. Partially meets objective.	Could be supported by the community. Dune dunes maintain beach conditions associated with storm damage protection and without negatively affecting recreational resources. Partially meet the objective. Impact on the regional economy. Partially meets this objective.	This measure would maintain or enhance recreational conditions associated with storm damage protection and without negatively affecting recreational resources. Partially meet the objective. Impact on the regional economy. Partially meets this objective.	Yes
Corried Forward		2	2	2	2	2	2	2	14
Eliminated		0	0	0	0	0	0	0	0
Fully Meets Objective		2	2	2	2	2	2	2	14
Partially Meets Objective		1	1	1	1	1	1	1	14
Does Not Meet Objective		0	0	0	0	0	0	0	0

St. Lucie County Coastal Storm Risk Management Project
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

St. Lucie County - Structural Management Measures for North, Power Plant, and Narrows

[illegible]

[illegible]

Management Measures	Planning Objectives		Coastal Erosion Control and State Regulation	National Economic Development (NEP)	Environmental Quality (EQ)	Other Social Effects (OSE)	Regional Economic Development (RED)	Total Points	Carded Forward
1.1 Reduce Storm Damages	Could provide storm damage reduction if constructed in conjunction with a beach fill, however risk of erosion would be increased due to increased beach width. Partially meets objective.	Maintain Recreation Opportunities	May help to maintain the recreational area and reduce the negative effects on other recreation activities such as surfing or fishing. Fully meets the objective.	Avoid conflict with coastal and state regulation.	Could partially contribute to NEP if economic benefits are realized, but could also have negative effects on other recreation activities. Partially meets objective and could require modifications.	Could partially contribute to EQ if beach fill allowed would help reduce erosion and improve recreation. Partially meets objective.	Could possibly have a minor positive impact on the regional economy in terms of tourism. Partially meets the objective.	5	Carded Forward
1.2 Beaches and Coastal Erosion	This measure could hypothetically reduce some erosion, but the impact is not clear. Partially meets objective.	Maintain Recreation Opportunities	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	May not be permitted by the state and other agencies. Partially meets objective.	Could partially contribute to NEP if economic benefits are realized, but could also have negative effects on other recreation activities. Partially meets objective and could require modifications.	Could partially contribute to EQ if beach fill allowed would help reduce erosion and improve recreation. Partially meets objective.	Could possibly have a minor positive impact on the regional economy in terms of tourism. Partially meets the objective.	5	Carded Forward
1.3 Erosion Breakwaters	Could provide storm damage reduction if constructed in conjunction with a beach fill. Partially meets objective.	Maintain Recreation Opportunities	May help maintain beach recreation but is likely to negatively interfere with other recreation opportunities. Partially meets the objective.	May not be permitted by the state. Partially meets objective.	Could partially contribute to NEP if economic benefits are realized, but could also have negative effects on other recreation activities. Partially meets objective and could require modifications.	Could partially contribute to EQ if beach fill allowed would help reduce erosion and improve recreation. Partially meets objective.	Could possibly have a minor positive impact on the regional economy in terms of tourism. Partially meets the objective.	5	Carded Forward
1.4 Storm and Erosion	This measure could provide a significant degree of storm damage reduction in a small storm scenario, but the impact is not clear. Partially meets objective.	Maintain Recreation Opportunities	Could provide storm damage reduction if constructed in conjunction with a beach fill. Partially meets objective.	May not be permitted by the state and other agencies. Partially meets objective.	Could partially contribute to NEP if economic benefits are realized, but could also have negative effects on other recreation activities. Partially meets objective and could require modifications.	Could partially contribute to EQ if beach fill allowed would help reduce erosion and improve recreation. Partially meets objective.	Could possibly have a minor positive impact on the regional economy in terms of tourism. Partially meets the objective.	5	Carded Forward

St. Lucie County Coastal Storm Risk Management Project
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

The measures in North Hutchinson Island, Power Plant, and Narrows of Hutchinson Island reaches were jointly screened due to their similarities and proximity to one another. For these reaches, structural management measures were not carried forward, due to the cost of construction as well as minimal damageable structures in the area, other than the Florida Power and Light (FPL) Power Plant in the Power Plant reach. Further, all three reaches are almost entirely within the CBRS unit, with the exception of the shoreline immediately in front of the FPL Power Plant which has a revetment, indicating that FPL Plant has already taken measures to protect the plant (including its existing elevation of 20 feet above sea level). For these reaches, there are little to no structures to protect, with the exception of A1A. This highway is a major evacuation route, but is set back from the immediate project area in the upper reaches, with the exception of the Narrows of Hutchinson Island reach. In the Narrows of Hutchinson Island reach where A1A is most potentially vulnerable to storm damage, USACE contacted Florida Department of Transportation (FDOT) to discuss potential needs for a Federal project to protect A1A. According to discussions with FDOT, needs have been met for A1A and will continue to be met by FDOT in specific locations, with no need for a Federal project at this time. Additionally, the CBRS unit effectively rules out any Federal participation. Most non-structural measures are already in place or are being accomplished passively through the CBRA unit. After careful consideration and evaluation of all measures, and discussion with the Sponsor, all non-structural and structural measures were screened out, except for the no-action measure. For all the reasons described above, it was assumed there would be no-action for these reaches.

The South Hutchinson Island reach was screened as a stand-alone reach, with a length of approximately 3.4 miles. The CBRS unit is present in this reach from R-98 to R-98 +200 feet and from R-101.5 to R-103.5. The non-CBRS shoreline is the southernmost part of St. Lucie County and stretches 2.6 miles from approximately R-103 to the St. Lucie/Martin County line at R-115+1000 feet. The following structural measures were carried forward: S-4 Beach Nourishment, S-5 Groins, S-6 Submerged Artificial Reefs, and S-9 Dunes and Vegetation. Most non-structural measures are already being pursued by the local sponsor, or were not feasibly implementable. Acquisition of land and structures was cost prohibitive due to the high cost to buy condominiums, the main damageable structures in the study area. These costs were estimated during the Value Engineering (VE) Study process, which can be referenced in Appendix I for the full documentation of this idea and for all other ideas considered during the VE process. . Flood proofing of structures (dry), such as flood shields, does not comply with FEMA ASCE 24 (Section 6.2.1) where dry floodproofing is not permitted in Coastal High Hazard Areas (Zone V). The following non-structural measures were carried forward: NS-1 No-action.

Management measures that were carried forward after initial screening include:

North Hutchinson Island, Power Plant, Narrows of Hutchinson Island reaches

NS-1: No-action

South Hutchinson Island reaches

NS-1: No-action

S-4: Beach Nourishment

S-5: Groins (low-profile)

S-6: Submerged Artificial Reefs

S-9: Dunes and Vegetation

3.7.2 FORMULATION STRATEGY

Measures, used singularly or in combination with others, create alternatives; and varying scales of each create additional alternatives. An alternative may be implementable for a portion of a reach but not for an entire reach. The combination of management measures results in alternatives that merit further analysis.

The CBRS (Coastal Barrier Resource System) unit is present from R-98 to R-98 + 200 feet, which is part of a privately owned undeveloped parcel and from R-101.5 to R-103.5, which is part of St. Lucie owned land for a public park. At this point, the alternatives with structural measures were avoided in the CBRS unit, with the exception of S-4 Beach Nourishment and S-9 Dunes and Vegetation (which are considered non-structural by USFWS). The length of R-98 to R-98 + 200 feet is a very small part of study area and has a remaining additional 70 feet of non-CBRA on the same private undeveloped parcel. In this case, it assumed that any alternatives which are not beach or dunes would begin at R-98 + 270 feet where a new parcel begins which is owned by St. Lucie County and a public park, rather than R-98 to avoid the CBRS unit in that area, as well as the small remaining distance on the private undeveloped parcel.

Avoidance of impacts to hardbottom was a prevalent part of the rationale, both from an environmental standpoint and cost standpoint, and played a large part in determination of feasible alternative combinations.

Non-Structural – Combinability Discussion

NS-1: No-action. This measure is a stand-alone alternative which could be used per reach.

Throughout the study area nonstructural risk reduction measures including education efforts, maintenance of evacuation route signage, zoning codes, and setback requirements were carried forward as elements of any complete systematic package of risk reduction measures. Many of these additional nonstructural efforts are currently being pursued by St. Lucie County and would be performed locally.

Structural Measures– Combinability Discussion

S-4: Beach Nourishment: This measure could be a stand-alone alternative or could be combined with S-5, S-6, or S-9.

S-5: Groins: This measure would need to be combined with S-4, in order to avoid starving downdrift areas of sand.

S-6: Submerged Artificial Reefs: This measure could be a stand-alone alternative or could be combined with S-4.

S-9: Dunes and Vegetation: This measure could be a stand-alone alternative or could be combined with S-4.

These measures were combined into alternatives, based on the combinability rationale discussed above, and using engineering judgment to assess the most effective combinations given the conditions in the study area. This included minimum and maximum nourishment templates, which would mimic a smaller

beach berm versus a larger beach berm, as well as a much smaller beach nourishment fill, where the purpose would be to fill in low lying areas which potentially act as a conduit for water flow and flooding. A truck haul option with an upland sand source versus offshore sand source was also detailed in the alternatives.

The resulting alternatives are listed below:

- Alternative 1 – No-action
- Alternative 2 – Dunes with Vegetation
- Alternative 3 – Beach Nourishment (smaller template)
- Alternative 4 – Beach Nourishment (smaller template) with trucking
- Alternative 5 – Beach Nourishment (smaller template) AND Dunes with Vegetation
- Alternative 6 – Beach Nourishment (larger template) with Hardbottom Mitigation
- Alternative 7 – Beach Nourishment (larger template) with Hardbottom Mitigation AND Dunes with Vegetation
- Alternative 8 – Submerged Artificial Reefs
- Alternative 9 – Submerged Artificial Reefs AND beach nourishment (one-time event)
- Alternative 10 – Groins (low-profile) AND Beach Nourishment (smaller template)

3.8 SECONDARY SCREENING: SCREENING WITH PRELIMINARY COSTS PRIOR TO BEACH-FX

During the process of developing screening level costs, the beach nourishment alternatives, or alternatives which include it, were expanded to minimum and maximum berms for both the smaller and larger templates. This offers a range for the alternatives to better focus on the efficiency of varying berm widths with regard to reducing storm damages. Additionally, the dune with vegetation alternatives, or alternatives which include it, were expanded to minimum and maximum dune extensions. This exercise created variations within the alternatives, the full list which is listed below:

- Alternative 1 – No-action
- Alternative 2 – Dunes with Vegetation
 - 2A: Minimum dune extension 10 feet
 - 2B: Maximum dune extension 20 feet
- Alternative 3 - Beach Nourishment (smaller template)
 - 3A: Minimum Berm 20 feet
 - 3B: Maximum Berm 40 feet
- Alternative 4 – Beach Nourishment (smaller template) with trucking
 - 4A: Minimum Berm 20 feet
 - 4B: Maximum Berm 40 feet
- Alternative 5 - Beach Nourishment (smaller template) AND Dunes with Vegetation
 - 5A: Minimum dune extension 10 feet + Minimum Berm 20 feet
 - 5B: Maximum dune extension 20 feet + Maximum Berm 40 feet
- Alternative 6 – Beach Nourishment (larger template) with Hardbottom Mitigation
 - 6A: Minimum Berm 60 feet
 - 6B: Maximum Berm 100 feet
- Alternative 7 – Beach Nourishment (larger template) with Hardbottom Mitigation AND Dunes with Vegetation

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- 7A: Minimum dune extension 10 feet + Minimum Berm 60 feet
- 7B: Maximum dune extension 20 feet + Maximum Berm 100 feet
- Alternative 8 – Submerged Artificial Reefs
- Alternative 9 – Submerged Artificial Reefs AND beach nourishment (one-time event)
 - 9A: Minimum Berm 20 feet
 - 9B: Maximum Berm 40 feet
- Alternative 10 – Groins (low-profile) AND Beach Nourishment (smaller template)
 - 10A: Minimum Berm 20 feet
 - 10B: Maximum Berm 40 feet

Screening with Screening Level Costs Prior to Beach-fx

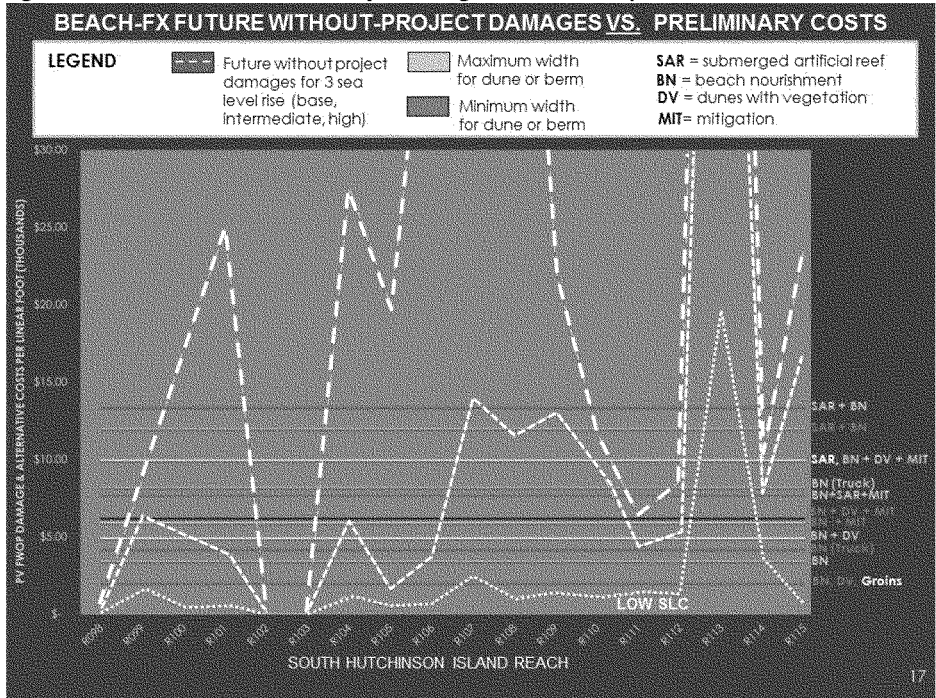
In order to screen the alternatives prior to Beach-fx modeling, preliminary costs were developed for each of the alternatives. The preliminary costs were developed using information from historical projects. These costs were brought to present value (PV) based on maintenance assumptions over 50 years.

Beach-fx, Future without-project Condition, and Sea-Level Change (SLC)

Beach-fx was run for the future without-project (FWOP) condition using each of the three Sea Level Change (SLC) scenarios prescribed by ER 1100-2-8162.

A project's benefit-to-cost ratio (B/C ratio) must be greater than 1.0 in order for an alternative to be justified and implementable; in short, the benefits must be greater than the costs. Benefits equal damages prevented, or the difference between without-project damages and damages resulting after implementation of an alternative.

At this point in the study, damages are used as a proxy for benefits. Using the value of without-project damages as a substitute for the benefits will overestimate the benefit provided by any measure since this assumes that 100 percent of damages have been averted. Therefore if the cost of implementing an alternative is equal to, or less than the without-project damages, the B/C ratio can be assumed to approximate 1. **Figure 3-1** displays the costs in addition to damages along the shoreline for each of the three SLC scenarios. Wherever damages were far below an alternative's implementation costs, it was assumed that the alternative would not be justified along that shoreline length and the alternative was screened out.

Figure 3-1. Beach-fx Future Without-Project Damages and Preliminary Costs.

Where damages are near or above preliminary costs it was assumed that the alternative was justified and was carried forward. This comparison not only helps in screening, but it also serves to scope alternatives that are carried forward.

The cost of an alternative's implementation may vary depending on the SLC scenario used for design. Because of this it is important to note that there is uncertainty regarding future costs, and alternatives with costs just above projected damages should not be screened out prematurely. Other measures may have the same implementation cost for any scenario.

In **Figure 3-1**, damages are shown for each preliminary Beach-fx sub-reach within the main South Hutchinson Island reach. Straight horizontal lines are the preliminary costs for the alternatives. The damages include damages to infrastructure (roads, houses, condos, dune walkovers, etc.).

Many combinations had preliminary costs that far exceed the expected damages along lengths of shoreline of sufficient length to realistically implement an alternative and were screened out.

This step was helpful to discern the alternatives which were too costly to provide BCRs above 1 in any of the sub-reaches. The alternatives screened out from this effort and reasons are listed below:

- All artificial reef alternatives, as the highest cost alternatives, were screened out (Alternatives 10 and 11).
- Alternative 7: All of the options for nourishment, dunes with vegetation, and hardbottom mitigation are screened out.
- Alternative 4: Although this alternative shows a different method of achieving the same goal as the other beach nourishment alternatives, it shows that at this time the trucking option is not viable for the maximum berm option. Trucking in general is more costly than the currently proposed offshore borrow area, and will be screened out at this time, but can be considered later if needed and viable.

The FWOP damages in the sub-reaches vary and the costs alone did not necessarily help to screen out alternatives. For additional screening, all alternatives were evaluated against planning objectives, constraints, P&G accounts, and criteria of completeness, effectiveness, efficiency, and acceptability. As a result, the following additional alternatives were screened out: Alternative 12 – Groins and Alternative 6 – Beach nourishment (large template) with hardbottom mitigation. The no-action alternative does not meet any of the planning objectives because it does not address any specific problems; however, it provides a comparison for all other alternatives.

A summary of the reasons for screening out the above alternatives are described below:

- Alternative 6 – Beach nourishment (large template) with hardbottom mitigation: Hardbottom mitigation is to be avoided within the study area, as stated in formulation strategy rationale, and would be environmentally unfavorable and as well costly.
- Alternative 12 – Groins: The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.

This resulted in the following alternatives carried forward to final screening:

- Alternative 1 – No-action
- Alternative 2 – Dunes with Vegetation
 - 2A: Minimum dune extension 10 feet
 - 2B: Maximum dune extension 20 feet
- Alternative 3 - Beach Nourishment (smaller template)
 - 3A: Minimum Berm 20 feet
 - 3B: Maximum Berm 40 feet
- Alternative 5 - Beach Nourishment (smaller template) AND Dunes with Vegetation
 - 5A: Minimum dune extension 10 feet + Minimum Berm 20 feet
 - 5B: Maximum dune extension 20 feet + Maximum Berm 40 feet

3.9 FINAL SCREENING: FUTURE WITH-PROJECT MODELING IN BEACH-FX

The 3 remaining alternatives, with minimum and maximum variations, were then modeled in Beach-fx, to evaluate future with-project (FWP) damages. Comparing “future without” to “future with” project damages results in the damage prevention provided by the alternative, where damage prevention is equivalent to storm damage reduction benefits.

The broad alternatives of 1, 2, 3, and 5 listed above in the previous section were then expanded to show possible berm widths, dune widths, and combinations of both berms and dunes. The alternatives were designated as follows:

- No-action represents an alternative where a project is not implemented. This alternative is always considered during the planning process.
- **A**BermxDuneEx represents maintenance of the existing berm (0-foot design berm), with an x foot extension, and maintenance of the 2008 dune (“existing condition”).
- **B**BermxDuneEx represents a 20-foot design berm, with an x-foot extension, and maintenance of the 2008 dune (“existing condition”).
- **C**BermxDuneEx represents a 40-foot design berm, with an x-foot extension, and maintenance of the 2008 dune (“existing condition”).
- DuneEx: represents maintenance of the 2008 dune only
- DuneX: represents maintenance of the 2008 dune with an additional x foot extension

The array shown in **Table 3-2** presents the results of the alternatives after running the Beach-fx model for 25 iterations (compared to 100 iterations). This allowed a preliminary output in a shorter timeframe, rather than running 100 iterations which would be more time consuming and would give similar outputs. The results give storm damage reduction benefits, and are organized by highest net benefits to lowest net benefits, and show that only nine alternatives have the highest net benefits which would then translate to benefit to cost ratios which are over 0.5. Selecting the alternatives with a BCR over 0.5 gives reasonable assurance that an alternative could then be justified {BCR over 1} after adding recreation and land loss benefits.

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Table 3-2. Expanded Array of Alternatives¹⁷.

Alternative Name	Avg Total Project Vol (CY) *	Avg Renourishment Interval (Years)	Mob, PED, S&A Cost (\$AAEQ)	Additional Initial Costs (\$AAEQ) *	Alternative Iteration.csv Avg Place Costs (\$AAEQ) *	Total Cost (\$AAEQ) *	FWOP Avg Damages (\$AAEQ) *	FWP Avg Damages (\$AAEQ) *	Avg Total Project Benefits (\$AAEQ) *	Net Benefits (\$AAEQ)	BC (**)
ABERM10DuneEx	6,006,856	12	\$ 321,119	\$ 9,218	\$ 534,271	\$ 864,608	\$ 978,091	\$ 87,470	\$ 890,621	\$ 26,013	1.03
ABerm20DuneEx	10,649,836	16	\$ 236,709	\$ 46,753	\$ 695,119	\$ 978,581	\$ 978,091	\$ 90,409	\$ 887,682	\$ (90,898)	0.91
Dune10	6,626,298	12	\$ 322,037	\$ 112,105	\$ 1,018,536	\$ 978,091	\$ 978,091	\$ 94,089	\$ 884,003	\$ (134,533)	0.87
ABerm30DuneEx	15,688,521	19	\$ 202,908	\$ 27,655	\$ 858,963	\$ 1,089,526	\$ 978,091	\$ 96,707	\$ 881,384	\$ (208,141)	0.81
ABerm10Dune10	10,089,763	15	\$ 275,250	\$ 116,969	\$ 769,961	\$ 1,162,180	\$ 978,091	\$ 87,790	\$ 890,302	\$ (271,879)	0.77
ABerm40DuneEx	20,003,186	20	\$ 193,283	\$ 69,025	\$ 1,036,247	\$ 1,298,555	\$ 978,091	\$ 95,265	\$ 882,826	\$ (415,729)	0.68
Dune20	10,575,649	14	\$ 285,845	\$ 219,558	\$ 834,055	\$ 1,339,458	\$ 978,091	\$ 94,463	\$ 883,628	\$ (455,830)	0.66
BBerm30DuneEx	7,424,509	9	\$ 429,293	\$ 27,655	\$ 984,323	\$ 1,441,271	\$ 978,091	\$ 82,305	\$ 895,786	\$ (445,488)	0.62
ABerm60DuneEx	28,788,703	22	\$ 183,737	\$ 55,310	\$ 1,389,344	\$ 1,628,391	\$ 978,091	\$ 93,546	\$ 884,545	\$ (743,848)	0.54
ABerm40Dune10	21,780,431	17	\$ 240,041	\$ 144,624	\$ 1,425,512	\$ 1,810,178	\$ 978,091	\$ 88,548	\$ 889,543	\$ (820,635)	0.49
ABerm20Dune20	12,840,428	12	\$ 328,178	\$ 233,938	\$ 1,251,632	\$ 1,813,748	\$ 978,091	\$ 81,806	\$ 896,285	\$ (917,463)	0.49
ABerm80DuneEx	37,709,339	23	\$ 173,412	\$ 73,746	\$ 1,701,669	\$ 1,948,828	\$ 978,091	\$ 101,274	\$ 876,817	\$ (1,072,010)	0.45
BBerm60DuneEx	22,527,784	16	\$ 261,768	\$ 55,310	\$ 1,644,761	\$ 1,961,838	\$ 978,091	\$ 86,620	\$ 891,471	\$ (1,070,366)	0.45
BBerm40Dune10	13,591,156	11	\$ 358,104	\$ 144,624	\$ 1,469,265	\$ 1,971,993	\$ 978,091	\$ 81,786	\$ 896,305	\$ (1,075,689)	0.45
CBerm60DuneEx	16,982,751	12	\$ 336,329	\$ 55,310	\$ 1,691,130	\$ 2,082,769	\$ 978,091	\$ 82,460	\$ 895,631	\$ (1,187,137)	0.43
ABerm40Dune20	23,019,924	16	\$ 257,148	\$ 258,821	\$ 1,668,656	\$ 2,184,625	\$ 978,091	\$ 88,444	\$ 889,647	\$ (1,294,978)	0.41
ABerm60Dune10	30,872,571	18	\$ 228,857	\$ 163,060	\$ 1,880,769	\$ 2,272,686	\$ 978,091	\$ 92,393	\$ 885,698	\$ (1,386,988)	0.39
BBerm40Dune20	14,388,859	10	\$ 387,414	\$ 252,374	\$ 1,710,127	\$ 2,349,916	\$ 978,091	\$ 82,281	\$ 895,811	\$ (1,454,105)	0.38
BBerm60Dune10	23,736,751	15	\$ 283,048	\$ 163,060	\$ 1,920,849	\$ 2,366,957	\$ 978,091	\$ 85,241	\$ 892,851	\$ (1,474,106)	0.38
BBerm80DuneEx	32,070,152	17	\$ 241,386	\$ 73,746	\$ 2,095,143	\$ 2,410,275	\$ 978,091	\$ 88,853	\$ 889,238	\$ (1,521,037)	0.37
CBerm60Dune10	17,689,214	11	\$ 368,051	\$ 163,060	\$ 1,972,853	\$ 2,503,964	\$ 978,091	\$ 82,601	\$ 895,490	\$ (1,608,474)	0.36
CBerm80DuneEx	21,354,281	12	\$ 338,117	\$ 73,746	\$ 2,142,950	\$ 2,554,812	\$ 978,091	\$ 83,945	\$ 894,146	\$ (1,660,666)	0.35
ABerm60Dune20	32,351,472	17	\$ 240,570	\$ 270,811	\$ 2,137,063	\$ 2,648,444	\$ 978,091	\$ 90,838	\$ 887,253	\$ (1,761,191)	0.34
ABerm80Dune10	39,240,918	20	\$ 219,843	\$ 181,497	\$ 2,269,825	\$ 2,671,165	\$ 978,091	\$ 87,318	\$ 890,773	\$ (1,780,392)	0.33
BBerm60Dune20	24,912,910	13	\$ 298,651	\$ 270,811	\$ 2,170,489	\$ 2,739,952	\$ 978,091	\$ 84,810	\$ 893,281	\$ (1,846,670)	0.33
BBerm80Dune10	33,976,671	17	\$ 248,645	\$ 181,497	\$ 2,329,114	\$ 2,759,256	\$ 978,091	\$ 84,513	\$ 893,578	\$ (1,865,677)	0.32
CBerm60Dune20	18,631,403	10	\$ 380,926	\$ 270,811	\$ 2,181,420	\$ 2,833,157	\$ 978,091	\$ 83,391	\$ 894,700	\$ (1,938,457)	0.32
CBerm80Dune10	21,905,423	11	\$ 356,877	\$ 181,497	\$ 2,392,275	\$ 2,930,648	\$ 978,091	\$ 83,579	\$ 894,512	\$ (2,036,136)	0.31
ABerm80Dune20	41,391,623	18	\$ 229,143	\$ 289,248	\$ 2,553,427	\$ 3,071,817	\$ 978,091	\$ 89,147	\$ 888,944	\$ (2,182,873)	0.29
BBerm80Dune20	34,933,321	16	\$ 259,840	\$ 289,248	\$ 2,564,408	\$ 3,113,496	\$ 978,091	\$ 84,768	\$ 893,323	\$ (2,220,173)	0.29
CBerm80Dune20	22,729,709	11	\$ 377,167	\$ 289,248	\$ 2,648,912	\$ 3,315,326	\$ 978,091	\$ 84,822	\$ 893,269	\$ (2,422,057)	0.27

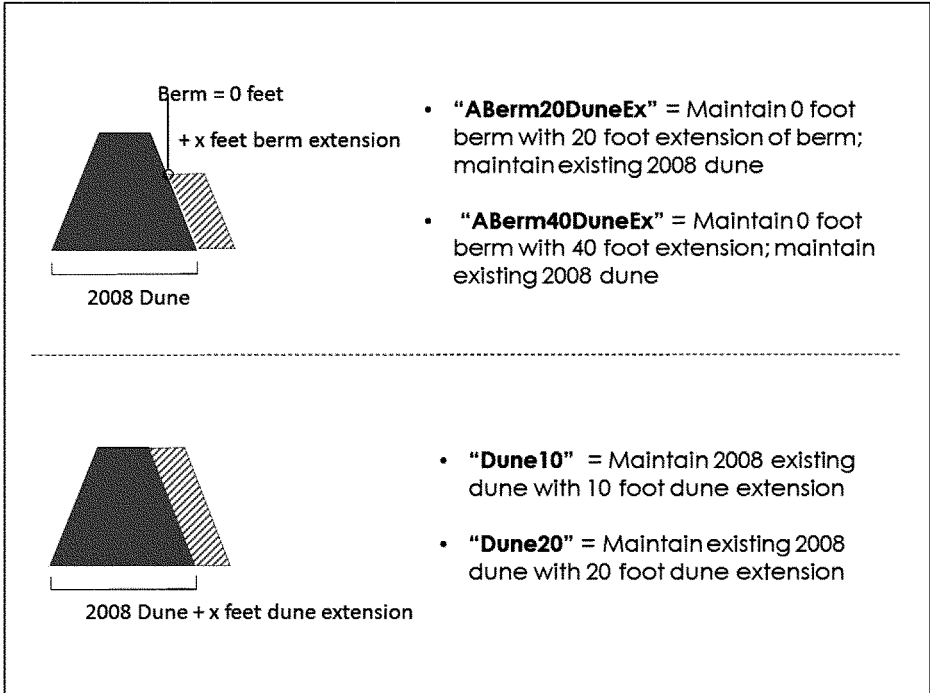
These nine alternatives are highlighted in blue on **Table 3-2**, and graphic examples are shown in **Figure 3-2**. They are also listed below, in order of highest net benefits to lowest:

- **No-action**
- **2008 Dune + 10 ft. Berm Extension (ABerm10DuneEx):** 0-foot design berm, Maintain existing berm with 10-foot extension; maintain existing dune
- **2008 Dune + 20 ft. Berm Extension (ABerm20DuneEx):** Maintain existing berm with 20-foot extension; maintain existing dune
- **2008 Dune + 10 ft. Dune Extension (Dune10):** Maintain existing dune with 10-foot extension
- **2008 Dune + 30 ft. Berm Extension (ABerm30DuneEx):** 0-foot design berm, Maintain existing berm with 30-foot extension; maintain existing dune
- **2008 Dune + 40 ft. Berm Extension (ABerm40DuneEx):** 0-foot design berm , Maintain existing berm with 40-foot extension; maintain existing dune
- **2008 Dune + 20 ft. Dune Extension (Dune20):** Maintain existing dune with 20-foot extension

¹⁷ Additional Initial Costs include associated costs to cover incidental work prior to initial construction of each alternative such as dune vegetation, turbidity monitoring, beach tilling, escarpment removal, environmental monitoring, traffic maintenance, etc.

- **2008 Dune + 20 ft. Design Berm+ 10-foot Berm Extension (BBerm30DuneEx):** 20-foot design berm, 10-foot extension; maintain existing dune
- **2008 Dune + 60 ft. Berm Extension (ABerm60DuneEx):** 0-foot design berm, Maintain existing berm with 60-foot extension; maintain existing dune

Figure 3-2. Examples of Dune and Berm Alternatives.



After the preliminary results were obtained as discussed in the previous section, the top five¹⁸ alternatives were chosen to be carried forward. Five was deemed to be a reasonable number of alternatives that could be modeled within the given timeframe, and had the best chance at being economically justified, as well as reasonably maximizing net benefits within the study area. The top five alternatives, along with the no-action alternative, were:

- **No-action**
- **2008 Dune + 10 ft. Berm Extension (ABerm10DuneEx)** = Maintain existing berm with 10-foot extension; maintain existing dune

¹⁸ ABerm10Dune10 was screened from Table 3-2 since it is not realistic from a constructability standpoint.

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- **2008 Dune + 20 ft. Berm Extension (ABerm20DuneEx)** = Maintain existing berm with 20-foot extension; maintain existing dune
- **2008 Dune + 10 ft. Dune Extension (Dune10)** = Maintain existing dune with 10-foot extension
- **2008 Dune + 30 ft. Berm Extension (ABerm30DuneEx)** = Maintain existing berm with 30-foot extension; maintain existing dune
- **2008 Dune + 40 ft. Berm Extension (ABerm40DuneEx)** = Maintain existing berm with 40-foot extension; maintain existing dune

For the numbers shown in **Table 3-2**, a preliminary cost was used for all alternatives which included dredging from the ocean borrow site and placement for all alternatives. At this point, benefits were influenced by three main factors. First, the rebuild assumption in the Beach-fx model was set at a very conservative numbers at this stage, which capped potential FWOP and FWP benefits. Second, benefits from R-115 to the Martin County line had not yet been incorporated. Third, the model runs were performed for 25 iterations only. For this table, only storm damage reduction benefits were included.

After more discussions, the 10-foot alternatives (both ABerm10DuneEx and Dune10) were considered to be too small to be reasonably constructed through a dredging operation. Therefore, at this level of consideration and screening, a revised preliminary cost was used for both 10-foot alternatives to show truck haul from an upland borrow site.

For the final round of screening, the 5 alternatives carried forward as described above were then modeled in Beach-fx using full (100 iterations) life-cycle simulations, with updated benefits for the portion from R-115 to Martin County line, and with rebuild assumptions that were more likely to occur, and with the truck haul estimates for ABerm10DuneEx and Dune10. The results of these simulations were used to select the NED Plan, presented in **Table 3-3**. The combination of storm damages reduction benefits and land loss are typically relied on for plan formulation and plan selection and are therefore both shown in **Table 3-3**. Recreation benefits in this case are shown after the recommended plan is determined. The Economics Appendix shows additional level of detail.

The 20-foot berm extension alternative, ABerm20DuneEx, was determined to be the NED plan, as the alternative with the highest net benefits, and meets the planning objectives, constraints, and P&G accounts and criteria as described above. It meets the Federal criteria of being economically justified, with a BCR equal to or more than 1.0.

Table 3-3. AAEQ Benefits and Costs for Final Array of Alternatives.¹⁹

Alternative Name	Total Primary Benefits	Total Costs	Primary Net Benefits	BCR
No-action	-	-	-	-
20-foot Berm (R-98.5 to Martin County line)	\$ 2,399,612	\$ 1,314,927	\$ 1,084,685	1.82
10-foot Berm (R-98.5 to Martin County line)	\$ 2,392,243	\$ 1,411,990	\$ 980,253	1.69
30-foot Berm (R-98.5 to Martin County line)	\$ 2,400,363	\$ 1,462,493	\$ 937,870	1.64
10-foot Dune (R-98.5 to Martin County line)	\$ 2,361,179	\$ 1,485,348	\$ 875,831	1.59
40-foot Berm (R-98.5 to Martin County line)	\$ 2,397,415	\$ 1,627,343	\$ 770,072	1.47

Table 3-4 lists alternatives considered in the environmental assessment and summarizes the major features and consequences of the future without-project (No-action Plan); the existing dune and 10-foot berm extension, and the 10-foot dune extension (both less than the recommended plan); the Recommended Plan which is the existing dune and 20-foot berm extension; and the existing dune and 30-40-foot berm (both greater than the recommended plan). As noted in the table, the effects are similar for all alternatives, except for minor differences in magnitude of effect, and therefore only the recommended plan is carried forward for detailed analysis in Chapter 5.

Costs were developed by SAJ District Cost Engineering personnel in FY17 dollars. Benefits are in FY17 discount rate.

Table 3-4. Summary of Direct and Indirect Impacts.

ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
GENERAL ENVIRONMENTAL SETTING (refer to Sections 2.1 and 5.1.1)	Increased protection of infrastructure as well as creation of additional beach habitat. Temporary adverse effects including, but not necessarily limited to sea turtles, benthic resources, aesthetics, and noise. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Increased protection of upland infrastructure as well as creation of additional habitat. Temporary adverse effects including, but not necessarily limited to sea turtles, benthic resources, aesthetics, and noise.	Upgraded protection of upland infrastructure as well as creation of additional beach habitat. Temporary adverse effects including, but not necessarily limited to sea turtles, benthic resources, aesthetics, and noise. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	Loss of beach habitat from continuing erosion. Other factors such as sea level rise would affect the general environmental setting).
Vegetation (refer to Sections 2.2.1 and 5.1.2)	Reduced erosion and reduced loss of dune vegetation. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Reduced erosion and reduced loss of dune vegetation.	Reduced erosion and reduced loss of dune vegetation. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	Continued erosion of the beach and dune would result in the loss of vegetation. Additional landowners may install armoring measures which would alter the remaining dune system and displace vegetation.
FISH AND WILDLIFE RESOURCES (refer to Sections 2.2.2 and 5.1.3)	Beach placement would temporarily impact fish and wildlife species that utilize the beach placement area. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Beach placement would temporarily impact fish and wildlife species that utilize the beach placement area.	Beach placement would temporarily impact fish and wildlife species that utilize the beach placement area. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	Species that utilize the beach may decrease in number due to erosion. No changes in fish and wildlife resources that occur below the swash zone are anticipated.

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ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
SEA TURTLES (refer to Sections 2.2.3 and 5.1.4)	Dredging and beach placement activities may affect sea turtles. Minor magnitude and duration changes with each berm width alternative. Protective measures would be implemented. Effects would be slightly less than the Recommended Plan.	Dredging and beach placement activities may affect sea turtles. Protective measures would be implemented.	Dredging and beach placement activities may affect sea turtles. Minor magnitude and duration changes with each berm width alternative. Protective measures would be implemented. Effects would be slightly greater than the Recommended Plan.	Beach erosion would result in less nesting habitat. An increase in armoring would also result in less nesting habitat.
MANATEE (refer to Sections 2.2.3 and 5.1.4)	Dredging operations may affect, but are not likely to adversely affect the manatee. Minor magnitude and duration changes with each berm width alternative. Protective measures would be implemented. Effects would be slightly less than the Recommended Plan.	Dredging operations may affect, but are not likely to adversely affect the manatee. Protective measures would be implemented.	Dredging operations may affect, but are not likely to adversely affect the manatee. Minor magnitude and duration would change with each berm width alternative. Protective measures would be implemented. Effects would be slightly greater than the Recommended Plan.	No effect.
SMALLTOOTH SAWFISH (refer to Sections 2.2.3 and 5.1.4)	Dredging operations may affect, but are not likely to adversely affect the sawfish. Minor magnitude and duration changes with each berm width alternative. Protective measures would be implemented. Effects would be slightly less than the Recommended Plan.	Dredging operations may affect, but are not likely to adversely affect the sawfish. Protective measures would be implemented.	Dredging operations may affect, but are not likely to adversely affect the sawfish. Minor magnitude and duration changes with each berm width alternative. Protective measures would be implemented. Effects would be slightly greater than the Recommended Plan.	No effect.

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ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
PIPING PLOVER AND RUFA RED KNOT (refer to Sections 2.2.3 and 5.1.4)	Beach placement operations may affect, but are not likely to adversely affect the plover and knot. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly less than the Recommended Plan.	Beach placement operations may affect, but are not likely to adversely affect the plover and knot. Protective measures would be implemented.	Beach placement operations may affect, but are not likely to adversely affect the plover and knot. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly greater than the Recommended Plan.	Beach erosion would result in less habitat for piping plovers and rufa red knots.
WHALES (refer to Sections 2.2.3 and 5.1.4)	Dredging operations within offshore borrow sites may affect, but are not likely to adversely affect whales. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly less than the Recommended Plan.	Dredging operations within offshore borrow sites may affect, but are not likely to adversely affect whales. Protective measures would be implemented.	Dredging operations may affect, but are not likely to adversely affect whales. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly greater than the Recommended Plan.	No effect
BEACH JAQUEMONTIA (refer to Sections 2.2.3 and 5.1.4)	Beach placement operations may affect, but are not likely to adversely affect the beach jaquemontia. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly less than the Recommended Plan.	Beach placement operations may affect, but are not likely to adversely affect the beach jaquemontia. Protective measures would be implemented.	Beach placement operations may affect, but are not likely to adversely affect the beach jaquemontia. Minor magnitude and duration changes with each berm width alternative. Protective measures would be slightly greater than the Recommended Plan.	Dune erosion would result in less habitat for beach jaquemontia.

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ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
HARDBOTTOM HABITAT (refer to Sections 2.2.4 and 5.1.5)	Dredging and beach placement would not exceed previous impacts to nearshore habitat. Mitigation for previous impacts to hardbottom has been successfully completed.	Dredging and beach placement would not exceed previous impacts to nearshore habitat. Mitigation for previous impacts to hardbottom has been successfully completed.	Dredging and beach placement would not exceed previous impacts to nearshore habitat. Mitigation for previous impacts to hardbottom has been successfully completed.	No effect.
ESSENTIAL FISH HABITAT (refer to Sections 2.2.5 and 5.1.6)	Dredging and beach placement would directly affect EFH. Minor magnitude and duration changes with each berm width alternative. Mitigation for previous impacts to hardbottom has been successfully completed. Effects would be slightly less than the Recommended Plan.	Dredging and beach placement would directly affect EFH. Mitigation for previous impacts to hardbottom has been successfully completed.	Dredging and beach placement would directly affect EFH. Minor magnitude and duration changes with each berm width alternative. Additional surveys to determine impacts to EFH may be required. Effects would be slightly greater than the Recommended Plan.	No effect.
OFFSHORE BORROW AREA SOURCES (refer to Sections 2.2.6 and 5.1.7)	Dredging of St. Lucie Shoals would directly affect bottom habitat. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than Recommended Plan.	Dredging of St. Lucie Shoals would directly affect bottom habitat. Protective measures would be implemented.	Dredging of St. Lucie Shoals would directly affect bottom habitat. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than Recommended Plan.	No effect.
COASTAL BARRIER RESOURCES (refer to Sections 2.2.7 and 5.1.8)	Additional beach habitat would be created. Federal funds within Unit P 11 would be expended in accordance with the USFWS determination (see USFWS letter dated November 2, 2015 in Appendix H: Pertinent Correspondence).	Additional beach habitat would be created. Federal funds within Unit P 11 would be expended in accordance with the USFWS determination (see USFWS letter dated November 2, 2016 in Appendix H: Pertinent Correspondence).	Additional beach habitat would be created. Federal funds within Unit P 11 would be expended in accordance with the USFWS determination (see USFWS letter dated November 2, 2016 in Appendix H: Pertinent Correspondence).	No effect.

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ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
WATER QUALITY (refer to Sections 2.2.8 and 5.1.9)	Dredging and beach placement would temporarily impact water quality. Minor magnitude and duration changes with each berm width alternative. Water quality would be monitored and protection measures implemented. Effects would be slightly less than the Recommended Plan.	Dredging and beach placement would temporarily impact water quality. Water quality would be monitored and protection measures implemented.	Dredging and beach placement would temporarily impact water quality. Minor magnitude and duration changes with each berm width alternative. Water quality would be monitored and protection measures implemented. Effects would be slightly greater than the Recommended Plan.	No effect.
HAZARDOUS, TOXIC, RADIOACTIVE WASTE (HTRW) (refer to Sections 2.2.9 and 5.1.10)	Encountering HTRW would not be anticipated.	Encountering HTRW is not anticipated.	Encountering HTRW would not be anticipated.	No effect.
AIR QUALITY (refer to Sections 2.2.10 and 5.1.11)	Slight increase in air pollution would be predicted. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Slight increase in air pollution is predicted.	Slight increase in air pollution is predicted. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	No effect.
NOISE (refer to Sections 2.2.11 and 5.1.12)	Construction noise levels would comply with local regulations. Construction noise would not be anticipated to exceed 55 dBA at noise sensitive areas. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Construction noise levels would comply with local regulations. Construction noise is not anticipated to exceed 55 dBA at noise sensitive areas.	Construction noise levels would comply with local regulations. Construction noise would not be anticipated to exceed 55 dBA at noise sensitive areas. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	No effect.

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ALTERNATIVE ENVIRONMENTAL FACTOR	10-foot Dune OR 10-foot Berm (smaller footprint than Recommended Plan)	20-foot Berm (Recommended Plan)	30-foot Berm OR 40-foot Berm (greater footprint than Recommended Plan)	No-Action Plan
AESTHETICS (refer to Sections 2.2.12 and 5.1.13)	Beach placement would temporarily impact aesthetics. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Beach placement would temporarily impact aesthetics.	Beach placement would temporarily impact aesthetics. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	Continued beach erosion would adversely affect aesthetics.
RECREATION (refer to Sections 2.2.13 and 5.1.14)	Beach placement would temporarily impact recreation. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly less than the Recommended Plan.	Beach placement would temporarily impact recreation.	Beach placement would temporarily impact recreation. Minor magnitude and duration changes with each berm width alternative. Effects would be slightly greater than the Recommended Plan.	Beach erosion would result in less recreational area.
CULTURAL RESOURCES (refer to Sections 2.2.14 and 5.1.15)	Dredging would not adversely affect cultural resources with protective buffers in place. Beach placement would have no effect.	Dredging would not adversely affect cultural resources with protective buffers in place. Beach placement would have no effect.	Dredging would not adversely affect cultural resources with protective buffers in place. Beach placement would have no effect.	No effect.
NATIVE AMERICANS (refer to Sections 2.2.15 and 5.1.16)	The Seminole Tribe of Florida have concurred with USACE determination of no effect.	The Seminole Tribe of Florida have concurred with USACE determination of no effect.	The Seminole Tribe of Florida have concurred with USACE determination of no effect.	No effect.

* All alternatives include maintenance of the existing (2008) dune.

3.10 THE RECOMMENDED PLAN

Typically, the NED plan becomes the Recommended Plan unless the non-federal sponsor opts to pursue a Locally Preferred Plan (LPP) which differs from the NED plan. An LPP is subject to the requirements described in ER 1105-2-100. The option of selecting an LPP was coordinated with the local sponsor, who opted not to pursue an LPP. The NED plan therefore is the Recommended Plan.

The 20-foot berm (7 ft-NAVD88) and maintenance of the existing dune is the Recommended Plan. The average initial construction volume over 100 Beach-fx iterations is 422,000 cubic yards (cy). The average volume of individual future periodic nourishments over 100 iterations is 390,000 cubic yards (cy).

Beach-fx reaches correspond, approximately, with FDEP range monuments (R-monuments). The shoreline extent of the Recommended Plan corresponds to a shoreline length spanning from R-monument R-98.5 to the Martin County Line (approximately R-115 plus 1000 feet). A detailed description of the Recommended Plan is included in the next chapter.

3.10.1 INCREMENTAL JUSTIFICATION OF THE RECOMMENDED PLAN

Model Reaches versus Geographic Reaches

Model reaches are 1000 feet long, centered on an R-monument. Therefore, model reach R-99 encompasses geographic reach R-98.5 to R-99.5.

Incremental analysis has been incorporated in the plan formulation process. The original project included the entire reach from R-97.5 to the Martin County line. During the incremental analysis, geographic location R-97.5 to R-98.5 (model reach 98) was not economically justified. Due to its location at the end of the project, and incidental length, R-97.5 to R-98.5 is not included in the full project length, and the project northern boundary is now geographic location R-98.5.

The nature of beach and dune nourishment is that performance of the project as a whole depends on the overall volume of sand placed and the dimensions of the placement. It is difficult to further divide the remaining segment (from R-98.5 to R-115) due to potential negative impacts on the overall project however to determine incremental justification of the Recommended Plan.

As defined in Engineering Regulation (ER) 1105-2-100, incremental analysis is a process used in plan formulation to help identify plans that deserve further consideration in an efficient manner. The analysis consists of examining increments of plans or project features to determine their incremental costs and incremental benefits. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs. The recommended plan was divided into three planning reaches for the incremental analysis.

On a long, straight sandy coast like the project area, it is assumed that a project of less than approximately one mile of shoreline length would not be implemented as a separate action or project. Therefore, the recommended plan area was divided into three planning reaches of roughly one mile. **Table 3-5** shows that each planning reach has positive net benefits, demonstrating that each is incrementally justified and recommended.

Table 3-5. Incremental Justification.

Geographic Planning Reach #	Model Reach #	Primary Benefits	Recreation Benefits	Certified Placement Cost	Net Benefits (without rec)	BCR (without Rec)	Net Benefits (with Rec)	BCR (With Rec)
R-98.5-R-104.5	R-99 to R-104	\$126,888	\$159,520	\$197,818	(\$70,930)	0.64	\$88,590	1.45
R-104.5 – R-110.5	R-105-R-110	\$248,645	\$130,173	\$199,771	\$48,873	1.24	\$179,046	1.90
R-110.5-R-115	R-111-R-115	\$2,024,080	\$275,978	\$178,272	\$1,845,808	11.35	\$2,121,786	12.90

*Plus 1000 feet to the Martin County line.



4

The Recommended Plan

4 RECOMMENDED PLAN

The recommended plan for St. Lucie County is a protective berm that extends the entire (2008) beach profile (7 ft-NAVD88) 20 feet seaward from the toe of the existing dune. The project construction reference line was established based on the 2008 “existing” dune and profile survey. The elevation of the construction reference line is a consistent +7 ft-NAVD88 (the nourishment template berm elevation). This will include restoration and/or leveling of the 2008 dune behind the construction reference line as well as extension of the berm.

The average initial construction volume over 100 iterations is 422,000 cubic yards (cy). The average volume of each future periodic nourishment over 100 iterations is 390,000 cubic yards (cy). It is important to clarify that the placed volume will be referenced throughout this report; however, the dredged volume is notably important as well for coordination of sand sources. The dredged volume is estimated to be 30% greater than the placement volume.

Traditionally, in CSRMs studies, a fixed periodic nourishment interval is defined and optimized for 50 year period of Federal participation. In Beach-fx, rather than having a fixed periodic nourishment interval, periodic nourishment events are triggered when specific criteria are met. The triggers were set up to simulate a point at which the berm extension erodes to at least half its equilibrated width. Based on these parameters, the average time interval between nourishment events over all 100 iterations is 18 years. In reality, this interval could vary significantly depending on erosion and storm events. More information about the periodic nourishment triggers is provided in the Engineering Appendix. Ultimately, planning based on life-cycle modeling results in plans that are more resilient and adaptable. Life-cycle modeling allows planners to design projects while recognizing the inherent uncertainty that exists when future events are simulated.

Beach-fx reaches correspond, approximately, with FDEP range monuments (R-monuments). The shoreline extent of the recommended plan, ABerm20DuneEx from Beach-fx corresponds to a shoreline length spanning from R-monument R-98.5 to the Martin County line (approximately R-001).

The economic results presented in this chapter reflect incorporation of storm damage reduction, land loss and recreation benefits, interest during construction (IDC) and operations, maintenance, repair, rehabilitation, and replacement (OMRR&R), as well as the refined costs in the Total Project Cost Summary (TPCS) found in **Appendix B – Cost Engineering and Risk Analysis**. Therefore the cost and economic results presented here will differ slightly from the values presented in previous chapters. A description of the recommended plan is shown in **Table 4-1**.

Table 4-1. Description of the Recommended Plan.

Recommended Plan Description	The Recommended Plan includes:
Average # Nourishment Events	1 initial construction event, approximately 2 periodic nourishment events
Average Volume of Initial Construction	422,000 cubic yards
Average Volume of Each Periodic Nourishment	First nourishment: 390,000 cubic yards Second nourishment: 390,000 cubic yards
Average Periodic Nourishment Interval	approximately 18 years
Initial Construction Duration	approximately 4 months
Recommended Plan project first cost (including contingency)	\$ 53,296,000 (October 1, 2017 (FY18) Price Level)
Cost sharing	Initial construction: 35% Federal / 65% non-federal Periodic nourishments: 27% Federal / 73% non-federal
Benefit-to-Cost Ratio (BCR)	2.20 @ 2.875% discount rate (FY17))

4.1 PROJECT DESIGN

The project design can be described by three factors: the dimensions of the dune, dimensions of the berm, and shoreline slopes.

4.1.1 PROJECT DUNE

Existing dune elevations in the Recommended Plan area are between 11 and 14 feet NAVD88 (Table 4-2). Evaluation of the design alternatives has shown that the existing elevations, when combined with berm and/or dune extension, provide sufficient protection. Therefore, no additional elevation is included in the selected design plan.

Table 4-2: Generalized Dune Characteristics of the Recommended Plan Area.

R monuments	Dune Height (ft-NAVD88)	Dune Width (ft.)
R-98.5 to R-102	11	55
R-103 to R-104	11	50
R-105 to R-106	11	120
R-107 to R-110	11	40
R-111	11	60
R-112	14	25
R-113 to Martin County	13	50

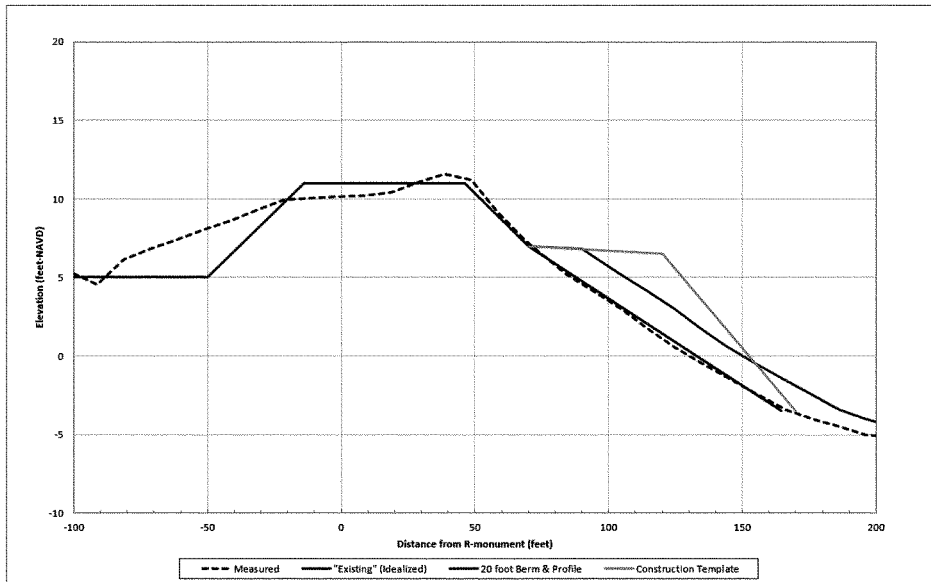
Within the area encompassed by the Recommended Plan, the average dune width ranges between 25 feet and 120 feet. Although the Recommended Plan does not include widening the existing dune, any erosion of material from the existing idealized dune template (i.e. the 2008 generalized profile) will be replaced during nourishment events. Therefore, the existing 2008 idealized dune template will be restored accordingly during initial construction and periodic nourishment of the project and is noted as an important feature of the project.

4.1.2 PROJECT BERM

The design berm elevation for the project area is 7 feet NAVD88, which is approximately at the natural berm elevation.

The project berm template consists of 20 feet of sacrificial fill (traditionally referred to as “advance” fill) designed to protect and maintain the existing dune between periodic nourishment events.

Figure 4-1: Existing profile and nourishment template for R-100 to R-111.



4.1.3 PROJECT BEACH SLOPES

After waves adjust and sort the placed sand, the sand is expected to settle into an equilibrium beach slope, similar to the native beach. In St. Lucie County, the native beach slopes in the project area are approximately 1 (vertical) on 6 (horizontal) at the dune, 1 on 10 from the berm to MLW (-2.5 ft-NAVD88), and 1 on 40 to 1 on 70 below MLW. The estimate of the slope of the material after adjustment is based on averaging the beach profile slopes of the native beach from the mean low water datum to the approximate location of the 15-foot depth contour. Sand from the project borrow site was determined to be a near match to the gradation and shell content of the existing beach. This will allow the beach fill to equilibrate to a shape similar to the existing profile.

It is unnecessary and impractical to artificially grade beach slopes below the low water elevation since they will be shaped by wave action. For this reason, the front slope of the beach fill placed at the time of

construction or future periodic nourishment may differ from that of the natural profile. The angle of repose of the hydraulically placed material depends on the characteristics of the fill material and the wave climate in the project area. With steep initial slopes, the material will quickly adjust to the natural slopes.

4.1.4 PROJECT VOLUMES

The average initial construction volume over 100 Beach-fx iterations is 422,000 cubic yards (cy). The average volume of individual future periodic nourishments over 100 iterations is 390,000 cubic yards (cy). It should be emphasized that these are average volumes based on Beach-fx modeling. The Engineering Appendix includes detailed description on how these averages are reached and the variability that can be expected.

4.1.5 PROJECT CONSTRUCTION

The Recommended Plan for St. Lucie County results in a protective berm that extends the entire (2008) beach profile (7 ft-NAVD88 to depth of closure) 20 feet seaward from the existing dune. Due to erosion, foot traffic, and intermittent repairs and maintenance, the project shoreline does not have a smooth, consistent dune feature. In order for the nourishment project to provide the maximum benefit and perform as predicted during the Beach-fx shoreline analysis, it is necessary to establish a smooth, relatively straight base construction reference line and to ensure that the dune is free of gaps and low points that would allow storm surge to penetrate at elevations inconsistent with the representative dune height(s) specified for the model reaches.

As previously discussed, the front slope of the beach fill placed at the time of construction, or future periodic nourishment, may differ from that of the natural profile. This reflects the capabilities of the construction equipment that will be used to build the coastal storm risk management project. Within the first year or two after placement of the beach fill, the construction profile will be reshaped by waves into an equilibrium profile, causing the berm to retreat to a position more characteristic of the project design template.

Based on the estimated average initial fill volume and constructability considerations, a construction template applicable to ABerm20DuneEx was determined. The construction template consists of a variable width berm with a 1 on 100 slope and foreshore fill extending to approximately -5.0 ft-NAVD88 with a slope of 1 on 5. This template, dimensioned for constructability, will then equilibrate into the project (20-foot berm and profile extension) template. The volume of material in the equilibrated profile (between the template and the “existing” condition) represents the material that is expected to erode between successive nourishment events.

4.1.6 PERIODIC NOURISHMENT EVENTS

As stated, the Recommended Plan includes a 20-foot berm extension of the existing berm, and maintenance of the existing dune.

Traditionally, periodic nourishment events take place based on both an economically optimized periodic nourishment interval and the physical performance of the project. Project performance, in the past, has been determined by assessing the condition of the design template. Should the design template be breached, the project is no longer providing the required level of protection and is considered for periodic nourishment. Part of this consideration is how close the project may be to the designated periodic nourishment interval.

While the basic principles of periodic nourishment still apply, due to the probabilistic nature of Beach-fx and the way in which the model assesses periodic nourishment requirements, a new means of assessing project performance must be employed. The former concepts of “design template” and “advance fill” are only loosely applicable. The entire 20-foot berm and beach profile extension template acts as the “advance fill”, while the existing beach profile is the minimum acceptable profile (making it akin to what was formerly the “design template”).

Assessing the performance of the project fill now has two stages. First, a survey of the project area (such as a monitoring or post-storm survey) will be assessed to determine if the shoreline at any of the R-monument locations within the project have receded past the pre-project (2008) condition. If recession beyond the pre-project condition has occurred at one or more of the R-monuments, then a summation of the volume required to restore those profiles to the initial construction template will be made. If the total volume required to restore the receded profiles exceeds the threshold volume (280,000 cubic yards), then a periodic nourishment event is recommended. The decision to periodically nourish may then be made based on traditional concerns, including such factors as budget cycle and available funding.

With an average time interval of 18 years, the nourishment years would be 2020 for initial construction, followed by periodic nourishment in 2038 and 2056.

4.1.7 PROJECT MONITORING

Physical monitoring of the recommended project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year period of Federal participation in the project. The monitoring plan will be directed primarily toward accomplishing systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project periodic nourishment is necessary. Post construction monitoring activities include topographic and bathymetric surveys of the placement area and adjacent areas on an annual basis for 3 years following construction and then biannually until the next construction event. Other monitoring efforts include bathymetric surveying of the sand source, which will be done prior to each periodic nourishment. Measured wind, wave, and water level information will be obtained from the best available existing data sources. This data will be applied in support of previously discussed monitoring efforts. It will also be used to periodically assess the state of sea level rise and to determine if reassessment of the project volumes and/or periodic nourishment intervals is required.

4.1.8 OPERATIONS AND MAINTENANCE CONSIDERATIONS

33 U.S. Code § 426e (Federal aid in protection of shores) states, “When in the opinion of the Chief of Engineers the most suitable and economical remedial measures would be provided by periodic beach nourishment, the term “construction” may be construed for the purposes of sections 426e to 426h–1 of this title to include the deposit of sand fill at suitable intervals of time to furnish sand supply to project shores for a length of time specified by the Chief of Engineers.” By this provision, periodic nourishment is considered construction and not maintenance, and therefore is cost shared. The Recommended Plan involves initial construction and periodic nourishment, and is technically “beach nourishment.” Physical (topographic and bathymetric) and environmental surveys supporting beach nourishment are cost-shared activities included in the total project cost. The operations, maintenance, repair, rehabilitation, and

replacement (OMRR&R) anticipated for this project includes any necessary long-term topographic and bathymetric surveys (different from those supporting beach nourishment activities) of the placement area and adjacent areas, and a monitoring report on an annual basis for 3 years following construction and then biannually until the next construction event. Other OMRR&R items may include revegetating the dune as needed between nourishment activities (per Policy Guidance Letter No. 27 (11/17/92)), scarp repair, and beach tilling. The operations and maintenance will also include the items of local cooperation. These items entail publicizing floodplain information, ensuring continued conditions of public ownership and use of the shore, performing surveillance of the beach, and any specific directions prescribed by the government. Based on the size and scope of the Recommended Plan and the cost of similar activities for similar projects, the annual average costs for OMRR&R are estimated to be \$32,245 per year.

Operations and maintenance is borne 100% by the non-federal sponsor and is detailed in a Project Partnership Agreement (PPA). An Operations and Maintenance Manual will be completed by USACE and provided to the sponsor following completion of initial construction.

4.2 RECOMMENDED SAND SOURCE

The recommended plan will require approximately 1,202,400 cubic yards of sand over a 50 year period. The initial construction volume of 422,000²⁰ cubic yards and the periodic nourishment volume is 390,000 cubic yards every 18 years on average.

As detailed in the **Geotechnical Appendix**, there is adequate beach quality sand (meeting FDEP permitting requirements for beach placement) to meet the estimated sand needs of the recommended plan. Currently, there is approximately 10.6 million cubic yards of compatible sand available within the St. Lucie Shoals, which is composed of the north and south shoals (8.3 million in the north and 2.3 million in the south). This volume is more than adequate to meet the average total forecasted project volume.

4.3 SEA LEVEL CHANGE CONSIDERATIONS

An important aspect about the recommended plan is its performance under different Sea Level Change scenarios. As discussed earlier in this report, the study area is experiencing Sea Level Rise (SLR). Each of the SLR scenarios described earlier are considered equally likely to occur. Therefore, if the project does not perform, then it cannot be considered a completely effective plan. **Table 4-3** shows the average BCRs and net benefits of the NED recommended plan under the three SLR scenarios. As shown below, the recommended plan performs satisfactorily in each SLR scenario.

²⁰ Note that these volumes are from Beach-fx and are approximate averages, due to the probabilistic nature of the model (randomly generated storm seasons over the life of the project). Volumes needed could be slightly more or less over the life cycle of the project. The Engineering Appendix, Table 6-2, provides a discussion of the project volume breakdown and confidence interval information.

Table 4-3. Average PV Benefits and Costs for the recommended plan in different SLR scenarios.

	Nourishment Interval (Years)	Total Cost	Total Benefits	Net Benefits	BCR
Base -SLR1	19	\$ 1,314,927	\$ 2,165,474	\$ 850,547	1.65
Intermediate - SLR2	7	\$ 2,729,218	\$ 7,098,469	\$ 4,369,251	2.60
High - SLR3	4	\$ 5,169,728	\$ 16,546,952	\$ 11,377,224	3.20

4.4 BENEFITS OF THE RECOMMENDED PLAN

4.4.1 ECONOMIC SUMMARY

St. Lucie County is highly susceptible to hurricane and storm damage. This is particularly true for the large and high-value commercial structures and more pronounced in the southern section of the project area. Beach-fx modeling has demonstrated that, in the absence of a Federal project, significant economic damage from coastal forces can be expected to occur over the next 50 years. When factoring in the potential for sea levels to rise in excess of baseline projections those economic damages could average almost half of a billion dollars in present-value terms.

The model results suggest that the recommended plan is highly effective at reducing nearly all damages, with primary economic benefits of the plan generated by reductions in erosion, wave, and inundation damages. The recommended plan is effective in the following ways:

Types of Damages: The project will reduce the number of structure types that are receiving damage. In the FWOP, 20 different structure types were being damaged (reference the Economic Appendix) whereas under the recommended plan only six different structure types receive damage; residential property, roads, and all high-rise structure are notably not among those 6 categories.

Effective over time: The recommended plan is also effective over time and requires only two periodic nourishment events throughout the 50-year period of analysis of the project.

Conclusion: The recommended plan prevents 98% of economic damages across 50 years with only two periodic nourishments and nets \$1,617,000 AAEQ worth of benefits. The project yields \$2.20 in benefits for every \$1.00 spent (i.e. BCR is 2.20). The plan is efficient, acceptable and complete. It is also increasingly efficient and resilient under sea level change scenarios. Though the recommended plan is relatively small in scope and scale, it represents the most prudent investment of Federal and sponsor dollars. The economic summary is shown in **Table 4-4**.

Table 4-4. Economic Summary in AAEQ of the Recommended Plan. (FY17 Price level and FY17 Water Resources Discount rate (2.875%).

ECONOMIC SUMMARY	STORM RISK MANAGEMENT BENEFITS ONLY	STORM RISK MANAGEMENT + LAND LOSS BENEFITS (PRIMARY)	STORM RISK MANAGEMENT + LAND LOSS + RECREATION BENEFITS
Storm Risk Management Benefits	\$2,165,000	\$2,165,000	\$2,165,000
Land Loss Benefits	\$0	\$234,000	\$234,000
Recreation Benefits	\$0	\$0	\$566,000
Total Benefits	\$2,165,000	\$2,400,000	\$2,965,000
Total Cost	\$1,349,000	\$1,349,000	\$1,349,000
Net-Benefits	\$817,000	\$1,051,000	\$1,617,000
Benefit Cost Ratio	1.61	1.78	2.20

4.4.2 LAND LOSS AND RECREATION BENEFITS

LAND LOSS BENEFITS

In outlining the process and procedures to be used in the evaluation of coastal storm risk management projects, ER-1105-2-100 mentions the inclusion of land loss due to erosion, stating that such damages should be computed as the market value of the average annual area expected to be lost. Prevention of land loss is a component of primary storm damage reduction benefits but is not computed within the Beach-fx model. Thus, calculation of land loss benefits must be completed external to the model and added to the structure and contents damage benefits to obtain the total storm damage reduction benefits of the project.

Following the guidance provided, two key pieces of information are needed to calculate land loss benefits of a storm damage reduction project: (1) the square footage of the land lost each year and (2) the market value of land in the project footprint. The Economics Appendix provides detail on how the square footage of land loss each year was calculated. As the second component of the land loss benefits calculation, ER 1105-2-100 instructs that nearshore land values be used to estimate the value of land lost. The Jacksonville District Real Estate Department estimated a nearshore land value of \$14.00 per square foot for the St. Lucie study area.

Using the analysis technique described, the total present value of land loss benefits over the 50 year period of analysis estimated at \$234,000 AAEQ.

RECREATION BENEFITS

According to ER-1105-2-100, incidental recreation benefits can be calculated for Coastal Storm Risk Management (CSRM) projects. While recreation benefits cannot make up more than 50% of the total benefits needed for project justification, the guidance states, "if the criterion for participation is met, then all recreation benefits are included in the benefit to cost analysis." Recreation benefits represent a vital component of a CSRM project and access for the public to use and recreate on the beach is the foundation for Federal interest in the project. Though recreation cannot be used for plan formulation, and though

the recommended plan is economically justified on primary benefits alone, recreation benefits play a significant role in increasing net-benefits.

Additionally, ER-1105-2-100 specifies that benefits arising from recreation opportunities created by a project be measured in terms of willingness to pay. As described in the **Economics Appendix**, the unit day value (UDV) method was used to calculate the incidental recreation benefit provided by the recommended plan resulting in an estimated total present value of recreation benefits of \$565,000 AAEQ.

4.4.3 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS

As mentioned earlier in the Plan Formulation Rationale, the four accounts NED, RED, EQ and OSE are always used as criteria in formulation and selection of a plan. In this case, this particular plan not only has significant NED benefits, but also has a number of worthy considerations in the OSE category, as well as other points that should be made which were key in plan formulation or engineering for the entire reach of South Hutchinson Island. These points are listed and briefly summarized below:

- Plan Formulation Rationale:
 - Florida Department of Environmental Protection (FDEP) Designation of Critically Eroded: The entire increment of R-98 to Martin County has been identified as being critically by FDEP Report on Critically Eroded Beaches in Florida, Division of Water Resource Management, FDEP, June 2015.
 - Early screening of project reaches: The original project scope included a total of four FDEP designated reaches. During the plan formulation process, the northern most upper three reaches were screened out, leaving one reach, South Hutchinson Island, as the study scope.
- Engineering considerations:
 - Constructability – Constructing the full project reach benefits the project in terms of stability, and efficiency of construction methods. If a gap were to occur where Dollman Park is for a small stretch, tapers north and south would overlap, creating an inefficient construction method compared to a continuous stretch, involving the same volume of sand.
 - Sea level rise scenarios – The project gains effectiveness from a continuous stretch, when faced with not only baseline but increasing potential damages under a without-project condition in the intermediate and high scenarios.
- Evaluation criteria (OSE):
 - Importance of Evacuation Route – The overall project experiences prevents flooding on A1A, and protects the entire project length from a potential breach in the barrier island. Such a breach could cut off access north or south to the nearest evacuation route, rerouting residents for a delay of up to 20 miles.
 - Public Access – There is considerable public access and parking in the Dollman Park area, which also transcends aesthetics and general accessibility for the public in the area to the rest of the project area.

- Amount of residents in northern extent: Despite the small length of a few thousand feet in the area of R-99 to R-101.5, this area contains five condominiums with upwards of 500 homeowners. A project over the entire reach protects these structures and homeowners who are vulnerable to hurricane and storm damages, under base, intermediate, and high sea level rise scenarios.

4.4.4 BENEFITS TO EVACUATION ROUTE STATE ROAD A1A

The recommended plan was modeled to obtain how effective it would be at preventing flooding of both one foot or more and two feet or more to Florida State Route A1A. The recommended plan was effective in achieving both of these goals since 0% of the iterations experienced flooding of either one or two feet. Thus, the recommended plan performs satisfactorily in keeping A1A accessible as an evacuation route.

4.5 FEDERAL IMPEMENTATION RESPONSIBILITIES

USACE is responsible for budgeting for the Federal share of future Federal construction projects. Federal funding is subject to budgetary constraints inherent in the formation of the national civil works budget in a given fiscal year. USACE would perform the necessary preconstruction engineering and design (PED) needed prior to construction. USACE would meet requirements for the use of Federal lands at the borrow area, obtain water quality certification, coordinate with the state as required by the Coastal Zone Management Act, and construct the project. Cost sharing of PED, initial construction, and periodic nourishment will be in accordance with WRDA 1986, as amended, subject to the availability of appropriations.

4.6 NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES

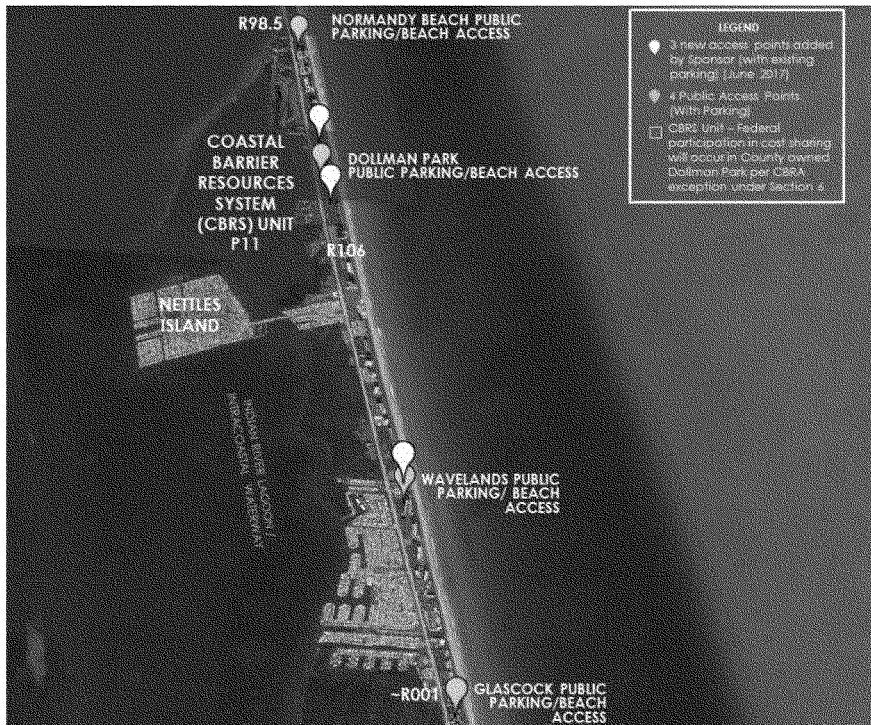
The non-federal sponsor for the CSRM project will be St. Lucie County. The non-federal project sponsor would provide an up-front cash contribution for initial construction costs of the proposed project. The amount of the non-federal up-front cash contribution would be based on cost sharing principles reflecting shoreline use, ownership, and public access in existence at the time of construction. The non-federal sponsor shall provide the entire cost of all material placed on or seaward of private undeveloped lands and developed private lands (which are inaccessible to the public). The non-federal sponsor shall provide lands, easements, and rights-of-way and bear a portion of the administrative costs associated with land requirements. Other general non-federal responsibilities, such as continuing public use of the project beach, for which benefits are claimed in the economic justification of the project, and controlling water pollution to safeguard the health of bathers, must also be assumed by the non-federal sponsor before the project can be constructed. The non-federal project sponsor will be responsible for all costs of operation, maintenance, repair, rehabilitation, and replacement of project features. Section 402 of the 1986 Water Resources Development Act (33 USC 701b-12) as amended by Section 14 of the 1988 Water Resources Development Act, states that "Before construction of any project for local flood protection or any project for hurricane or storm damage reduction, that involves Federal assistance from the Secretary, the non-federal interests shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs." The non-federal sponsor and communities must be enrolled in, and in compliance with, the National Flood Insurance Program (NFIP) to receive Federal funding for a

recommended storm damage reduction project. St. Lucie County is enrolled in, and in compliance with, the NFIP.

4.7 RECOMMENDED PLAN COST

Cost-sharing percentages are based on ownership and use of parcels landward of where the full 20-foot equilibrated berm extension (and maintenance of the 2008 dune) will be placed. Parcels landward of the 1,000 foot tapers are not used to calculate cost sharing, but construction of the tapers will be cost shared in the calculated amount. For full Federal cost sharing, public access with adequate parking (or another way for the public to reach access, such as a public bus or beach shuttle) must be provided every ½ mile. There are currently 4 public access and parking sites within the recommended plan area, plus three additional access points created by St. Lucie County as of June 2017 which use existing parking (REF-3). **Figure 4-2** includes public access and parking locations for the Recommended Plan area, depicting the shoreline lengths that are covered by adequate public access and parking.

Figure 4-2. Public Access and Parking within the Recommended Plan Area.



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The current cost share estimates are based on policy guidance provided by ER 1105-2-100, Appendix E and ER 1165-2-130. Cost sharing for this project is determined by section 103(c)(5) of WRDA 1986, which establishes a maximum cost share of 65% (Federal)/35% (non-Federal) for CSRM. This maximum initial cost sharing percentage is then subject to further considerations as described in Appendix F. To provide for other than the cost sharing established in section 103, statutory language directing a different cost sharing percentage would have been required. The WRDA of 1999 changed the cost sharing policy previously provided by WRDA 1986 by setting the non-federal share of periodic nourishment carried out after January 1, 2003 to 50% for projects authorized for construction after December 31st, 1999. Planting of dune vegetation following initial construction is cost shared with the Federal government. However, per Policy Guidance Letter No. 27 (11/17/92), the replacement of dune vegetation following periodic nourishment is a non-federal responsibility. **Table 4-5** shows the Federal and non-federal cost sharing for the Recommended Plan. Additional detail on how percentages were calculated is given in Appendix F. Changes to shoreline ownership and use prior to construction could change the stated cost sharing percentages. Cost sharing for initial construction is 35% Federal / 65% non-federal. Cost sharing for periodic nourishments is 27% Federal / 73% non-federal. **Table 4-5** includes approximately 150 feet of privately owned parcels within CBRS Unit P11. Federal expenditures for any alternative implementation, including beach nourishment, in this area would be prohibited by the CBRA due to the fact that such action could encourage development.

Table 4-5. Recommended Plan Cost Sharing.

Shore Ownership and Project Purpose (as defined in EC 1105-2-100)	INITIAL CONSTRUCTION			PERIODIC NOURISHMENT			
	Maximum Level of Federal Participation in Construction Costs	Shoreline Length (feet)	Length of Federal Participation (feet)	Length of non-Federal Participation (feet)	% of Federal Participation for Periodic Nourishment	Length of Federal Participation (feet)	Length of non-Federal Participation (feet)
I. Federally Owned	100%	0	0	0	100%	0	0
II. Publically and Privately Owned, Protection Results in Public Benefits							
A. Coastal Storm Risk Management (CSRM) on Developed Lands	65%	7,196	4,678	2,519	50%	3,598	3,598
	65%	2130	1,385	746	50%	1,065	1,065
III. Privately Owned, Use Limited to Private Interests (No public access within 1/4 mile)	0%	7,196	0	7,196	0%	0	7,196
IV. Privately owned, undeveloped	0%	626	0	626	0%	0	626
V. CBRA	0%	150	0	150	0%	0	150
	Total Distance:	17,299	6,062	11,237	Total Distance:	4,663	17,636
	Cost Shares:		35.0%	65.0%	Cost Shares:	27.0%	73.0%

4.8 RECOMMENDED PLAN COST SHARING

The current cost share estimates are based on policy guidance provided by ER 1105-2-100 Appendix E and ER 1165-2-130. The Water Resources Development Act (WRDA) of 1999 changed the cost sharing policy previously provided by WRDA 1986 by setting a maximum Federal share of periodic nourishment carried out after 1 January 2003 to 50% for projects authorized for construction after 31 December 1999.

The recommended plan total project cost including contingency is \$53,296,000 (October 1, 2017 (FY18) Price Level). The **Cost Appendix** provides additional detail.

Table 4-6 shows the breakdown between initial project cost and periodic nourishments for each main project item for the recommended plan. **Table 4-7** shows the Federal and non-federal cost sharing for the recommended plan. Changes to shoreline ownership and use prior to construction could change the

CHAPTER 4.0: THE RECOMMENDED PLAN

stated cost sharing percentages. Cost sharing for initial construction is 35% Federal / 65% non-federal. Cost sharing for periodic nourishments is 27% Federal / 73% non-federal.

Table 4-6. Recommended Plan Cost Summary (Project First Cost, FY18 Price Levels).

WBS Code	Item	Initial Construction	Periodic Nourishments
		Total Project First Cost (FY18)	Total Project First Cost (FY18)
017	Mob/Demob	\$4,303,000	\$8,606,000
017	Beach Fill	\$8,227,000	\$15,046,000
017	Associated General Items	\$1,235,000	\$802,000
	Subtotal	\$13,764,000	\$24,454,000
01	Lands and Damages		
	- lands and damages		
	- administrative		
	-Federal Admin	\$1,041,000	\$47,000
	-non-federal Admin	\$694,000	\$31,000
30	PED	\$1,492,000	\$4,151,000
31	Construction Management	\$2,012,000	\$2,931,000
30	Post-Project Monitoring	\$1,273,000	\$1,406,000
			(x 2 periodic nourishments)
	Total Project First Cost	\$20,276,000	\$33,020,000
	Total Project Cost for 50 year period of Federal participation = \$53,296,000		

Table 4-7. Recommended Plan Cost Sharing (Project First Cost, FY18 Price Levels).

St. Lucie County, FL CSRM Project					
Summary of Project Cost Sharing (Project First Costs) (FY18 Price Levels)					
R98.5 - R115+1000 feet (total placement area, with additional potential maximum tapers up to 1000 feet north and south)					
Initial Construction					
Item	Federal Cost Share	Federal Cost	Non-federal	Non-federal Cost	Project First Cost
Coastal Storm Risk Management Costs	35.0%	\$7,097,000	65.0%	\$13,179,000	\$20,276,000
Non-federal LERRD Contribution*				\$725,000	
Non-federal Cash Contribution***				\$12,454,000	
Periodic Nourishments					
Periodic Nourishment**	27.0%	\$8,915,000	73.0%	\$24,105,000	\$33,020,000
Initial Construction + Periodic Nourishments					
Final Project Cost Share and Cost (50 years)		\$16,737,000		\$36,559,000	\$53,296,000
* Includes non-federal admin costs only. Non-federal LERRD contribution is not cost shared but is part of the Project First Cost. Displayed cost sharing percentages take this into account. **Per Policy Guidance Letter No. 27 (Nov. 17, 1992), the replacement of dune vegetation following periodic nourishment is a non-Federal responsibility. There is currently no cost for dune replanting in the periodic nourishment cost due to rationale that natural recruitment of seagrasses will occur. ***A taper longer than 200 feet past R98.5 (northern project boundary) would extend into CBRS unit P11 and would change cost apportionment amounts due to the CBRA which would constitute no Federal cost sharing in that area (approx 750 feet). Taper length will be determined in PED and cost apportionment as affected will be refined at that time for initial nourishment and periodic nourishments.					

As public access and parking relates to Federal Interest, the sponsor is actively working with their contractor, and the liaison to the condominium association, to investigate ways to implement additional access and associated parking to reduce their cost share. Already as a part of their commitment, the sponsor has added three additional access points which use existing parking. The sponsor's intentions are documented in a letter by the sponsor sent on July 12, 2016. Future efforts could include potential expansion of city transit with additional bus stops at new public access locations or easements. The sponsor and their contractor have drafted a scope of work for this specific issue, which will be carried out in the upcoming weeks. While the sponsor's share is currently 65% (initial construction), preliminary estimates show that maximization of public access intervals and associated parking could potentially significantly decrease the non-federal share.

CBRS unit P11 has been taken into account for cost sharing purposes. There are three portions of P11 in the recommended plan area. The first is a portion of P11 for a length of approximately 750 feet in the potential taper area at the northern boundary of the project. If the taper extends beyond 200 feet north of R98.5, the cost sharing for this length would be allocated 100% non-federal sponsor cost due to the a. CBRS unit and b. privately developed parcel. This is noted in **Table 4-6** and if the taper extends into the CBRA, the cost sharing will be refined during Pre-construction, Engineering and Design (PED). The second portion of P11 is just north of Dollman Park for a length of approximately 150 feet. This portion will be 100% non-federally funded due to the presence of the CBRS unit. The third portion of P11 is within Dollman Park (for a length of approximately 1800 feet), which is publically owned by St. Lucie County. Coordination with USFWS indicates that this third portion, but not the second portion, is "exempt" from the CBRA under Section 6 because this is a public park where development is prohibited, and therefore Federal cost-sharing in this third portion could occur. Therefore, this length has been allocated 65% Federal cost sharing and 35% non-federal cost sharing, according to Appendix E from ER 1105-2-100 and ER 1165-2-130. More information on cost sharing can be found in the **Public Access and Cost Sharing Appendix**.

4.9 FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES

A financial analysis is required for any plan being considered for USACE implementation that involves non-federal cost sharing. The ultimate purpose of the financial analysis is to ensure that the non-federal sponsor understands the financial commitment involved and has reasonable plans for meeting that commitment. By memorandum dated April 24, 2007, the Assistant Secretary of the Army (Civil Works), granted approval of the self-certification of non-federal sponsors for their ability to pay the non-federal share of projects. The self-certification is required prior to submission of the Project Partnership Agreement, typically during the PED phase of the project. Included with the self-certification, the financial analysis shall include the non-federal sponsor's statement of financial capability, the non-federal sponsor's financing plan, and an assessment of the sponsor's financial capability.

4.10 VIEWS OF THE NON-FEDERAL SPONSOR

St. Lucie County is the non-federal sponsor for the Recommended Plan. They have been an integral part of the project team from the conception of the project. At each step of the process, St. Lucie

County has contributed to the available information, participated in the formulation, and reviewed the products. St. Lucie County fully supports the Recommended Plan.

4.11 RISK AND UNCERTAINTY

First, as an event-based Monte Carlo life-cycle simulation, Beach-fx fully incorporates risk and uncertainty to determine an optimized plan under many future scenarios. Second, a Cost Schedule Risk Analysis (CSRA) has been completed, which addresses risks to project implementation and construction. Based on the results of the analysis, the Jacksonville District recommends a contingency value of \$11.9M or 28%. This contingency includes risks related to costs for the effect of schedule delay on overall project cost. There are no high risks associated with this project and remaining risks are typical of civil works projects, such as those related to quantity estimates or unforeseen environmental risks. In the future, the risks will continue to be assessed and managed in the design and construction phase of the project.

4.11.1 RESIDUAL RISK

The proposed project would greatly reduce, but not completely eliminate, future coastal storm risk and damages. Coastal storm damages, caused primarily by erosion, are reduced by approximately 98% (not including prevention of land loss) in the location of the recommended plan over the 50 year period of analysis; therefore, the residual damages would be 2% in this area. It is important to note that the volumes and damages discussed throughout the report are averages. The methods of monitoring and data assessment, while periodically revisiting sea level rise trends, described earlier will be crucial for adaptive management to manage risk.

The Recommended Plan will 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. During study scoping, it was determined that the vast majority of coastal storm risk is within 600 feet landward from dune line and therefore this boundary was set as the extent of the study area. As a result, the project is not claiming any benefits beyond this designation as damages to structures past this extent were not calculated. Notably, infrastructure on the backside of the barrier island on which the project area is located, although outside of the project area, are susceptible to impacts from sea level rise in the future. Structures within the project area would continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from these processes. The project purpose is coastal storm risk management, and the recommended plan is not designed to prevent loss of life. Public safety risks can be reduced by actions taken at the local, state, and Federal levels.



5

Effects of
The Recommended Plan

5 EFFECTS OF THE RECOMMENDED PLAN*

This section is the scientific and analytic evaluation of effects that would result from implementing the Recommended Plan. Chapter 2 of this report provides information on existing conditions as well as effects resulting from the “no-action alternative,” or the “Future Without-Project Conditions.” **Table 3-4** provides a summary of direct and indirect effects of the final array of alternatives. The following section focuses on anticipated changes to the existing environment including direct, indirect, and cumulative effects as a result of the Recommended Plan, or the “Future With-Project Conditions.”

5.1 NATURAL (GENERAL) ENVIRONMENT

5.1.1 GENERAL ENVIRONMENTAL EFFECTS

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

In accordance with permits issued by the State of Florida and USACE, the non-federal sponsor has previously placed beach quality material from the designated offshore borrow site along this shoreline. The Recommended Plan proposes to continue to use the same borrow site and construct a smaller berm along a shorter reach of this same placement area. Impacts to hardbottom resources within this area have been previously mitigated by the sponsor.

The beneficial effects of continued sand nourishment along the proposed project area include establishing a larger buffer beach to protect upland infrastructure and populations against storms and flooding. Sand nourishment also creates additional habitat for beach flora and fauna as well as more space for recreational activities.

The proposed project would likely produce more favorable environmental conditions than exist at present, although construction operations would produce some temporary adverse effects. These effects would be primarily temporary in nature, and most affected resources would return to pre-construction conditions either immediately after dredging, with respect to resources such as aesthetics and noise, or within one or two years, with respect to sea turtle nesting and benthic resources.

5.1.2 VEGETATION

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The plan would result in minor, short-term impacts to herbaceous dune vegetation that inhabits the upper beach and foredune. Fill placement would not occur landward of the dune crest. The proposed beach restoration would help stabilize and protect the dune vegetative communities from storm surge and erosion. Adding sand to the system would promote further dune habitat development.

If needed, the plant community could be reestablished by planting a mix of native dune species that, depending on nursery availability, may include sea oats (*Uniola paniculata*), beach sunflower (*Helianthus debilis*), railroad vine (*Ipomoea pes-caprae*), and dune panic grass (*Panicum amarum*).

5.1.3 FISH AND WILDLIFE RESOURCES (OTHER THAN THREATENED AND ENDANGERED SPECIES)

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Effects that could potentially affect fish and wildlife resources include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities.
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities.
- Modification of the St. Lucie Shoal feature.
- Turbidity.
- Underwater noise and vibration from dredging activities.
- Construction noise.

Alteration (Burial) of Exposed Nearshore Hardbottom

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. St. Lucie County provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, no additional mitigation is proposed. Please refer to Section 2.2.5 and to **Appendix G, Attachment 3** for more information on the mitigation previously provided by the non-federal sponsor.

Disturbance of Sand Bottom Habitats

Dredging activities within the shoal borrow area and beach fill sites would continue to impact the demersal and pelagic fish species, macrofaunal invertebrates, and infaunal benthic invertebrates. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes. Injuries to infaunal invertebrates and any motile macrobenthic invertebrate species would most likely occur during entrainment as part of the dredging and sand pumping operations. Some benthic infaunal invertebrates would survive and recolonize parts of the submerged beach fill area, but any aerially exposed on the new beach berm are not anticipated to survive nourishment activity.

Greene (2002) summarized a number of studies of benthic invertebrate recovery rates. These studies show that benthic invertebrate communities' recovery can occur in as few as two weeks but often with an assemblage dissimilar to the preconstruction infaunal community composition. Recovery of the populations typically occurs two to seven months after nourishment, given that organisms living in the high-energy beach environment, especially the intertidal area, are adapted to disturbances (Atlantic States Marine Fisheries Commission 2002). Recovery of organisms in soft-sediments typically occurs through larval transport and post-settlement life-stages (juveniles and adults) and varies with the season, habitat, and the species' life history characteristics. Active dredging operations during project activities would displace motile macrobenthic invertebrates and especially demersal and pelagic fish species that use the soft bottom habitats, shoal areas and beach fill areas, unless these groups avoid the dredging areas. Dredging activities would restrict motile macrobenthic invertebrates and demersal/pelagic fishes from feeding on the infauna and flora living in and on the soft bottom habitat.

Numerous studies have examined the impacts to the infaunal communities of borrow areas including (but not limited to) Turbeville and Marsh (1982), Byrnes et al. (2003), Hammer et al. (2005), Byrnes et al. (2004), and Burlas et al. (2001, 2002). Those studies determined that the community composition, diversity, and abundance recovered to pre-dredge condition within two years.

Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within those years the sites they considered still developed infaunal biomass that provided a food source for fish and macrocrustaceans. In addition, Turbeville and Marsh (1982) examined an offshore dredging operation off Hillsboro Beach in 1972. They determined that although the faunal similarity analysis indicated a qualitative change in the fauna of the borrow area had occurred, the change was not detrimental. They concluded that the offshore dredging operations conducted caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity within the borrow area.

Hammer et al. (2005) found that physical, chemical, and biological factors influence the composition of benthic assemblages. Although excavation of sand borrow areas can expose underlying sediments and change the sediment structure and composition, their research found that the vertical sediment composition in the borrow pits offshore of central Florida tended to be uniform. Therefore, recolonization would likely proceed if, as proposed for the St. Lucie County project, dredging does not cut below the depth of the adjacent grade. In addition, warmer waters (e.g., the Atlantic Ocean waters of central Florida including St. Lucie County) may shorten infaunal recolonization time.

Hammer et al. (2005) also determined that dredging at the sand borrow sites located in central east Florida would not likely adversely affect pelagic fish populations unless dredging disrupts specific spawning, aggregation, or migratory areas. Impacts from routine dredging operations and accidents would be avoided and minimized with the appropriate management of dredging operations and use of best management practices.

Infaunal sampling performed by CSA (2011) included sampling of the St. Lucie Shoal borrow area, the refuge patch proposed by the non-federal sponsor for the 2013 beach nourishment project and an adjacent sand habitat reference site. The analysis of these data indicated that although more total organisms occurred within samples collected at the borrow area sites (11,553) than in the reference site samples (6,268), the same taxa occurred in both locations in similar percentages. The density of organisms per m² within the three sampled areas were also similar with 33,483 organisms per m² for the reference sites, 49,372 organisms per m² for the borrow area sites, and 45,641 organisms per m² for the refuge patch sites. The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site). Such differences are typical of benthic infauna distribution, characterized by patchiness and wide variability in numbers of individuals. The results of this sampling effort indicated that with the excavation of a portion of the St. Lucie Shoal, although the infaunal community would experience impacts, numerous organisms would remain within the refuge patch and the surrounding area to provide feeding opportunities for demersal/pelagic fishes and for recovery of the organisms within the dredged area.

The temporal duration of construction would be short. Technical literature suggests that soft bottom infaunal invertebrate assemblages typically recover relatively rapidly (two to three years). While recovery

of the infaunal invertebrate assemblage takes place, feeding opportunities would be present in the surrounding areas.

Modification of the St. Lucie Shoal Feature

Offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging. Offshore shoal habitats have been identified as important benthic habitats along the eastern U.S. and South Florida. Vasslides and Able (2008) found the richest fish assemblages at study sites off the coast of southern New Jersey associated with sand ridges in the 9 – 14 m depth range.

Recent studies by Gilmore (2009) have determined that as many as 200 species of fish use sand shoal habitats within their life cycle, particularly during their cross-shelf migration, an important phase to the demersal reef fish population. These shoal habitats also function as aggregating points for small pelagic fishes, important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups. Modification of the St. Lucie Shoal feature could impact the demersal/pelagic fish and invertebrate assemblages that use this feature. Depending on the dredging design and execution, this action could alter this shoal structure permanently and could affect the local ecological processes occurring at this location. The St. Lucie Shoal accounts for only a small fraction of the total sand bottom habitat in the region. The adjacent un-dredged areas would provide the infaunal source to recolonize the excavated area. The excavation would not result in long-term negative impacts to benthic populations or the benthic community.

USACE will continue to collect additional geotechnical and geophysical data within the proposed St. Lucie Shoal borrow area during Preconstruction Engineering and Design (PED). These more refined data will inform the final borrow area design parameters prior to construction. The overall goal is to ensure that physical and biological processes following dredging are maintained within the St. Lucie shoal complex to the maximum extent practicable.

Based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, USACE and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the Federal project.

In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). Slacum et al. (2006, 2010) have indicated that for similar sand shoal habitats in the mid-Atlantic bight off the coasts of Maryland and Delaware, winter dredging may provide the least impactful period for dredging as that period includes the lowest use of the habitat by finfishes and invertebrates. Diaz et al. (2004) characterized seasonal changes in invertebrate fauna, concluding that appropriate project timing and engineering could lessen impacts on fishes by reducing stress on crustaceans that serve as primary prey items. The proposed project (and future projects) would use a dredging window from November through April in order to comply with the U.S. Fish and Wildlife Service Statewide Programmatic Biological Opinion and avoid beach placement during the primary sea turtle nesting season. Thus, the dredging period could also minimize potential impacts on shoal resources if the site exhibits similar biological cycles to those described in recent

literature. Scott (2007), studying benthic communities of sand shoals off Cape May, New Jersey, concluded that continued dredging of the study area had not resulted in impacts to benthic taxa, abundance, or biomass. Based on differences in benthic assemblages in dredged and non-dredged areas, Scott and Burton (2005) concluded that “developing dredging plans for beach replenishment activities to limit the creation of dredge pits over at least a depth of 10 feet could reduce the chances of causing changes in benthic community, bottom sediment and water quality parameters detected in this study.” They found no significant differences in the finfish communities associated with the study sites and stated, “Since the fish community did not display an impact, the change in water quality and the benthic community observed in this study may have little impact on higher living resources.”

Turbidity

Several activities during construction are anticipated to affect water quality. The main source of water quality impacts — borrow area dredging and sand placement on the beach face — would produce turbidity at the borrow site and along the shoreline. Even if it does not kill fish, turbidity has been shown to have negative impacts during extreme natural events (Robins 1957). The nearshore hardbottom fish assemblages would most likely avoid any extreme turbidity conditions. Impacts may occur to fishes in planktonic stages of development and to some juveniles related to turbidity. However, past offshore dredging efforts by USACE, while monitored closely, have not produced visible kills of juvenile fishes. Most fishes able to do so would likely avoid the area until the water quality returns to acceptable levels.

At the borrow site, the vibracore samples logs indicated that the sand layer exposed within the proposed borrow area after dredging contains less than 4% fines. This is the same percent of fines present in the existing exposed top layer of sediment on the shoal in the area to be excavated. Mobile species would move out of the dredge area during dredging activities due to the short-term disruption to the area from the construction activities. Once dredging ceases, the mobile species are anticipated to return to the area and, based on the geotechnical data, are not expected to experience more turbidity after dredging than prior to dredging. No reports or observations of fish impacts sufficient to harm a species significantly could be identified.

Implementation of proper design and BMPs could reduce the magnitude and extent of impact resulting from proposed project activities, which would likely be limited in extent and short in duration.

Underwater Noise and Vibration from Dredging Activities

In general, the expected short-term sources and levels of underwater noise and vibration generated during a dredging project such as proposed should cause only negligible impacts on marine mammals, fish, and other wildlife present in the project area. Wildlife that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities.

Construction Noise

In general, the sources and noise generated during the project construction activities would include temporary sources of noise and could result in short-term, minor, adverse effects to shorebirds and seabirds in the vicinity of both the beach fill and borrow area sites. Shorebirds and seabirds that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities.

5.1.4 THREATENED AND ENDANGERED SPECIES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

USACE and BOEM have determined that the Recommended Plan may affect nesting sea turtles and sea turtles in the water. Also, the plan may affect, but is not likely to adversely affect manatees, whales, smalltooth sawfish, piping plover, or the rufa red knot. The terms and conditions of the 1997 NMFS South Atlantic Division Regional Biological Opinion (SARBO), 2015 USFWS Statewide Programmatic Biological Opinion, and 2013 Programmatic Piping Plover Biological Opinion will be followed for these species. Additional consultation between USACE, BOEM, and USFWS has been performed on the rufa red knot.

USACE and BOEM have also determined that the proposed dredging and beach placement could temporarily impact the physical or biological features (PBF) and primary constituent elements (PCE) of loggerhead critical habitat unit LOGG-T-FL-09 and LOGG-N-18 during construction. Hatchling egress from the water's edge to open water and nesting female transit back and forth between the open water and the nesting beach during nesting season could be hindered by the presence of the dredge and pipeline. However, the construction phase would typically last 3-5 months approximately every 18 years (erosion due to storms could require more frequent events) and the daily construction activity would occur within only a small area at a time. Hatchling egress from the water's edge to open water and nesting female transit back and forth between the open water and the nesting beach during nesting season could be hindered by the presence of the dredge and pipeline. Finally, the placement of sand may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project (i.e. the project complies with the terms and conditions of the SPBO). Therefore, USACE has determined that the project will not destroy or adversely modify loggerhead critical habitat.

The USFWS concurred with USACE and BOEM determinations by letter dated November 21, 2016 (refer to Appendix H: Pertinent Correspondence). USACE and BOEM also notified the NMFS by letter dated June 16, 2016, that all consultation responsibilities for dredging and beach placement activities associated with the Recommended Plan would be covered under the existing 1997 SARBO and/or superseding documents associated with the ongoing reinitiated SARBO consultation (refer to **Appendix H: Pertinent Correspondence**).

Sea Turtle Nesting Habitat

Of the threatened and endangered species found in coastal St. Lucie County, nourishment activities are more likely to impact sea turtles, simply by their ubiquity during nesting season. Escarpments obstructing beach accessibility, altered beach profiles, different sand color characteristics, and increased sand compaction often hinder nesting success the first year after nourishment (USFWS, 2015). Impacts of a nourishment project on sea turtle nesting habitat are typically short-term because natural processes rework a nourished beach in subsequent years. Constant wave and current action reworks the beach, and reduces sand compaction and the frequency of escarpment formation while the sun bleaches darker sand (USFWS 2015).

The non-federal sponsor initiated an emergency beach fill project in 2005 due to damages to project area beach and dunes during hurricanes Frances and Jeanne in 2004. The upland sand used in the 2005 emergency fill project was incompatible with the native beach (PBS&J 2005). A dune remediation project excavated, removed, and replaced the incompatible sand with more carefully characterized beach-compatible sand (Coastal Tech 2009: Design Document). The area of sand replacement provided an opportunity for an unplanned experiment comparing turtle nesting on natural sand with turtle nesting on replacement beach sand. Below, the term “nourished” applies to the section of beach that required remediation and “natural” to the adjacent sections of beach not impacted and remediated.

Nesting success provides a gauge of beach nesting suitability (Ecological Associates, Inc. [EAI] 2009a). Less suitable beaches tend to have lower nesting success (a higher false crawl to nest ratio). EAI performed sea turtle nesting surveys for the St. Lucie beach before the storms and after replacement of poor quality sand with suitable quality sand (EAI 2007, 2008, 2009a). **Table 5-1** summarizes nesting success between 2003 and 2009 for the three sea turtle species nesting on nourished and natural beach sections of the project area beach (EAI 2009a; personal communication, Beth Brost, FWC; personal communication, Jonathan Gorham, Inwater Research Inc., 2010).

During 2005, all three marine turtle species exhibited lower nesting success on the nourished beach than on the natural beach. Loggerhead and green turtles exhibited the greatest differences (**Table 5-1**). During the years before the emergency nourishment (2003 – 2004) and the years following 2005 (2006 – 2009), all three species displayed similar or greater nesting success on the nourished beach than on the natural beach. EAI (2009a) attributed the apparent improvement in the suitability of the restored beach for nesting to changes in beach conditions resulting from the dune remediation project.

With the exception of 2005, the nourished area generally showed higher loggerhead and green turtle nest densities (**Table 5-2**: nests per kilometer). In 2005, all three species showed lower nest densities on the nourished beach than on the natural beach. Beginning in 2006, however, loggerhead and green turtle have since maintained nest densities on the nourished beach similar to or greater than densities on the natural beach. According to EAI (2009a), the shift back to pre-2005 patterns in the relative distribution of loggerhead and green turtle nest densities in the nourished beach suggests that the remediation project succeeded in mitigating the negative effects of the poor quality sand placed during the 2005 dune restoration project and in providing nesting habitat similar to natural conditions.

Table 5-1. Sea Turtle Nesting Success (%) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach.

Species	2003		2004		2005		2006		2007		2008		2009	
	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural
Loggerhead	65.7	54.2	59.6	49.6	14.1	33.0	55.9	49.5	52.1	50.6	58.9	56.3	57.3	46.2
Green	75	37.5	46.8	50	11.4	39.6	42.0	30.0	41.3	27.0	65.1	47.4	54.3	45.8
Leatherback	80	87.5	80	74.1	31.0	40.0	78.6	80.0	80.8	83.3	78.4	77.8	76.9	74.3

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Table 5-2. Sea Turtle Nesting Density (nests/km) in Project Area: Restored (INBS Zone V-X) vs. a Natural (L-N) Beach.

Species	2003		2004		2005		2006		2007		2008		2009	
	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural	Nourished	Natural
Loggerhead	224.3	164.3	175.3	170.3	110	205	205.0	117.3	163.3	123.3	211.7	157.7	198.3	133.3
Green	6	1	7.3	6	9.7	12.3	5.3	9.0	30.7	9.3	11.0	8.0	8.3	7.3
Leatherback	4	9.3	2.7	6.7	0.3	5.3	1.3	3.0	6.7	7.7	4.0	5.0	6.7	8.7

Source Data 2003, 2004, 2009: INSB Zones L, V-X - personal communication: Beth Brost, Florida Fish and Wildlife Commission Index Nesting Beach Survey Database as of July 1, 2010. Zones L, V-X include data between May 15 and August 31. INSB Zones M and N - personal communication: Jonathan Gorham, Inwater Research Group, Inc. May 6, 2010. Zones M and N are year totals.
Source Data 2005 to 2008: EAI, 2009a

Note regarding data sources: The tables include year totals when available, seasonal totals otherwise. FWC and Inwater Research Group data span May 15 – August 31; EAI data include the entire year. EAI (2009a) provided **Table 5-1** data between 2006 and 2008, while the FWC dataset provided data for years 2003, 2004, and 2009. For consistency, nesting density per kilometer of shoreline in **Table 5-2** contains only data from Inwater Research and FWC. Leatherback nest densities did not show the same post-remediation increase in nest densities seen in loggerhead and green turtle nest densities (**Table 5-2**, EAI, 2007, 2008). Leatherback nest densities remained lower on the nourished beach throughout the study period. During all seven years (2003 – 2008), fewer leatherback turtles nested on the nourished beach than on the natural beach. These data suggest that the changes in beach conditions between 2003 and 2008 affected leatherback nesting to a lesser extent than loggerhead or green turtle nesting.

The data presented above supports the hypothesis that impacts from beach nourishment to sea turtle nesting and habitat are short term (about one year) assuming the placement of appropriate quality sand. The data also suggest that the beach nourishment could have positive effects on sea turtle nesting through the creation of additional high quality beach habitat. Continuous monitoring of the sea turtle activity in the project area would dictate whether the changes observed between 2003 and 2009 will repeat themselves in the next projects.

In summary, within a year following the project (construction year up to a year post- construction), impacts to sea turtles associated with the project may include:

- Disturbance of nesting female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities
- Behavior modification of nesting females from beach escarpment formation during a nesting season. Example: Behavioral changes could result in false crawls or selection of marginal or unsuitable nesting areas to deposit eggs.
- Destruction, damage, or burial of existing nests during nourishment activities
- Effects to eggs and hatchlings from changes in the physical and chemical characteristics of the nourished beach. Example: The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.
- Lighting-induced disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water
- Alteration (burial) of nearshore exposed hard substrate (feeding grounds to sea turtle juveniles) during and subsequent to nourishment activities

USFWS biological opinions for similar projects recognize that placement of sand on a critically eroded beach can enhance sea turtle nesting habitat if the sand placed is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments at the recipient site, and compaction and escarpment remediation measures are properly adopted (USFWS 2015). State permit requirements for beach nourishment projects usually address avoidance and minimization of potential impacts to nesting turtles and nesting habitat. Permit conditions may include consideration of:

- Sand quality: a major component of the beach nourishment permitting process is to assure the sand placed on the beach is compatible with the natural beach.

CHAPTER 5.0 Effects of the Recommended Plan

- Timing of construction activities: USFWS has jurisdiction over sea turtles (nesting adults, incubating eggs, and hatching young) on the beach. In St. Lucie County, USFWS requires that nourishment activities avoid the peak nesting season from May 1 through October 31 to minimize the impact to nesting sea turtles. If projects require nighttime construction activities, State permits would restrict nighttime construction to specific areas, usually no more than 500 feet in length.
- Pre-nesting season compaction monitoring, mechanical tilling, and grading of the beach: these activities can greatly reduce or eliminate the effects of increased sand compaction and scarp formation. Post-construction compaction monitoring or tilling before nesting season is a state and Federal permit requirement after nourishment activities, and for three years after project completion. State and Federal agencies require tilling the project area beaches if penetrometer testing demonstrates compaction in excess of 500 pounds per square inch at any two adjacent sampling stations or depths. Additionally, leveling of escarpments greater than 18 inches in height or 100 feet in length must occur before nesting season begins.
- Relocation of sea turtle nests: USFWS requires monitoring and relocating sea turtle nests between March 1 and April 30 if nourishment activities occur during that period.
- Hardbottom impacts: avoidance and minimization of hardbottom impacts also comprise major considerations during review of any beach nourishment permit application.

Because the proposed project would use sand with characteristics very similar to the native beach sand, sand quality is unlikely to have negative effects on sea turtle nesting or hatchling emergence. However, the Recommended Plan may still have negative effects on nesting sea turtles resulting from construction-related impacts during and after construction. These impacts could include nesting disturbance, sand compaction, scarp formation, and artificial lighting.

As natural processes rework the nourishment area and the beach equilibrates, the increase in beach area provided by this alternative could have a long-term benefit on sea turtle nesting..

5.1.4.1 INNER SHELF SEA TURTLE HABITAT

Effects associated with the plan including offshore dredging that could potentially affect sea turtles include:

- Vessel traffic
- Entrainment by hopper dredge drag heads
- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic raises a chance of these vessels colliding with sea turtles. The risk would vary depending upon location, vessel speed, and visibility. Most sea turtles occur within nearshore waters off St. Lucie County and waters of the continental shelf. All life stages (hatchling, juvenile or subadult, and adult) may occur within the project area. During the hatching season, researchers believe that hatchling turtles leave their nesting beaches and swim offshore to areas of mass convergence. A moving vessel could have difficulty spotting hatchling and juvenile turtles in these areas, especially when

the individuals lie within patches of floating *Sargassum*. Adult turtles are generally visible at the surface during periods of daylight and clear visibility.

To reduce the risk of impacts from dredging and vessel strikes, the project would comply with the “Sea Turtle and Smalltooth Sawfish Construction Conditions” (NMFS 2006b) and “Vessel Strike Avoidance Measures and Reporting for Mariners” issued by NOAA Fisheries, Southeast Region. Operators and crews receive instructions to maintain a vigilant lookout for turtles during offshore transits and maneuvers.

Despite these precautions, turtles could prove very difficult to spot from a moving vessel when resting below the water surface, during nighttime, and during periods of inclement weather. A collision between a sea turtle and a slow moving vessel may occur. Adult, subadult, and perhaps juvenile turtles are often capable of avoiding moving dredge related vessels when these vessels operate within limited areas at slow to relatively slow speeds.

Entrainment by Hopper Dredge Drag Heads

Entrainment within hopper dredge drag heads could injure or kill sea turtles, particularly within areas of soft sediment in ship channels where turtles are known to bury themselves partially when resting (National Research Council Committee on Sea Turtle Conservation 1990). Sea turtles have also been observed to partially bury themselves in soft sediments that have settled into previous dredge borrow pits (Michals 1997p; Keith Spring and David Snyder, personal communication: observations of sea turtles using borrow pits off Hobe Sound, Florida). Numerous methods have been implemented to reduce the number of turtle takes during hopper dredge operations, including special turtle deflecting hopper dredge drag heads, relocation trawling, dredging windows, and the implementation of trained protected species observers during dredging operations (<http://el.erdc.usace.army.mil/tessp/pdfs/1997SADBO.pdf>).

The numerous areas of emergent hard substrate in the general project area represent high quality shelter for turtles. The proposed offshore borrow area presents a lower quality refuge, as it is an area of bare sand positioned along the inner continental shelf, proximal to hardbottom habitat.

NMFS-approved protected species observers would be stationed on hopper dredges, which would come equipped with a sea turtle deflecting drag head deflector within the proposed borrow site (<http://el.erdc.usace.army.mil/seaturtles/docs/observercriteria.pdf>) during all dredging operations. Even with these measures in place, incidental take(s) of sea turtles during dredging remains a possibility.

Alteration (Burial) of Exposed Nearshore Hardbottom

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. St. Lucie County provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, no additional mitigation is proposed. Please refer to Section 2.2.5 and to **Appendix G, Attachment 3** for more information on the mitigation previously provided by the non-federal sponsor.

Turbidity

Several activities during construction would affect water quality. Dredging and sand placement on the beach face would produce turbidity at the borrow site and along the shoreline. The limited extent and short duration of the reduced water clarity should reduce the magnitude and extent of temporary impacts of project activities. Turbidity generation would cease at the completion of construction.

Underwater Noise and Vibration from Dredging Activities

Little is known how turtles may respond to noise from offshore activities. In contrast to marine mammals, relatively little is known about sea turtles' hearing ability or their dependency on sound, passive or active, for survival cues. Only two species, loggerhead and green sea turtles, have undergone any auditory investigations. The anatomy of the sea turtle ear does not lend itself to aerial conduction; rather, it lends itself to sound conduction through bone and water (Békésy 1948, Lenhardt 1982, Lenhardt and Harkins 1983). Auditory testing and behavioral studies show that turtles can detect low frequency sounds (Ridgway et al. 1969, Bartol et al. 1999).

Sea turtles could likely hear low frequency underwater noise from construction activities and possibly experience some disturbance. The main noise sources include vessel engines. The most likely impacts would include short-term behavioral changes such as evasive maneuvers, disruption of activities, or short-term departure from the area.

5.1.4.2 MARINE MAMMALS

Effects associated with the proposed action that could potentially affect listed marine mammals include:

- Vessel traffic
- Turbidity
- Underwater noise and vibration from dredging activities

Vessel Traffic

Dredge, dredge support, and construction vessel traffic associated with the proposed action raises the chance these vessels could collide with listed marine mammals. The risk would vary depending upon location, vessel speed, and visibility. North Atlantic right whales may occur in the project area during the wintering and calving period. Humpback whales may also travel through the middle shelf, offshore of the project area; however, as anticipated, they would not occur within the borrow area or within nearshore waters. Both of these species are large and readily visible at the surface during periods of daylight and clear visibility. Florida manatees may, but are unlikely to occur within the project area. On-board trained and NMFS approved protected species observers would be stationed on dredges during all dredging operations, and dredge support vessel operators and crews would receive instructions to maintain a constant lookout for marine mammals during transits and maneuvers.

Despite these precautions, these species could prove very difficult to spot from a moving vessel when they are resting below the water surface, during nighttime, and during periods of inclement weather. However,

these animals are capable of avoiding moving dredge-related vessels, especially when these vessels operate within limited areas at slow to relatively slow speeds.

Turbidity

Several activities during construction would affect water quality. Turbidity created by borrow area dredging and sand placement on the beach face represents the primary source of water quality impacts at the borrow site and along the shoreline. Turbidity generation would cease at the completion of construction. Due to the limited extent and short duration of reduced water clarity, potential project impacts on marine mammals should be negligible.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by operator-generated noise to marine mammals include the following:

- Limiting the detection by the mammals of natural sounds
- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals hear at different frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of an operator-generated sound. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland 2005). Although underwater noise can affect marine mammals (Richardson et al. 1995), the project does not involve any high energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project should cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The North Atlantic right whale uses the project area as part of the species' migratory route and as potential calving grounds during the winter months; however, these whales are rare to the project area. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. Manatees have been observed along the coast in the shallow, nearshore waters, though only rarely. Marine mammals would likely avoid areas where a dredge is operating. The project area is an extremely small area when compared to the overall waters used for migration and calving. Standard protective measures would be taken during placement activities to ensure the safety of manatees and other marine mammals.

5.1.4.3 SMALLTOOTH SAWFISH

Effects associated with the proposed action that may potentially impact smalltooth sawfish include:

- Turbidity
- Underwater noise and vibration from dredging activities

- Entrainment by hopper dredge drag heads

Turbidity

Several activities during construction could affect water quality. The main sources of water quality impacts are borrow area dredging and sand placement on the beach face, which would produce turbidity at the borrow site and along the shore. Turbidity could cause temporary impacts to about one acre of hardbottom habitat. Proper implementation of the approved design and construction BMPs should limit the level and extent of construction-related turbidity. Turbidity generation would cease at the completion of construction. Due to the limited extent and short duration of the reduced water clarity, any potential impacts on smalltooth sawfish should be negligible.

Underwater Noise and Vibration from Dredging Activities

In general, the sources and short-term levels of underwater noise and vibration generated during the project should cause only negligible impacts on smalltooth sawfish. Smalltooth sawfish that may visit the project area during the construction period are likely to move from or avoid disturbance caused by construction activities. These temporary avoidance behaviors should cause negligible impacts on smalltooth sawfish.

Entrainment by Hopper Dredge Drag Heads

The smalltooth sawfish normally inhabits shallow waters (10 m or fewer) often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters of the continental shelf at depths greater than 20 meters (NMFS 2006a). Sawfish encounter a small risk of being entrained in the hopper dredge drag head as it extracts sand from the St. Lucie Shoal. To reduce the risk of impacts from dredging and vessel strikes, the project would comply with the “Sea Turtle and Smalltooth Sawfish Construction Conditions” (NOAA Fisheries 2006). Mitigation measures would minimize entrainment risks. Measures would include the use of sea turtle deflecting drag head deflector, which would also help deflect smalltooth sawfish.

Disturbances from ongoing activities could displace smalltooth sawfish that may visit the project area during the construction period. These disturbances could result in temporary movement or avoidance of the area, but the species would likely return when the temporary disturbance ended.

5.1.4.4 PIPING PLOVER AND RUFA RED KNOT

Wintering grounds and migration stopovers for piping plovers and red knots include Hutchinson Island. While coastal development has reduced important beach habitat for wintering bird species, beach nourishment can restore beach habitat for many shore birds. However, during the beach periodic nourishment construction phase, some short-term displacement of foraging and resting birds, including piping plovers and red knots, could occur. During construction activities, displaced species may use habitats with similar characteristics north and south of the project area.

Beach nourishment activities are more likely to affect birds that use the beach for nesting and breeding than birds that use the area for feeding and resting during migration (Greene 2002). Dredges, pipelines, and other equipment along the beach could displace piping plovers, or could cause them to avoid foraging along the shore if they are aurally affected (Peterson et al. 2000). If the sand placed on the beach is too coarse or high in shell content, it can inhibit the birds' ability to extract food particles from the sand (Greene 2002). Fine sediment that reduces water clarity can also decrease the feeding efficiency of birds (Peterson et al. 2000).

Minimal direct impacts to plovers and knots should occur from project construction because motile birds can avoid construction activities. The placement of sand on the beach may temporarily interrupt foraging and resting activities of shorebirds that use the project beach area. This limited interruption would occur on the immediate area of placement and last for the duration of construction. A temporary reduction to the prey base for many shorebirds, which includes benthic organisms, would also occur in the project area. Recovery from this short-term reduction should occur within about one year after sand placement.

5.1.4.5 BEACH JACQUEMONTIA

In its letter dated December 14, 2011, the USFWS indicated that based on observations made in January 2010, the endangered beach jacquemontia may occur within the project area. The potential location(s), quantity, and current vegetative state are unknown for beach jacquemontia specimens that may occur within the project area.

Fill placement would not occur landward of the dune crest. The primary habitat for beach jacquemontia occurs landward of the dune crest on the more stable portions of the dune system.

The implementation of protective measures would avoid and minimize potential impacts to beach jacquemontia. Protective measures would likely include a pre-construction survey to locate and mark beach jacquemontia growing within or adjacent to the project area. For beach jacquemontia identified outside of the project fill footprint, creation of a minimum 25-foot protective buffer around each individual would exclude construction activities within that area. Measures to minimize potential impacts to beach jacquemontia growing within the project fill footprint may include transplanting individual plants to suitable habitat out of harm's way. If transplanting is necessary, the USFWS staff must review and approve a detailed plan before initiating transplanting activities.

5.1.5 HARDBOTTOM

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Effects associated with the applicant's preferred alternative that may potentially affect nearshore hardbottom include:

- Alteration (burial) of exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Alteration of exposed nearshore hardbottom and associated epibenthos resulting from the sand delivery pipelines

- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. St. Lucie County provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, no additional mitigation is proposed. Please refer to Section 2.2.5 and to **Appendix G, Attachment 3** for more information on the mitigation previously provided by the non-federal sponsor.

Re-exposure of hardbottom likely occurs due to high-energy dynamics of the area and downdrift and cross-shore erosion of the fill material after equilibration of beach fill. Worm rock, turf, and macroalgae would likely recolonize these re-exposed hard substrates in the same fashion they colonize any previously buried hardbottom. Organisms with high recruitment capabilities dominate the nearshore hardbottom community; coverage and re-exposure of hardbottom substrate is a common occurrence in the project area. Pipeline placement would use corridors previously used to the maximum extent practicable.

5.1.6 ESSENTIAL FISH HABITAT (EFH)

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Effects associated with the plan that could potentially affect EFH include:

- Alteration (burial) of previously mitigated and subsequently re-exposed nearshore hardbottom and associated epibenthos during and subsequent to nourishment activities
- Disturbance of the sand bottom habitats and associated macroinfauna of the shoal borrow area and beach fill sites during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity

Alteration (Burial) of Exposed Nearshore Hardbottom

As previously stated, approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. St. Lucie County provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, additional mitigation is not proposed. Please refer to Section 2.2.5 and to **Appendix G, Attachment 3** for more information on the mitigation previously provided by the non-federal sponsor.

Disturbance of the Sand Bottom Habitats

Members of the penaeid shrimp EFH management groups use soft bottom habitats contiguous with the surf zone and nearshore hardbottom as forage or shelter habitats. Spiny lobsters use soft bottom habitats contiguous with the nearshore hardbottom as foraging areas. The potential disturbances to the sand bottom habitats include anchoring of the hopper barge during pump out activities, vibrations caused from the pump out activities, and placement of the pump out and conveyance pipes.

Modification of the St. Lucie Shoal Feature

The plan would continue to alter the local bathymetric profile in the borrow area. Sand shoals include EFH for coastal pelagic species and some highly migratory species, particularly coastal sharks. In addition, offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging (CSA International et al. 2009). Studies (Gilmore 2009) have determined that 200 fish species use the sand shoal habitats along southeast Florida. Gilmore (2009) postulates that the shoal habitats are an intermediate habitat integrated in the cross-shelf migration used by many EFH managed groups. These shoal habitats also function as aggregation areas for small pelagic fishes, important prey for the coastal pelagic fish, dolphin and wahoo, and highly migratory species groups.

Removal of or modification of the St. Lucie Shoal feature could impact the EFH for multiple SAFMC-managed species groups that use this feature. The proposed dredging action could conceivably alter the shoal structure and change the fundamental ecological processes within and near this feature. Dibajnia and Nairn (2010) summarized field investigations and modeling studies intended to recommend offshore dredging guidelines to protect and maintain the integrity of ridge and shoal found on the OCS. They found that for shoals fewer than 30 meters deep, the shoal they studied reformed itself with the remaining (smaller) volume. They concluded, "There was no indication that there exists a critical threshold for dredging that once crossed, ridge and shoal features may deflate, losing their morphologic integrity."

The St. Lucie Shoal covers approximately 1.04×10^7 m² including state and Federal waters (Hammer et al. 2005, Coastal Tech 2009, Design Document). The St. Lucie Shoal represents only a portion of the offshore shoals in the central Florida OCS. In addition, Hammer et al. 2005 determined that dredging at the sand borrow sites located in the central Florida OCS is not likely to adversely affect pelagic fish populations unless specific spawning, aggregation, or migratory areas are disrupted. With the appropriate management, impacts of routine dredging operations could be reduced using best management practices.

USACE will continue to collect additional geotechnical and geophysical data within the proposed St. Lucie Shoal borrow area during Preconstruction Engineering and Design (PED). These more refined data will inform the final borrow area design parameters prior to construction. USACE and the Bureau of Ocean Energy Management (BOEM) will coordinate with NMFS to develop a refined borrow area design that provides a sufficient volume of compatible sediment to support the project objectives while maintaining overall shoal integrity. The overall goal is to ensure that physical and biological processes following dredging are maintained within the St. Lucie shoal complex to the maximum extent practicable.

Based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, USACE and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the Federal project. USACE and BOEM will continue to coordinate with NMFS as additional information becomes available.

In addition, numerous studies have examined the impacts to the infaunal communities of borrow areas including (but not limited to) Turbeville and Marsh (1982), Byrnes et al. (2003), Hammer et al (2005), Byrnes et al. (2004), and Burlas et al. (2001). Those studies determined that the community composition, diversity, and abundance recovered to pre-dredge conditions within two years.

Hammer et al. (2005) found that physical, chemical, and biological factors influence the composition of benthic assemblages. Although excavation of sand borrow areas can expose underlying sediments and change the sediment structure and composition, their research found that the vertical sediment composition in the borrow pits offshore of central Florida tended to be uniform. In addition, recovery times of infaunal recolonization may be shorter in warmer (e.g., central Florida) waters than in colder waters. With the appropriate management of dredging operations using best management practices the proposed dredging could avoid and minimize impacts to EFH and managed species within the study area.

Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within those years the sites they considered still developed infaunal biomass that provided a food source for fish and macrocrustaceans. In addition, Turbeville and Marsh (1982) examined an offshore dredging operation off Hillsboro Beach in 1972. They determined that although the faunal similarity analysis indicated that a qualitative change in the fauna of the borrow area had occurred the change was not detrimental. They concluded that the offshore dredging operations conducted caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity within the borrow area.

Infaunal sampling performed by CSA included sampling of the St. Lucie Shoal borrow area, the refuge patch maintained by the non-federal sponsor during the previous dredging event, and an adjacent sand habitat reference site. The analysis of these data indicated that although more total organisms occurred within samples collected at the borrow area sites (11,553) than in the reference site samples (6,268), the same taxa occurred at both locations in similar percentages. The density of organisms per m² within the three sampled areas were also similar with 33,483 organisms per m² for the reference sites, 49,372 organisms per m² for the borrow area sites, and 45,641 organisms per m² for the refuge patch. The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site). Such differences are typical of benthic infauna distribution, characterized by patchiness and wide variability in numbers of individuals. These results indicate that although the infaunal community would experience impacts with the excavation of a portion of the St. Lucie Shoal, numerous organisms present within the refuge patch and the surrounding area could provide feeding opportunities for demersal/pelagic fishes and for recovery of the organisms within the dredged area.

Dredging activities within the shoal borrow area could also entrain multiple South Atlantic Fish Management Council (SAFMC) managed species groups, both fish and invertebrates, including the penaeid shrimp, and spiny lobster. Settle (2003) working for the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service, National Centers for Coastal Ocean Science, prepared a report entitled *Assessment of Potential Larval Entrainment Mortality Due to Hydraulic Dredging of Beaufort Inlet*. In this assessment, Settle estimated that entrainment mortality of larval fish, even under the worst-case scenario, is minimal (0.1 %/day). Under the worst case scenario the dredge operated 24 hours/day, all larvae were

located in the navigation channel, on the bottom, and with poor retention in the estuary following flood stage. Settle further stated that “the impact at the population level (of larval fish) would be insignificant.”

Similarly, Burton, Weisberg, and Jacobson (1992) utilized an Empirical Transport Model to simulate a “worst case scenario” of entrainment of striped bass (*Morone saxatilis*), herring (*Alosa spp.*) and white perch (*Morone americana*) larvae involving the simultaneous operation of four hydraulic dredges in the Delaware River. For species such as striped bass, the study concluded that less than 1 percent of the total larval population would be entrained by dredges. They concluded that the effects of these entrainment rates on larval populations for these and similar species would be minimal. It is expected that dredging activities within the shoal area would result in even less entrainment since it is a relatively large feature.

Turbidity

Several activities during construction are anticipated to affect water quality. The main source of water quality impacts is borrow area dredging and sand placement within the beach fill sites. These activities would produce increased turbidity levels in both areas. Turbidity has been shown to negatively impact and sometimes cause fish mortality during extreme natural events of increased turbidity (Robins 1957). The nearshore reef fish assemblages would most likely avoid any extreme turbidity conditions. The limited dredge and fill extent and short duration of the reduced water clarity, along with implementation of BMPs and proper design are expected to minimize adverse effects.

5.1.7 OFFSHORE BORROW AREA RESOURCES

The proposed offshore sand source is the portion of the St. Lucie Shoal (see REF-4) located in Federal waters, approximately three to seven miles offshore of the proposed fill template (refer to **Appendix D**, Plate B - 1). The proposed preliminary sand source locations and associated vibracores are depicted on Plate B - 2 and Plate B - 3 of Appendix D. Use of the shoal would require completion of a lease agreement with the Department of Interior, Bureau of Ocean Energy Management (BOEM). BOEM is authorized under Public Law 103-426 [43 United States Code (U.S.C.) 1337 (k) (2)] to negotiate on a non-competitive basis the rights to OCS sand resources for coastal storm risk management projects. BOEM is expected to be requested to undertake a connected action (i.e., authorize use of the OCS borrow areas) that is related to, but unique from, the USACE proposed action. BOEM’s proposed action is to issue a negotiated agreement authorizing use of the sand source areas at the request of the local sponsor and USACE.

Effects associated with the Recommended Plan potentially impacting offshore borrow area resources include:

- Disturbance of the shoal borrow area sand bottom habitat and associated macroinfauna during nourishment activities
- Modification of the St. Lucie Shoal feature
- Turbidity
- Underwater noise and vibration from dredging activities

Modification of the St. Lucie Shoal Feature

Benthic species' ability to perform life functions (e.g., burrowing, feeding, or settling as larvae) varies with sediment quality, and members of the current benthic community may or may not have the same success in the physical characteristics of the underlying sediment as in the existing sediment. A literature synopsis by the U.S. Geological Survey (USGS) in 2004 examined community composition, diversity, and abundance to determine the recovery and/or recolonization time of benthic communities. Studies such as Burlas and Clarke (2001), Byrnes et al. (2004, 2005), Hammer et al. (2005), and Turbeville and Marsh (1982) found that recovery durations could range from three months to 2.5 years. Hammer et al. (2005) found evidence to suggest that recovery times of infaunal recolonization are shorter in warmer waters (such as the east central Florida shelf) than in colder waters. Recovery of the original community composition has been suggested to potentially take a substantial amount of time, especially in sand mining areas used repeatedly. However, Wilber and Stern (1992) found that while borrow sites may remain in an early successional stage for two to three years, within those years, sites still continue to develop infaunal biomass providing a food source for commercially and recreationally important fishes and invertebrates.

The literature review of infaunal density and species richness studies examining benthic composition of dredged shoals found no consistent pattern of faunal response to dredging (USGS, 2004). For example, Byrnes et al. (2004) determined that infaunal community recovery was dependent primarily on the depth of excavation where shallow excavation areas were impacted less than areas of deep excavation. Similarly, Hammer et al. (2005) found that recolonization was dependent on physical, chemical, and biological factors within the vertical sediment structure of the borrow pit. Hammer et al. (2005) studied borrow areas on the east central Florida shelf and demonstrated that initial recolonization would begin within days and later successional stages would proceed, even if dredged shoals were not completely reestablished, as long as the depth of dredging did not cut below the adjacent grade (as with the proposed project) and impact the vertical sediment composition in the borrow pit. Finally, Turbeville and Marsh (1982) examined an offshore dredging operation off Hillsboro, Florida and concluded that while dredging operations resulted in a qualitative change in fauna of the borrow area, dredging caused no observable adverse effects in terms of reduced numbers of species, reduced faunal abundance, or reduced species diversity. Given the short temporal duration of proposed dredging activities and relatively rapid recovery of the soft bottom infaunal invertebrate assemblage, short duration impacts to soft bottom assemblages within the borrow site are expected.

Excavation alters the seabed topography, creating pits that may refill rapidly or cause detrimental impacts to the benthic community for extended periods. In contrast, dredging can also create habitats different from the surrounding area, which could result in increased habitat complexity and biodiversity of the area. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years to return to pre-dredge topography (Wright 1977). In general, shallow dredging over large areas causes less change than smaller deep pits. Borrow pits excavated in small deep pits reduce current velocities at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition from the original (Hammer et al. 2005). This action could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. However, these potential changes in the shoal structure may not cause long-term changes in the benthic community species abundance and richness but could alter the community composition. St. Lucie County sampled infauna at the south end of the St.

Lucie Shoal borrow area within their proposed “refuge patch” within the borrow area and within an adjacent sand habitat reference site. Analysis of those samples indicated that although more total organisms occurred within the borrow area site than within the reference site, the same taxa occurred in both locations in similar percentages. The primary difference in the numbers occurred because of greater numbers of annelids and other taxa sampled in the reference site. In addition, the percentage of organism groupings differed significantly between the refuge patch and the other two sites (the borrow area site and reference site) and is typical of benthic infauna distribution, which is characterized by patchiness and wide variability in numbers of individuals. Dredging related changes could shift the percent composition of a set of species common to the general area.

As previously stated, based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, USACE and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the Federal project.

In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). The St. Lucie Shoal accounts for only a small fraction of the total sand bottom habitats in the region. The adjacent unimpacted areas would provide a source for recolonization of the excavated area and reduce the potential for long-term negative impacts to the benthic community.

Offshore sand shoal habitats have been shown to provide fundamental ecological functions for demersal/pelagic fish species and motile macrobenthic invertebrates that include categories of spawning, shelter, or foraging. Offshore shoal habitats have been identified as important benthic habitats along the eastern U.S. and South Florida. Vasslides and Able (2008) found the richest fish assemblages at study sites off the coast of southern New Jersey associated with sand ridges in the 9 – 14 m depth range.

Recent studies by Gilmore (2009) have determined that as many as 200 species of fish use sand shoal habitats within their life cycle, particularly during their cross-shelf migration, an important phase to the demersal reef fish population. These shoal habitats also function as aggregating points for small pelagic fishes, important prey for numerous managed species, particularly from the coastal pelagic and highly migratory groups. Modification of the St. Lucie Shoal feature could impact the demersal/pelagic fish and invertebrate assemblages that use this feature. Depending on the dredging design and execution, this action could alter this shoal structure permanently and could affect the local ecological processes occurring at this location. St. Lucie Shoal accounts for only a small fraction of the total sand bottom habitat in the region. The adjacent un-dredged areas would provide the infaunal source to recolonize the excavated area. The excavation would not result in long-term negative impacts to benthic populations or the benthic community.

USACE will continue to collect additional geotechnical and geophysical data within the proposed St. Lucie Shoal borrow area during Preconstruction Engineering and Design (PED). These more refined data will inform the final borrow area design parameters prior to construction. The overall goal is to ensure that

physical and biological processes following dredging are maintained within the St. Lucie shoal complex to the maximum extent practicable.

Based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, USACE and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the Federal project.

In addition, borrow pits are known to attract numerous fishes and have also been known to provide resting places for sea turtles (Spring, K. and D. Snyder, CSA International, personal observations). Slacum et al. (2006, 2010) have indicated that for similar sand shoal habitats in the mid-Atlantic bight off the coasts of Maryland and Delaware, winter dredging may provide the least impactful period for dredging as that period includes the lowest use of the habitat by finfishes and invertebrates. Diaz et al. (2004) characterized seasonal changes in invertebrate fauna, concluding that appropriate project timing and engineering could lessen impacts on fishes by reducing stress on crustaceans that serve as primary prey items. Thus, the dredging period could also minimize potential impacts on shoal resources if the site exhibits similar biological cycles to those described in recent literature. Scott (2007), studying benthic communities of sand shoals off Cape May, New Jersey, concluded that continued dredging of the study area had not resulted in impacts to benthic taxa, abundance, or biomass. Based on differences in benthic assemblages in dredged and non-dredged areas, Scott and Burton (2005) concluded that “developing dredging plans for beach replenishment activities to limit the creation of dredge pits over at least a depth of 10 feet could reduce the chances of causing changes in benthic community, bottom sediment and water quality parameters detected in this study.” They found no significant differences in the finfish communities associated with the study sites and stated, “Since the fish community did not display an impact, the change in water quality and the benthic community observed in this study may have little impact on higher living resources.”

Turbidity

Increased turbidity levels could result from dredging sediments at the borrow area and from suspending fine grained fractions of the borrow material in the water column. Suspended sediments could create a visible, turbid plume in the water column. In addition, excess seawater, decanted and discharged overboard by the hopper dredge, could temporarily increase turbidity during construction. If the borrow material contains only a small portion of fine grained materials, turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, turbidity can remain for longer periods or, in some cases, persist over the long term.

Underwater Noise and Vibration from Dredging Activities

Potential effects of the elevated background noise levels caused by dredge operator noise to marine mammals include:

- Limiting the detection by mammals of natural sounds

- Disturbing their normal behavior, resulting in possible displacement from areas
- Causing temporary or permanent reductions in hearing sensitivity

The potential effects depend on the type of marine mammal involved because different marine mammals have different hearing frequencies. The levels and types of ambient noise also strongly influence the potential area or zone of influence of a dredge-made sound. Clarke et al. (2002) characterized underwater sounds generated by bucket, hydraulic cutterhead, and hopper dredging operations, but have not reported the relationships between such noises and faunal behavioral changes associated with those noises. An animal's sensitivity to different sounds varies with frequency, and its response to a sound likely depends strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Ports Corporation of Queensland 2005). Underwater noise can affect marine mammals (Richardson et al. 1995). However, the project does not involve any high-energy sound sources that could cause temporary or permanent auditory damage. In general, the sources and levels of underwater noise and vibration generated during the project are expected to cause only minor impacts on marine mammals. The most likely impacts are temporary behavioral responses such as avoidance or altered diving or swimming behavior.

The proposed dredging activity would occur in part of the North Atlantic right whales migratory route and potential calving grounds during the winter months; however, these whales are rare to the project area which is an extremely small area when compared to the overall waters used by the North Atlantic right whale for migration and calving. The humpback whale is rarely present within the vicinity of St. Lucie County during its spring/fall migration. As manatees use the open ocean relatively infrequently, manatees would not likely occur in the offshore shoal area. Marine mammals would likely avoid areas where the dredge is operating.

Thomsen et al. (2009) studied the possible noise sensitivity of marine life off the coast of England. They found that dredging noises occurred at frequencies between high level noise (e.g., low frequency sonar and pile driving) and lower-level noise (e.g., normal vessel traffic). They identified specific vertebrate and invertebrate species in their study area potentially impacted by dredging noises. However, they gave no indication that such noise had the potential for permanent adverse effects. They concluded that the main issues with dredging noise included the lack of information about the noise generated by dredging operations and the lack of any experimental study of potential impacts.

5.1.8 COASTAL BARRIER RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Coastal Barrier Resource System (CBRS) unit P11 occupies approximately 15% (roughly R-98 to R-98+210 and R-101.5 to R-103.5) of the project area proposed by the recommended plan. The purposes of the Coastal Barrier Resources Act (CBRA) include minimizing the loss of human life, wasteful expenditure of Federal revenues, damage to fish, wildlife, and other natural resources associated with CBRS units. There are limits to Federal expenditures related to actions that could affect a unit. Section 6 of the CBRA provides an exception to this limitation if the Federal expenditure is for non-structural¹ shoreline stabilization projects that are designed to mimic, enhance, or restore a natural stabilization system. There are a small

¹ FWS includes beach and dune features as non-structural options.

number of privately owned parcels within the project area, and within P11, which are not under any perpetual conservation designation. Federal expenditures for any alternative implementation (including beach nourishment) in this area would be prohibited by the CBRA due to the fact that such action could encourage development. A Section 6 CBRA exception would only apply if these private parcels were covered under a perpetual conservation easement which is not the case. However, non-federal funds could be used to nourish the beach in this area. Dollman Park, a publicly owned parcel within the project area, does meet the Section 6 exception since development is prohibited in this location; therefore, Federal funds could be used to nourish the beach adjacent to the park. The U.S. Fish and Wildlife Service, by letter dated November 2, 2016, concurred with this determination (refer to **Appendix H: Pertinent Correspondence**).

Any of the beach nourishment alternatives could benefit adjacent coastal barrier resources by dispersing sand into those areas as the project beach subsequently erodes. Placement of sand within the project area is anticipated to contribute to the sand-sharing system and provide feeder benefits to adjacent shorelines.

5.1.9 WATER QUALITY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Implementing the plan would likely cause temporary increases in turbidity levels due to the dredging of sediments at the borrow area and placement of sediments on the beach. Turbidity results from the suspension in the water column of fine grained fractions of the borrow material. Suspended sediments create a visible, turbid plume in the water column. This turbid plume can cause physical or behavior impacts to invertebrates, particularly sessile organisms on the nearshore hardbottom areas. If the borrow material contains only a small portion of fine grained materials, turbidity should diminish rapidly and have little impact on organisms in the area; however, if the fine grained portion is high, turbidity can linger for longer periods or, in some cases, persist long term.

During project construction, turbidity monitoring would provide information to demonstrate compliance with state water quality standards at the mixing zone boundary. Monitoring would occur at both the borrow area and at material placement locations. Background monitoring at the borrow material placement site would occur approximately 65 m from shore and 150 m up-current from the fill discharge or placement location. Compliance monitoring would occur no more than 65 m from shore within the densest portion of any visible turbidity plume, 150 m down current of the discharge point.

5.1.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The plan is not anticipated to affect hazardous, toxic, or radioactive waste sites or producers in the project area, including the FPL Hutchinson Island Nuclear Power Plant. No impacts associated with the disturbances of such sites are anticipated. The proposed project would not involve placement, use, or storage of hazardous and toxic materials in or near the project area. A potential for hydrocarbon spills exists with dredging and construction equipment in the area, but accident and spill prevention plans delineated in the contract specifications should prevent most spills. The construction contract would include requirements to properly manage, store, and dispose of all materials generated by the project.

5.1.11 AIR QUALITY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The short-term impacts from emissions by dredges and other construction equipment associated with the project are not anticipated to affect onshore or offshore air quality significantly. Exhaust emissions from vehicles, vessels, and construction equipment associated with the project would have a temporary and localized effect on air quality. Offshore sea breezes are anticipated to disperse pollutants. This project requires no air quality permits. The analysis below estimates emissions from the non-federal sponsor's preferred plan, but the emissions levels of the other build alternatives are sufficiently similar to reach the same conclusion concerning air quality impacts as provided below.

An analysis was performed to estimate emissions from the project previously completed by the non-federal sponsor (Taylor 2012). The analysis included calculation of total project emissions of nitrogen oxides (NO_x), sulfur dioxide (SO₂), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM) less than 10 microns and greater than 2.5 microns.

Power requirements, duration of operations, and emission factors for the various equipment types used in project construction provided the basis for estimates of air pollutant emissions resulting from construction of the non-federal sponsor's preferred alternative.

The product of horsepower (hp) rating, activity rating factor (percent of total power), and operating time provided the estimate of project energy use. The energy use value multiplied by an engine-specific emission factor yielded emission estimates. Operational data reported in the Martin County FEIS (USACE 2010) for a beach nourishment project of similar size immediately south of the proposed project area provided power requirements and duration for each phase of the proposed dredging activity.

The hp rating of the dredge plant considered propulsion (3,500 hp), dredging (2,565 hp), pumping (2000 hp), and auxiliary (600 hp). Different rating or loading factors were used for dredging, propulsion, and pumping. The air quality analysis contains the following assumptions:

- The previously constructed non-federal project placed an estimated 645,164 cubic yards within the beach template. The proposed Federal project would dredge 422,000 cubic yards for initial construction of the design beach profile and approximately 2 periodic nourishment events averaging 390,000 cubic yards each.
- Dredging cycle time (dredging, travel to transfer point, pump-out, and return to dredge site, and idle time) would last five hours.
- Each dredging cycle would move on the order of 2,000 cubic yards of material, requiring approximately 243 loads to excavate enough material to place 485,900 cubic yards of sand on the beach.
- Dredging could last 65 to 181 days.
- Distance from dredge site to transfer point would span three-seven miles.
- Placement and relocation of nearshore mooring buoys used during pump out may involve up to two tender tugboats, a derrick barge, two work barges, and pipeline hauler/crane.

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- Construction would include moving the buoy (and the subline) five times during the project; each move would require approximately 12 hours of machine operation.
- Crew/supply vessel operation would approach four hours per day.

The analysis assumed that all dredging, hopper transport, and crew/supply vessel activities would occur over state waters and at the placement site. The beach fill related estimates assumed the use of up to four bulldozers/pipeline movers and two trucks, each operating 80% of the time for the duration of the project.

Emission factors for the diesel engines on the hopper dredge, barge, and tugboats came from EPA's *Compilation of Air Pollutant Emissions Factors, AP-42, Volume 1* (2002). Derived emission factors for tiered equipment used in beach construction came from NONROAD model (5a) estimates.

Any of the action alternatives may result in small, localized, and temporary increases in concentrations of NO_x, SO₂, CO, VOCs, and PM (Table 5-3). Because the project is located in an air quality attainment area, the EPA requires no preliminary air quality conformity assessment. The proposed Federal project would result in approximately 35% less emissions for initial construction, and approximately 40% less emissions for the 2 proposed periodic nourishment events as compared to the non-federal sponsor's previously constructed project.

Emissions associated with the dredge plant would provide the largest contribution to the inventory. However, the total project emissions represent a minor percentage of the existing point and nonpoint and mobile source emissions in St. Lucie County (Table 5-3). Prevailing winds would quickly disperse any pollutant released into the atmosphere from the project area. Since the recommended plan of the proposed Federal project is smaller in size, the resulting emissions would be even less significant. Green House Gas emissions would minimally effect global emissions or total United States emissions. Dune vegetation planted would contribute to Green House Gas reduction through carbon sequestering.

Emission quantities vary with the number of trips and total operating time required to dredge the necessary quantity of sand. The calculated emissions of the non-federal sponsor's project would fall between those with lower sand volume and related construction activity requirements and those with greater sand requirements. The no-action alternative would have no impact on air quality.

Table 5-3. Estimated Emissions of the Non-Federal Sponsor's Previously Constructed Project.

Activity	Emissions (tons)					
	NO _x	SO ₂	CO	VOC	PM _{2.5}	PM ₁₀
Dredge Plant (Hopper)						
Dredging/Operation	11.1	0.2	2.5	0.3	0.2	0.2
Turning/Sail	23.3	0.4	5.3	0.6	0.4	0.4
Pump-out	6.2	0.1	1.4	0.2	0.1	0.1
Idle/Connect- Disconnect	2.2	0.0	0.5	0.1	0.0	0.0
Supporting Offshore Activities	6.8	0.1	1.6	0.2	0.1	0.1

St. Lucie County Coastal Storm Risk Management Project

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

CHAPTER 5.0 Effects of the Recommended Plan

Beach Fill	4.6	0.8	2.2	0.3	0.4	0.4
Total Project Emissions	54.2	1.7	13.5	1.6	1.2	1.2
2002 Countywide Emissions Nonpoint + Mobile	9,509	1,661	70,230	12,636	1,480	6,646
2002 Countywide Emissions Point and Nonpoint + Mobile	10,037	1,681	70,777	14,162	1,551	6,743

St. Lucie County 2002 emissions from EPA National Emission Inventory <http://www.epa.gov/air/data/>

5.1.12 NOISE

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Project construction activities could result in short-term minor adverse effects to the noise environment in the vicinity of both the beach fill and borrow area sites. Construction would include temporary sources of noise. This noise has the potential to disturb biological resources such as fishes, sea turtles, marine mammals, and seabirds. Sound would likely dissipate significantly over the three-mile+ distance between the dredging area and shoreline.

Proper maintenance of construction, dredging, and pumping equipment would minimize the noise impacts, and construction activities would likely occur for a short period. Construction noise may have a short-term, minor effect on sound levels in the vicinity of the construction activities.

5.1.13 AESTHETIC RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Effects associated with the plan include:

- Presence of construction equipment
- Noise
- Turbidity

The pipeline coming out of the water and along the beach, earthmoving equipment spreading sand along the beach, and associated construction activities would temporarily affect the aesthetics in the project area. Earth moving equipment used to distribute the sand would temporarily create visual disturbance as well as noise and exhaust fumes, which would decrease the overall aesthetic value in the immediate vicinity of the project activities. Earth moving equipment would operate from along the beach front to distribute the sand effectively after initial placement on the beach from the discharge pipes. Sand placement would cause short-term turbidity increases in the nearshore waters, resulting in a change in water color and clarity, and resulting in temporary minor impacts.

Analysis of grain size, color, and hue of the proposed borrow area sand area indicates that the dredged sand would be similar to the existing sand. With restoration of the currently eroded beaches, the overall aesthetic value within the project beach area is anticipated to increase.

The view within the proposed borrow area during project implementation may be affected by the presence and operation of equipment performing dredging and beach fill operations.

Any of the build alternatives could result in diminished aesthetic values as the beach continues to erode and narrow. Dispersion of sand from the south segment could partially offset this erosion.

5.1.14 RECREATION RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Effects associated with the plan include:

- Limited and/or restricted access
- Turbidity

Recreational use of the beaches and coastal waters would temporarily decrease in the immediate vicinity of active nourishment and borrow dredging efforts. Temporary public safety restrictions would keep beachgoers and recreational users from the areas of active construction on the beach and at the borrow site. The active construction areas would shift along the project area beach; recreational users could access areas already nourished. Increased turbidity and resulting decrease in visibility would reduce or eliminate scuba diving and snorkeling in the project construction zone and in the mixing zone down current of the project area beach, where temporary increased turbidity could occur. The project would not likely affect nearshore coastal boating and fishing, which could continue as usual during nourishment activities. Project implementation could result in overall short-term impacts to recreational opportunities.

The Recreational Benefits Assessment conducted from 2007 to 2008 (Stronge 2008) surveyed beach users on south Hutchinson Island in St. Lucie County from R-77 to the Martin/St. Lucie County line to determine the amount beach users would willingly pay during each visit to use the beach. Based on the amount that beach users would willingly pay, Stronge concluded that nourishment would add a recreational use benefit of \$549,690 compared to the existing beach, resulting in a positive impact to recreation from project implementation.

5.1.15 CULTURAL RESOURCES AND HISTORIC PROPERTIES

As discussed in the Section 2: Existing Conditions and Future Without-Project Conditions portion of this document, substantial cultural resources work and investigations have been conducted throughout various portions of the project area. This project has been coordinated with the Florida SHPO and the appropriate federally-recognized tribes in accordance with Section 106 of the NHPA, as amended (16 USC 470) and it's implementing regulations (36 CFR 800) and consideration given under the NEPA.

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The Recommended Plan would see shoreline impacts occurring between FDEP Range Monuments R-98 and the Martin County line. No cultural resources have been identified within this portion of the project area. As discussed in Section 2, this area was previously surveyed in 2007 and no cultural resources were identified as a result of this survey. Additionally, there are no previously identified historic properties or districts adjacent to the sand placement template; however, beach nourishment will benefit those structures that may be potentially eligible for listing in the NRHP by minimizing the potential of erosion. The SHPO reviewed the survey record and concurred with the recommendation of no effect on cultural resources in a letter to USACE dated 27 July 2010 (DHR File No. 2008-02141-B) (**Appendix H**).

Based on remote sensing surveys conducted between 2007 and 2010 of the proposed offshore borrow locations, one cluster of magnetic anomalies was identified in the southern borrow area and two historic wreck sites are located adjacent to the northern borrow area. No diver evaluations were performed on the magnetic targets, and a buffer of 200 feet was recommended to avoid effects on the potentially significant resource. In a letter dated 31 July 2008 USACE determined that a 500-foot buffer of the anomalies would be utilized during dredging to avoid impacts (**Appendix H**). This letter also noted that the two previously recorded historic shipwrecks are located outside of the project area and determined that, contingent upon the preservation of the anomaly cluster with a 500-foot buffer zone, no historic properties would be affected by dredging. The SHPO concurred with the determination of effects in a letter dated 4 September 2008 (DHR File No. 2008-05091) (**Appendix H**).

During implementation of the Recommended Plan, USACE will continue to protect these cultural resources by maintaining the 500-foot buffer previously implemented during dredging. Contingent upon maintaining the buffer, USACE has determined that the Recommended Plan will have no effect on historic properties listed or eligible for listing in the NRHP. As a result of consultation, both the Florida SHPO and the Seminole Tribe of Florida concur with USACE determination of no effect to historic properties in letters dated May 3, 2016 and April 27, 2016 respectively (**Appendix H**). The Miccosukee Tribe of Indians of Florida declined to comment.

5.1.16 NATIVE AMERICANS

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

As part of the development of this project, the Recommended Plan has been coordinated with the appropriate federally-recognized tribes within the immediate area of potential effect. As discussed in Chapter 3, there are no known Native American properties within the project area and the project will have no effects to Native Americans. Consultation with the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida has been undertaken. As a result of this consultation, the Seminole Tribe of Florida concurred with USACE determination of no effect and the Miccosukee Tribe of Indians did not provide comment (**Appendix H**).

5.1.17 PUBLIC SAFETY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

As a public safety measure, beach and water-related recreation in the immediate vicinity of the discharge pipe would be prohibited during project construction. Likewise, water related activities near the dredge site would also be prohibited during project construction. Recreational access to these areas would return to pre-construction conditions following completion of the project. Long-term effects are not anticipated.

5.1.18 NATURAL OR DEPLETABLE RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

No natural energy resources occur within the proposed project area. The St. Lucie Shoal proposed as a source for beach fill is considered a depletable resource. Project dredging would reduce the quantity of shoal sand.

Excavation of sediments from borrow sites exposes underlying sediments and can change the sediment structure and composition of the borrow site. This can lead to changed benthic community composition. Benthic species' ability to perform life functions (e.g. burrowing, feeding, or settling as larvae) varies with sediment quality and members of the current benthic community may or may not have the same success in the physical characteristics of the new sediment as in the existing sediment. In addition, excavation alters the seabed topography, creating pits that may refill rapidly or remain for extended periods. Studies have shown that some borrow areas located within highly depositional areas have a relatively short filling time, whereas other areas may take up to 12 years returning to pre-dredge topography. In general, shallow dredging over large areas causes less change than smaller deep pits. If borrow pits are excavated in small deep pits, current velocity is reduced at the bottom, which can cause the deposition of fine particulate matter and potentially create a biological assemblage much different in composition than the original (Hammer et al. 2005). These assemblages may not provide the same trophic support as the original benthic community. However, the project dredging design provides a maximum dredging depth of only 10 feet below the existing surface (a relatively shallow dredging template) and the dredge footprint comprises a very small portion of the total benthic habitat area. Predators on the benthic community would still have ample forage area after dredging ends.

Structurally, however, dredging could alter this shoal structure permanently and locally affect the seabed topography within the borrow site. BMPs applied to the design of the dredging profile of the shoal including avoidance of dredging across the shoal and maintaining a refuge patch at the highest shoal elevations would help minimize the impacts to the shoal habitat. In addition, based on physical geological models of shoal formations, there does not appear to be a mechanism that supports the idea that structural integrity of a shoal feature would "deflate" or "unravel" when subject to repeated dredging events (CSA International et al. 2009a), which has been suggested by Michel et al. (2001). Dibajnia and Nairn (2010) summarizing field and modeling studies of shoal behavior with dredging indicated that dependent upon dredging location, shoals will reform and retain existing original height after completion of dredging.

However, not all impacts from dredge pits are detrimental. Borrow pits are known to attract numerous fishes and have been known to provide resting places for sea turtles (K. Spring and D. Snyder, personal observations off Hobe Sound, Florida).

5.1.19 ENERGY REQUIREMENTS AND CONSERVATION

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Energy requirements for the proposed alternative would be limited to the fuel for the dredging and pumping equipment, labor transportation, and construction equipment associated with beach placement. The use of sand from the proposed borrow areas would require less energy expenditure than obtaining sand from any other distant source.

5.1.20 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

5.1.20.1 IRREVERSIBLE

An irreversible commitment of resources is one in which the ability to use a resource is lost forever. The use of sand from offshore or upland borrow areas would irreversibly commit those sand resources to this project and preclude their use for future nourishment projects. However, the offshore borrow area for this project is estimated to contain 10.6 million cubic yards of beach-compatible sand, which is more than adequate for the sand required by the project.

Use of sand from offshore borrow areas would also irreversibly preclude its current use as habitat for benthic organisms. However, portions of the existing shoals may be left undisturbed as “refuge patches” to minimize impacts to existing benthic resources and to provide for re-colonization of disturbed borrow areas. Sufficient remaining sand reserves within and adjacent to the borrow area would provide for recolonization of benthic organisms. Due to the dynamic nature of nearshore benthic environments, sand used to nourish the beach would eventually disperse in the nearshore areas and create habitat for shallow water benthic communities.

Impacts of beach restoration on nearshore hardbottom communities have been previously mitigated. These nearshore hardbottom areas are also cyclically covered and exposed due to seasonal and other temporal changes in beach profiles. In view of the natural, highly dynamic fluctuations in exposure and burial of the nearshore rock resource and the modest scale of the proposed beach fill activity, abandonment of the project at any point can be reasonably anticipated to result in the near or wholly complete recovery of existing conditions.

5.1.20.2 IRRETRIEVABLE

An irretrievable commitment of resources means that opportunities for other uses are foregone for the period of the Proposed Action. Typically, it refers to the use of renewable resources, including human effort, and to other utilization opportunities foregone in favor of the Proposed Action.

The loss of hardbottom habitat has been previously mitigated through the implementation of a program to construct nearshore artificial reef. As noted, impacts of beach restoration on nearshore hardbottom communities are reversible and do not represent an irretrievable commitment of these resources for project use.

5.1.21 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The main unavoidable adverse impact of the plan would be impacts to nearshore hardbottom habitat; however, this impact has been previously offset by the non-federal sponsor. Re-exposure of hardbottom is also possible due to high-energy dynamics of the area and equilibration of beach fill. Recolonization of re-exposed hard substrates by worm rock and turf and macroalgae is probable as these organisms have high recruitment capability.

Other unavoidable adverse impacts of fill projects to the marine environment include:

- Burial of infauna and non-motile epifauna in nearshore sand bottom areas due to placement of beach fill. Recovery would depend on the ability of buried organisms to burrow through the sediment layer and the ability of adjacent populations to recolonize the area. However, the affected area is a small percentage of the total sand bottom habitat in the region.
- Impacts to infaunal communities in the offshore borrow area due to sand removal and habitat alteration. These impacts are reversible, as the affected areas would gradually fill with sand from adjacent areas and be recolonized by infauna. Portions of the existing shoals are proposed to be left undisturbed as “refuge patches” to minimize impacts to existing benthic resources and also provide for recolonization of benthic resources in the disturbed borrow areas.
- Temporary, localized water column turbidity in the offshore borrow area and along the project shoreline. BMPs implemented during construction should reduce the magnitude and extent of turbidity and the project should result in only minor, temporary adverse effects on water quality. Turbidity would be monitored during construction to ensure that turbidity from construction activities conforms to State water quality standards at the mixing zone boundary.
- Temporary, localized air quality and noise impacts due to emissions from offshore and onshore construction equipment.
- Temporary aesthetic/visual impacts due to the presence of construction equipment in the offshore borrow area and along the project shoreline.
- Temporary loss of recreational use of the beach and adjacent nearshore areas during construction. Minor impacts to recreational opportunities would likely occur. The project area comprises a small percentage of the total area available for similar recreational activities in St. Lucie County.

5.1.22 LOCAL SHORT-TERM USES AND MAINTENANCE / ENHANCEMENT OF LONG-TERM PRODUCTIVITY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The plan is expected to produce localized, short-term impacts on nearshore benthic communities and water quality, but it is not expected to cause significant adverse impacts on long-term productivity. Shoreline protection using periodic beach nourishment is an ongoing activity along much of the Florida shoreline. Beach nourishment projects have a temporary and short-term impact on nearshore biological resources and local offshore biological communities when offshore dredging supplies the nourishment sand. Most motile organisms (fishes, crabs, and some sand dwelling organisms) within the offshore borrow area and nearshore fill zone should be able to escape these areas during construction. Less-motile individuals that are unable to escape from construction would be lost, but lost populations of those individuals typically recolonize rapidly after project completion. The plan would produce temporary increases in turbidity but would not result in significant long-term water quality degradation. Short-term reductions in primary productivity and reproductive and feeding success of invertebrate species and fish are expected. These impacts should not negatively affect the sustainability of these populations given the localized scale of impacts and the creation of mitigation reefs.

5.1.23 INDIRECT EFFECTS

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Some prior studies have concluded that beach nourishment projects lead to greater development, tourism, investment, and subsequently greater long-term requirements for shoreline protection (National Research Council Committee on Beach Nourishment and Protection 1995, Pilkey and Dixon 1996, Dean 1999). However, other studies concluded that shoreline development is fostered mainly by economic factors other than public investment in shoreline protection (Cordes and Yezer 1998, Cordes et al. 2001). If allowed to occur, increased shoreline development could result in additional indirect ecological impacts such as adverse effects on sea turtle nesting due to increased artificial lighting, etc.

Few sites in the uplands adjacent to the project area remain open for development, so there is little or no opportunity for future development growth adjacent to the project beach. The existing shoreline includes a mix of residential, commercial (lodging), and public park facilities. More importantly, the potential for indirect development effects has been minimized in the design of the build alternatives. The non-federal sponsor has delineated the project area to (a) include that portion of the study area that is designated by FDEP as “critically eroded.” The project qualified for state cost-sharing where beach nourishment appears feasible for obtainment of a FDEP permit, but (b) excludes shoreline segments where minimal or no beach-front development exists and where little or no storm damage prevention benefits would be realized via beach nourishment.

5.1.24 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

Recognizing the importance of the state's beaches, the Florida Legislature in 1986 adopted a posture of protecting and restoring the state beaches through a comprehensive beach management planning program. Under the program, the FDEP's Bureau of Beaches and Coastal Systems evaluates beach erosion problems throughout the state seeking viable solutions. The primary vehicle for implementing the beach management planning recommendations is the Florida Beach Erosion Control Program, a program established to work in concert with local, state, and Federal governmental entities to achieve the protection, preservation, and restoration of the coastal sandy beach resources of the state. Eligible activities include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sand transfer, dune restoration and protection activities, and other beach erosion prevention activities consistent with the adopted Strategic Beach Management Plan.

The FDEP has classified most of the south St. Lucie County beaches as "critically eroded areas," a level of erosion that threatens substantial development, recreational, cultural, or environmental interests. One way to restore eroded beaches is through beach nourishment where sand is collected from an offshore location by a dredge and is piped onto the beach. A slurry of sand and water exits the pipe on the beach and once the water drains away, only sand is left behind. Bulldozers move this new sand on the beach until the beach matches the design profile. Beach nourishment comprises a preferred way to add sand to a system because it provides a significant level of storm protection benefit for upland properties and includes the relatively few impacts to the coastal system. An additional benefit of beach restoration projects is that such projects quickly restore shorebird and marine turtle habitat.

The St. Lucie County coastline is a valuable resource providing storm protection, recreation, economic value, and wildlife habitat. The preservation of this coastline is a long-term, ongoing non-federal sponsor commitment. The non-federal sponsor's main objective is to abate ongoing and historical beach erosion; specific non-federal sponsor criteria for plan formulation include optimizing project performance and cost effectiveness — generally consistent with USACE planning regulations for coastal storm risk management projects, and minimizing environmental impacts to the extent feasible.

Along many coastal areas, including the project area, erosion threatens oceanfront properties. Beach and dune restoration is necessary to help prevent the loss of property and/or the construction of numerous emergency shoreline armoring structures and other stopgap measures that would very likely continue to narrow the beach. With beach narrowing, sea turtle nesting habitat diminishes until (ultimately) no nesting habitat remains. While narrow beaches may still support nesting, if high tides reach a dune line on a regular basis, hatching success dramatically decreases from nest inundation and washout. In addition, recreational use of narrowed beaches diminishes. Therefore, the proposed project is consistent with Federal, state, and local objectives.

5.1.25 CONFLICTS AND CONTROVERSY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The NMFS expressed concerns regarding the beach nourishment project previously constructed by St. Lucie County, and mitigation that St. Lucie County provided for impacts to hardbottom habitat (refer to Section 2.2.5 and Appendix G, Attachment 3 for more info). The NMFS requested continued coordination between the Jacksonville District and the NMFS Habitat Conservation Division until these issues are fully resolved. These concerns shall be fully addressed by USACE Regulatory Division prior to construction of the Federal project.

5.1.26 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The proposed activity (i.e. beach nourishment) is commonly conducted, and has previously been permitted and conducted in St. Lucie County. To date, USACE has identified no uncertain, unique, or unknown associated with the plan considered in this EA.

5.1.27 REUSE AND CONSERVATION POTENTIAL

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

There is no potential for reuse associated with the proposed project activities; therefore, this is not applicable to the proposed periodic nourishment project. Energy requirements for the proposed alternatives would be confined to fuel for the dredge, labor transportation, and other construction equipment.

5.1.28 URBAN QUALITY

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

No direct permanent impacts related to urban quality are expected as a result of the proposed project. Implementation of the proposed project would indirectly and positively impact urban quality by restoring an eroded beach, by increasing the recreational beach activity, and by increasing the tax revenue and tourism commerce.

The commercial businesses and residential properties along the project beach could benefit from the storm protection afforded by the project and incur less risk of property damage. The presence of construction equipment could temporarily detract from the aesthetics of the environment, possibly temporarily affecting the localized visual aesthetics associated with south Hutchinson Island.

5.1.29 SOLID WASTE

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

No impacts related to solid waste are expected due to this project. Precautionary measures anticipated in the contract specifications would identify and require proper disposal of solid wastes. Precautionary measures include proper containment and avoidance of overflow conditions by emptying containers on a regular schedule. Disposal of any solid waste material into Atlantic waters would not be permitted.

5.1.30 SCIENTIFIC RESOURCES

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

There are no known scientific resources associated with the plan.

5.1.31 DRINKING WATER

FUTURE WITH-PROJECT (RECOMMENDED PLAN)

The proposed plan would have no effect on drinking water.

5.2 CUMULATIVE IMPACTS

Cumulative impacts are those that result from “the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions” (40 CFR 1508.7). Cumulative impacts result from spatial (geographic) and temporal (time) crowding of environmental perturbations. The impacts may result from the accumulation of similar effects or the synergistic interaction of different effects (Council on Environmental Quality 1997).

Table 5-4 summarizes cumulative impacts by identifying the past, present, and reasonably foreseeable future condition of the various resources with and without the project.

5.2.1 CUMULATIVE ACTIVITIES SCENARIO

The geographic scope of this analysis includes the shoreline of St. Lucie County and Martin County between Ft. Pierce Inlet and St. Lucie Inlet (about 22 miles of shoreline) and Atlantic Ocean sand shoals between about three and six miles offshore of the Central Florida coastline. The project impact area extends from R-96.5 in St. Lucie County to R-1.5 in Martin County due to the proposed mixing zone (150 meters from the point of sand discharge) and potential downdrift (southerly) transport of sand in the nearshore area. Other similar projects to the north and south and all the other reasonably foreseeable actions along the shoreline of Hutchinson Island could, together with the proposed project, result in cumulative impacts. In addition to the coastline, the area includes the offshore borrow area located in a sand ridge (St. Lucie Shoal) three miles offshore of R-88 to R-115 in water depths of approximately 36 to 43 feet. Cumulatively, the project and other similar projects could impact sand shoals three to five miles offshore.

5.2.1.1 PAST CONDITIONS AND ACTIVITIES

A Conditions Assessment Report (Coastal Tech 2009) summarizes historical shoreline changes from R-77 through R-115. Except for the segment from R-103 to R-109, the shoreline within the study area predominantly retreated from 1972 to 2006. A volumetric study conducted by USACE indicates that from 1997 to June 2004, the beaches of the study area cumulatively experienced slight erosion. From June 2004 to November 2004, following landfall of hurricane Frances and Jeanne (September 2004), a much stronger trend of erosion occurred.

Following hurricanes Frances and Jeanne, emergency dune restoration was conducted by the non-federal sponsor — including placement of about 162,000 cubic yards of sand along the dune from R-98.4 to R-101.5, and from R-103.3 to the Martin County line (PBS&J, 2005) — over about 15,500 feet of dune and corresponding to a fill density of about 10 cubic yards/foot. Individual property owners have also undertaken dune restoration projects; placed quantities are unknown, but the non-federal sponsor believes these amounts are relatively minor. North of the project area, the Federal Ft. Pierce Shore Protection Project area (about 1.3 miles in length) has received nourishment sand since 1971, before the Federal project was defined. The Federal project began in 1980. Since that time, 14 nourishments have placed sand on various portions of the project beach. Abutting the proposed project to the south, the Federal Martin County Shore Protection Project, initiated in 1995, has renourished a four-mile project three times with the last renourishment completed in 2013. In addition, Martin County nourished Bathtub Beach, about 1,000 feet of shoreline, in spring 2010. Sail Fish Point Beach, just south and about 1,500 feet in length, received sand in 2005 and 2009.

Table 5-4. Summary of Cumulative Impacts.

Resource	Past and Present (Baseline/Existing Condition)	Future Without-Project	Future With-Project
Threatened and Endangered Species: Sea Turtles	Five sea turtle species occur in the area (loggerhead, green, hawksbill, Kemp's ridley, and leatherback). Loggerhead, green, and leatherback turtles nest on area beaches. Juvenile green turtles use nearshore hardbottom areas for feeding (macroalgae), resting, and shelter from predators. Past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of discarded anthropogenic marine debris.	Sea turtle nesting and nearshore habitat use would continue in the area. Project-specific impacts would be avoided, but ongoing threats to sea turtle populations would continue. In the absence of the project, property owners may armor their shoreline to protect their property, which may result in loss of nesting habitat and possible impacts on nearshore hardbottom habitat.	In addition to ongoing threats, the project would result in loss of a small defined area of juvenile developmental habitat (nearshore hardbottom). Sea turtles may be disturbed by turbidity and noise during construction. There is a small risk of sea turtles being struck by a construction vessel or entrained in the hopper dredge draghead; these risks would be minimized through vessel-strike avoidance and dredge related impact mitigation measures. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are anticipated.
Threatened and Endangered Species: Marine Mammals	Three endangered marine mammal species may occur in the area: Florida manatee, humpback whale, and North Atlantic right whale. Only the manatee is common. Past and current threats to marine mammal populations include vessel strikes, fishing gear entanglement, ingestion of marine debris, pollution, and underwater noise.	Marine mammals would continue to occur in the area. Project-specific impacts would be avoided, but ongoing threats to marine mammal populations would continue.	In addition to ongoing threats, marine mammals may be disturbed by turbidity and noise during construction. There is a small risk of marine mammals being struck by a construction vessel or entrapment within a hopper dredge draghead. Mortality of a manatee or North Atlantic right whale would represent a significant cumulative impact due to the small population of these species. The risk would be minimized through vessel-strike avoidance and dredge impact-related mitigation measures.
Threatened and Endangered Species: Smalltooth Sawfish	The smalltooth sawfish is an endangered species inhabiting shallow, nearshore waters. Historically, its population and range have declined, mainly due to fisheries bycatch. Other past and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance.	Smalltooth sawfish would continue to inhabit the area. Project-specific impacts would be avoided, but ongoing threats to sawfish populations would continue and may result in further decreases in population size and range.	In addition to ongoing threats, sawfish may be disturbed by turbidity and noise during construction. There is a small risk of sawfish being entrained in the hopper dredge draghead, which would be minimized through mitigation measures. Due to the small spatial extent and short duration of project impacts, the smalltooth sawfish would not likely incur other than minor impacts.
Nearshore Hardbottom	Two nearshore hardbottom communities occur in the area. One consists of low- to medium-relief habitat with worm rock and supports hydroids, encrusting sponges, macroalgae, and turf algae. The other consists of low-relief coquina ledges with little or no epibiotic cover. These communities have historically been subjected to the dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure.	Nearshore hardbottom areas would continue to exist in the area, subject to the natural dynamics of the nearshore environment including sand movement, scouring, and alternating burial/exposure. In the absence of the project, property owners may construct shoreline armoring to protect their property, which may result in impacts to nearshore hardbottom.	Impacts to the nearshore hardbottom from previous beach placement activities have been mitigated.

CHAPTER 5.0 Effects of the Recommended Plan

Resource	Past and Present (Baseline/Existing Condition)	Future Without-Project	Future With-Project
Fish and Wildlife Resources	Nearshore soft bottom habitats including sand shoals support a variety of invertebrates and demersal fishes. Invertebrates using shoals include infaunal and epifauna species represented primarily by annelid worms, gastropods, bivalves, crustaceans, and echinoderms. Most of these species are used as food by demersal fishes.	Project-specific impacts would be avoided, but soft bottom communities would continue to be affected by natural sand movement. In the absence of the project, property owners may armor their shoreline to protect their property, which may result in impacts to nearshore soft bottom communities. Regionally, other sand shoal areas are likely to be used in support of future beach nourishment projects.	In addition to ongoing processes affecting soft bottom fish and wildlife resources, there would be localized effects of dredge and fill activities along the beach and in the offshore borrow area that may persist for a few months to a few years. Major long-term effects are not anticipated because resident fish and wildlife species are wide-ranging or migratory and spend only a portion of their life cycle at the borrow area and beach fill sites.
Essential Fish Habitat	Managed species and species groups in the project area include <i>Sargassum</i> ; coral, coral reefs, and live/hardbottom habitats; penaeid shrimp; spiny lobster; red drum; coastal pelagic fishes; reef fishes; dolphin and wahoo; and highly migratory pelagic species. Habitats of Particular Concern (HAPCs) for coral, coral reefs, and live/hardbottom habitats of the eastern Florida area include the <i>Phragmatopoma</i> worm reefs found in nearshore waters; nearshore hardbottom found in water depths of 0 to 4 m; and hardbottom found in water depths of 5 to 30 m.	Project-specific impacts would be avoided, but the acreage of nearshore hardbottom Essential Fish Habitat (EFH) would fluctuate with natural sand movement. Increased exposure of hardbottom may provide increased habitat for surf zone fishes, increased foraging habitat for green sea turtles, and increased refuge for juvenile fishes. In the absence of the project, property owners may construct armoring to protect their property, which may result in impacts to nearshore EFH.	Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. St. Lucie County provided mitigation to offset these impacts. The recommended plan, with its smaller placement area, would not exceed previous impacts and, therefore, additional mitigation is not proposed. Please refer to Section 2.2.5 and to Appendix G, Attachment 3 for more information on the mitigation.
Water Quality	The project area consists of Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well balanced population of fish and wildlife. The predominant issue that affects water quality in the area is turbidity, which varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU. Historically, coastal water quality has been affected by unrelated anthropogenic sources such as stormwater and effluent runoff resulting in increased nutrients and freshwater inputs. Urbanization and population growth in the region contributes to coastal water quality degradation.	Project-specific impacts would be avoided, but turbidity would continue to occur intermittently due to storm activity, rainfall, currents, and other natural phenomena. Water quality may deteriorate due to unrelated anthropogenic sources such as stormwater and effluent runoff.	In addition to the ongoing natural and anthropogenic fluctuations in water quality, local, short-term turbidity would occur adjacent to the beach fill sites and offshore borrow area. BMPs would be implemented during construction to reduce the magnitude and extent of turbidity, and adverse effects on water quality are expected to be minor. Turbidity would be monitored during construction to ensure that State water quality standards are met at the mixing zone boundary. Due to the small spatial extent and short duration of project impacts, no long-term effects are expected.

St. Lucie County Coastal Storm Risk Management Project

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

5.2.1.2 . PRESENT/ONGOING ACTIVITIES

There are no ongoing beach restoration activities in the project area. The St. Lucie shoal is not currently being used for any other beach restoration projects. Recreational usage along the beaches within the project area includes shore based water sports such as scuba diving, snorkeling, surfing, surf fishing, and kayaking. Additionally, the area beaches are used for sunbathing, picnicking, and exercising. Boating is a popular recreational pastime for many residents and tourists to the area. Fishing, scuba diving, and snorkeling are often done from boats in nearshore hardbottom areas close to the shore. These shallow nearshore hardbottom areas are attractive areas for scuba diving and lobster fishing as well as angling from small vessels. Angling may occur near the proposed borrow site, although there are no known fish havens near the borrow area.

5.2.1.3 REASONABLY FORESEEABLE FUTURE ACTIVITIES

To provide for future periodic nourishment of the project, a conceptual 50-year borrow area dredge plan has been proposed based upon the report titled “St. Lucie County Sand Search – Geotechnical Investigations – Reconnaissance Level Investigations” (Coastal Tech 2010c). The periodic nourishment interval and volume are 18 years and 390,000 cubic yards, respectively. The proposed borrow area for project periodic nourishment is located offshore St. Lucie County in reasonable proximity to the project fill area. The borrow area can also likely yield the 50-year total estimated volume of beach compatible sand.

The Martin County Beach Erosion Control Project authorizes construction of a protective and recreational beach along four miles of shoreline southward from the St. Lucie County line to near the limit of Stuart Public Beach Park (R-1 to R-25). The authorized project was initially constructed in 1996 with a planned periodic nourishment interval of 11 years. Federal participation (cost sharing) is authorized for 50 years from date of initial construction and expires in 2046. The previously approved borrow area, used for initial construction, was depleted after the 2005 renourishment. Subsequently, Martin County and USACE investigated three sand shoals including portions of the St. Lucie Shoal complex located approximately three to seven miles offshore Martin and St. Lucie Counties on the OCS. The USACE and BOEM completed an EIS in 2011 which authorized a borrow area southeast of the St. Lucie Shoal on the OCS as a source of beach-compatible sand. The new Martin County OCS borrow area was used for the 2013 renourishment. The total sand needed for the remainder of the 50-year period of Federal participation is estimated to total between 2.4 and 4.0 million cubic yards.

Regionally, beach nourishment is expected to continue in the coming years, compounding opportunities for recurring impacts. In southeast Florida alone, approximately 100 nourishment events are projected to occur between 1969 and 2050 dredging at least 100,000,000 cubic yards of sediment from an area 4 miles wide by 120 miles long (from Dade County to Martin County) (USACE 1996).

Future periodic nourishment projects at the proposed site would require less sand (390,000 cubic yards) than the initial nourishment on a 18-year periodic nourishment cycle. This results in a requirement of about 1.2 million cy over the 50-year project period of analysis. This amount comprises approximately 12% of the sand resources in the St. Lucie Shoal. Additionally, based on recent beach nourishment projects, construction of a 390,000 cubic yard project using upland sand sources can reasonably occur within a single annual period outside turtle nesting season. A future periodic nourishment project proposal should carefully evaluate the use of upland sand for construction.

The non-federal sponsor provides local sponsorship to the State of Florida for implementing the state Ft. Pierce Inlet Management Plan. Part of that sponsorship has included investigations to meet and maintain sand bypassing requirements across Ft. Pierce Inlet identified in the sand management plan. In 2004, Taylor Engineering completed a study for the non-federal sponsor to identify an annual bypassing operation that could either meet the state adopted bypassing requirements or, at a minimum, supplement the USACE coastal storm risk management project just south of Ft. Pierce Inlet (Taylor Engineering 2004). The bypassing operation could buffer high erosion rates seen immediately south of the Ft. Pierce Inlet south jetty and maintain the Federal beach restoration project's design template over its periodic nourishment interval. The study identified two alternatives — north jetty sand tightening with mobile sand bypassing plant and north jetty sand tightening with nearshore dredging — as reasonably attractive alternatives to bypass sand across the inlet. The non-federal sponsor has recently completed a feasibility study of a third alternative — construction of a sediment basin in the inlet (Taylor Engineering 2010). An effective deposition basin in the inlet would capture incoming sediments and provide a sand source for bypassing operations. A deposition basin (sand trap) would create an area of deep water, effectively decreasing flow velocities within the basin and causing sediment to deposit there, rather than further in the navigation channel and inlet interior. Past experience at several east coast Florida inlets has proven the effectiveness of channel deposition basins as replenishing sand sources for bypassing projects. At Ft. Pierce Inlet, a deposition basin within the inlet with periodic dredging could potentially fulfill or supplement sand bypassing volume requirements. The non-federal sponsor's Board of County Commissioners has recently directed non-federal sponsor staff to move ahead with design and permitting of a sand trap in the northwest corner of the inlet, adjacent to Ft. Pierce Inlet State Park. Bypass sand quality would likely equal or exceed that available from other sources (offshore or upland) and might in the long-term serve to improve the general quality of the sand and the nearshore environment along Hutchinson Island. The sand trapped in the impoundment comes from beaches updrift (north) of the inlet rather than from offshore or upland sources, and so provides very similar quality sand to the Hutchinson Island nearshore system that it received prior to construction of the inlet. This sand would ultimately make its way to the south St. Lucie County beaches.

5.2.1.4 SEA-LEVEL CHANGE

Potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. Future sea-level change is likely to result in both direct and indirect impacts on nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion, which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. The largest uncertainty is predicting the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level.

USACE Circular No. 1165-2-211 provides estimates of sea level rise ranging from 0.39 ft. (0.12 m) to 2.1 ft. (0.63 m) over the next 50 years. The U.S. Climate Change Science Program (CCSP 2009) Synthesis and Assessment Product 4.1 (SAP 4.1) *Coastal Sensitivity to Sea-Level Rise: A Focus on the MidAtlantic Region* details both how sea-level change affects coastal environments and what planners should address to protect the environment and sustain economic growth. SAP 4.1 represents implications of rising sea levels and possible adaptive responses. Many options are available for protecting land from inundation, erosion, and flooding ("shore protection"), or for minimizing hazards and environmental impacts by removing development from the most vulnerable areas ("retreat"). However, policymakers have not decided whether the practice of protecting development should continue as sea level rises, or be modified to avoid adverse environmental consequences and increased costs of shore protection. Most shore protection

structures are designed for the current sea level, and retreat policies that rely on setting development back from the coast are designed for the current rate of sea level rise. Those structures and policies would not necessarily accommodate a significant acceleration in the rate of sea-level rise.

5.2.1.5 CONCLUSIONS

Ongoing beach restoration activities in the area include USACE coastal storm risk management projects at Ft. Pierce and the Martin County Shore Protection Project immediately south of the proposed project area. Long-term monitoring of those projects has not revealed cumulative impacts, and USACE and FDEP have found the mitigation projects have reached the anticipated ecological success. Regionally, dredging projects for beach nourishment are expected to continue, compounding opportunities for recurring impacts. Ongoing recreational usage of the nearshore environment includes fishing, boating, diving, snorkeling, and beach recreation activities.

Future sea-level change may result in significant direct and indirect impacts to nearshore marine resources in the project area. Direct impacts could include changes in the areal extent of exposed hardbottom habitat due to sand movement. Indirect impacts could result from increased beach erosion, which may prompt more frequent (and possibly more extensive) beach nourishment projects in the area. Predicting sea level rise and the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level comprise the largest uncertainties in estimating cumulative impacts.

Over the next 50 years without the project, important factors affecting the nearshore environment are likely to include sea-level change and ongoing, low-impact human uses such as fishing, diving and snorkeling, and boating. If the project is not implemented, property owners may construct revetments or other armoring to protect their property, which may result in indirect impacts to nearshore hardbottom by exacerbating erosion, sand movement and scour.



6

Environmental Compliance

6 ENVIRONMENTAL COMPLIANCE

This chapter discusses the status of coordination and compliance of the Recommended Plan with environmental requirements. Additionally, it shows how the Recommended Plan meets USACE environmental operating principles.

6.1 SCOPING

An initial scoping period for the project was conducted from May 31 through June 30, 2006. The National Marine Fisheries Service (NMFS) responded to this early scoping letter with concerns about the proposed dredging of the offshore shoals and that the EFH assessment and NEPA documents on this action should be prepared with sufficient detail. This assessment is included in Sections 2.3.5 and 5.1.6 of this report. The Florida Department of Environmental Protection (FDEP) coordinated a review of the early scoping letter and the proposed project with the appropriate state agencies. FDEP stated that “based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program.” FDEP also stated that “it is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification.” Other stakeholders raised concerns regarding the use of St. Lucie Shoal as a borrow site, impacts to hardbottom resources, and cumulative impacts.

The non-federal sponsor was issued a USACE permit (No. SAJ-2009-03448) and State permit (No. 0154626-001-JC) for a larger beach nourishment project in this area in 2012. An Environmental Impact Statement (EIS) was prepared as part of the issuance of the USACE permit. USACE subsequently coordinated the EIS with the agencies and general public. In accordance with 43 CFR 46.160, this Integrated Feasibility Report and Environmental Assessment (IFR/EA) tiers off of that EIS. The USACE permit and draft EIS were also provided to the agencies and public for review and comment.

A Notice of Availability (NOA) of the Draft IFR/EA was issued on May 2, 2016 to the agencies and general public (see Appendix H: Pertinent Correspondence). As stated in the NOA, the draft IFR/EA was placed on USACE Jacksonville District’s website and hard copies were placed in the St. Lucie Library-Fort Pierce Branch. The comment period on the draft IFR/EA ended on June 17, 2016. The NOA also served as an invitation to a public scoping meeting which was held on June 2, 2016. The meeting provided stakeholders an opportunity to further discuss the proposed work. The format of the meeting included an overview of the Recommended Plan as well as a formal comment period.

Pertinent correspondence associated with this NEPA scoping process is included in **Appendix H**.

6.2 COOPERATING AGENCIES

This proposed project has been coordinated with, but not limited to the following agencies: Bureau of Ocean Energy Management (BOEM), U.S. Fish and Wildlife Service, N M F S , U.S. Environmental Protection Agency, Florida State Clearinghouse, Florida State Historic Preservation Officer (SHPO), Florida Department of Environmental Protection, and Florida Fish and Wildlife Conservation Commission. BOEM by letter dated February 9, 2016 accepted USACE’s invitation to participate as a cooperating agency in this study. As a cooperating agency, BOEM participated and provided input in the NEPA process, developed

information and provided analysis for which BOEM has special expertise, and provided comments on the draft IFR/EA. The NMFS by letter dated February 22, 2016 also accepted USACE's invitation to participate as a cooperating agency. As a cooperating agency, NMFS provided comments on the draft IFR/EA and participated in teleconferences. Correspondence from all Federal and State agencies is included in **Appendix H**.

6.3 LIST OF RECIPIENTS

The NOA of the draft IFR/EA and Draft FONSI was mailed to those listed in Appendix H, NEPA Mailing List.

6.4 COMMENTS RECEIVED AND RESPONSE

Comments received on the draft IFR/EA or from the public scoping meeting are as follows:

PUBLIC COMMENTS

Comment No. 1: What can be done to decrease sponsor cost-share?

Response: The sponsor will need to add more public access, with associated parking, to cover the gaps between ¼ mile lengths from existing access points, via easements, land acquisition or transportation.

Comment No. 2: Can the project be constructed sooner than 2020?

Response: That is the earliest the project can be constructed, as the study still has many more steps, processes and approval points to go through.

Comment No. 3: Why were the upper three reaches screened out of the project?

Response: This was due to lack of damageable infrastructure (making it economically unjustified), as well as the presence of hardbottoms, and an extensive portion of the CBRS unit in the area.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION COMMENTS (see **Appendix H: Pertinent Correspondence**)

Comment: Based on the information contained in the submittal, the state finds that the proposed Draft Environmental Assessment is consistent with the Florida Coastal Management Program (FCMP). The state's continued concurrence will be based on the activities' compliance with FCMP authorities, including Federal and state monitoring of the activities to ensure their continued conformance, and the adequate resolution of issues identified during this and subsequent regulatory reviews. The state's final concurrence of the project's consistency with the FCMP will continue to be determined during the ongoing state's environmental permitting process, in accordance with Section 373.428, Florida Statutes. FDEP also stated that "it is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification."

FLORIDA STATE HISTORIC PRESERVATION OFFICER (see Appendix H: Pertinent Correspondence)

Comment: We have reviewed the above referenced TSP from the Feasibility Study. This office concurs that there will likely be no effect on historic properties conditioned upon the maintenance of 500-foot buffers around shipwrecks and anomaly clusters located in the borrow areas.

NMFS ESSENTIAL FISH HABITAT (EFH) CONSERVATION RECOMMENDATIONS/COMMENTS (see Appendix G, Attachment 3 for more information and attachments)

The NMFS provided the following EFH conservation recommendations by letter dated June 9, 2016. The USACE and BOEM requested additional time to respond to the NMFS letter via email dated July 4, 2016, and the NMFS acknowledged the additional time to respond. The USACE and BOEM provided the following responses by letter dated December 28, 2016.

Recommendation No. 1: The remaining 0.79 acres of mitigation reef should be constructed as described in the Federal permit in addition to any mitigation needed to offset the longer temporal lag that has resulted between burial of the live/hardbottom and establishment of the mitigation reefs.

Response: As reflected in the August 2015 “as-built survey (see attachment A)” and as cited in the corresponding September 18, 2015 “Mitigation Reef Certification Report (see Attachment B)”, a total of 1.93 acres of mitigation reef were constructed in 2013 & 2015 – in excess of the 1.89 acres required by USACE permit (Permit No: SAJ-2009-03448 [IP-GGL]). In addition, note that as identified in the August 31, 2015 “AS-BUILT CERTIFICATION BY PROFESSIONAL ENGINEER” submitted to USACE:

- Overall, the mitigation reef was built in substantial compliance with the plans and permit conditions. Adjustments to specific reef cell locations were made to comply with water depth requirements prescribed by USACE and Florida Department of Environmental Protection (DEP) permits.
- Ocean Bay Site 5 was moved to the northeast and only ten cells were constructed at that site due to limited water depths within the limits of the archeological survey. No cells were constructed at Ocean Bay Site 6 due to too shallow water depths. The ten cells that were unable to be constructed at Ocean Bay due to too shallow of water depths were moved to Blind Creek. Five cells were added to the south end of Site 4 at Blind Creek; one cell to the south end of Blind Creek Site 3; four cells to the south end of Site 2.
- In addition, at Blind Creek Site 1 Cell 7 could not be constructed in the permitted location due to insufficient corridor width between cells and the previously constructed reef. This cell was moved to the south end of Site 2.

Recommendation No. 2: The final IFR/EA should describe quantitatively the status of the existing 1.1 acres of mitigation reef with regard to the established biological performance standards.

Response: Please see Attachment C, the 2015 Monitoring Report and Attachment D, the Florida Department of Environmental Protection review letter. In addition, ongoing monitoring results, including assessment of permit compliance, will be provided to NMFS upon completion of the associated reports. Natural hardbottom impacts are expected to be concluded in concert with the forthcoming 2016 monitoring report expected by January 2017. Although the 2016 report will assess fulfillment of permit

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conditions relative to the artificial mitigation reef, continued monitoring of the mitigation reef is expected through 2018 as required by the FDEP permit (Permit No. 0154626-001-JC), including documentation of compliance with “biological performance standards”. All of these pending reports will be provided to NMFS upon completion. Reference to the recently completed monitoring reports describing the status of the existing mitigation reef and the commitment to provide NMFS with future reports to ensure compliance with “biological performance standards” will be documented in the final IFR/EA.

Recommendation No. 3: The final IFR/EA should provide the amount of mitigation reef constructed in water depths less than 4.0 meters.

Response: As reflected in the as-built survey, 1.93 acres of mitigation reef were constructed in areas with ambient bottom elevations between -12’ and -15’ NAVD 88, consistent with the drawings (see Attachment A) approved by USACE and included in the original USACE permit. At low tide these areas are expected to have ambient water depths between 9.37’ and 12.37’, less than 13.1’ or 4m. In addition, note that the ocean bottom area surrounding the mitigation reef:

- is within the active nearshore littoral system – landward of the “depth of closure”,
- was observed to accrete about 2 feet of sand associated with the passage of Hurricane Sandy in 2012, and
- has apparently experienced scouring around the individual reef cells after the reef construction – as is common with such structures in the nearshore region.

This summary related to the amount of mitigation reef constructed in water depths less than 4.0 meters will be documented in the final IFR/EA.

Recommendation No. 4: The final IFR/EA should include a synthesis of the available post construction monitoring reports and quantify direct and indirect impact predictions to live/hardbottom habitats seaward of the Equilibrium Toe of Fill.

Response: Construction of the Mitigation Reef was initiated in the summer of 2013, but was not completed until the summer of 2015. As identified in Special Conditions 32 and 33 of the USACE permit, it is anticipated that “success” of the Mitigation Reef will be assessed after 3 years following completion of the construction in 2018. Upon completion of the 2018 monitoring report, NMFS will be provided a copy for review and concurrence that “success” criteria have been met. To date, hardbottom impacts associated with the 2013 non-federal beach fill project appear to be within the “impact predictions”. Per Specific Conditions 46 and 47 of the FDEP permit, the forthcoming 2016 Report (expected by January 2017) constitutes the “first (a year after construction)” year monitoring report, a “second and third” annual mitigative artificial reef monitoring report shall be provided to NMFS upon completion. These monitoring reports are to address fulfillment of “all permit conditions.” A summary of the status of post construction monitoring reports and commitment to provide NMFS with the 2018 monitoring report for review and concurrence that “success” criteria have been met will be integrated into the final IFR/EA.

Recommendation No. 5: The final IFR/EA should estimate temporal and direct impacts to nearshore live/hardbottom occurring as a result of project construction during 2013 based on the year 2 monitoring report (and year 3 if that information is available) and evaluate compliance with permit condition 44(i)(6).

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Response: See response to NMFS Recommendation 4 cited above. Actual impacts to natural hardbottom are expected to be concluded by the forthcoming 2016 monitoring report – expected by January 2017. The 2016 report constitutes the final natural hardbottom monitoring report as required by Specific Condition 38 of the FDEP permit. A summary of the status of post construction monitoring reports and commitment to provide NMFS with future monitoring reports for review will be integrated into the final IFR/EA.

Recommendation No. 6: The year 3 monitoring report should reflect sampling and analysis of 10 reference areas the District agreed in July 2012.

Response: Ongoing monitoring and the year 3 monitoring report do and will reflect FDEP and USACE permit requirements to sample/analyze reference areas. The Scope of Work specifically cites for monitoring of natural hardbottom areas:

A total of twenty (20) monitoring transects will be surveyed: ten (10) within the Project area, two (2) downdrift in Martin County, and eight (8) updrift in St. Lucie County, previously established in 2008/2009 and/or pre-construction monitoring in 2012.

Transect positions and lengths are to be permanent.

Recommendation No. 7: The final IFR/EA should summarize results from the infaunal monitoring at the borrow site.

Response: Infaunal monitoring results will be made available to NMFS upon completion of 2016 monitoring and completion of the associated report. The final IFR/EA will summarize these results.

Recommendation No. 8: Dredging at the borrow site should limit dredging to the prevailing downdrift flanks of the shoals, limiting the depths of the dredge cuts to 3 to 6 feet, and limit the dredging to the portions of the shoal expected to fill in most quickly once dredging has stopped.

Response: This recommendation implies that the proposed borrow area located within the St. Lucie shoal complex may recover through active littoral processes following dredging. However, this shoal complex is considered a relic feature and is not connected to the active littoral system. USACE will continue to collect additional geotechnical and geophysical data within the proposed borrow area during Preconstruction Engineering and Design (PED). These more refined data will inform the final borrow area design parameters prior to construction. USACE and BOEM will coordinate with NMFS to develop a refined borrow area design that provides a sufficient volume of compatible sediment to support the project objectives while maintaining overall shoal integrity. The overall goal is to ensure that physical and biological processes following dredging are maintained within the St. Lucie shoal complex to the maximum extent practicable.

Based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, USACE and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the Federal project. USACE and BOEM will continue to coordinate with NMFS as

additional information becomes available. The final IFR/EA will document a commitment to continue coordination with NMFS during PED as the borrow area design is refined.

Recommendation No. 9: A biological monitoring and adaptive management plan that reflects substantive input from NMFS for the nearshore hardbottom impacts is provided prior to the commencement of any new work in the project area.

Response: The DEP/USACE permits for the 2013 non-federal beach fill project reference the approved Biological and Physical Monitoring Plans. Comparable monitoring (a) should be adequate for the reduced footprint associated with the proposed Federal project, and also (b) will likely be required for monitoring of the Federal project per the associated State Water Quality Certification (DEP permit).

The NMFS issued a second letter dated January 9, 2017, which expressed additional concerns regarding the implementation of the Department of Army permit issued to St. Lucie County (refer to Appendix G, Attachment 3). Specifically, these concerns are in regard to the beach nourishment project previously constructed by St. Lucie County, and mitigation that St. Lucie County provided for impacts to hardbottom habitat. USACE Regulatory Division has determined that the beach placement, mitigation, and monitoring have been performed in compliance with the County's permit SAJ-2009-03448. The USACE and BOEM provided a joint response to NMFS dated April 3, 2017, which included the compliance letter also dated April 3, 2017. All correspondence with NMFS can be found in Appendix G, Attachment 3.

6.5 ENVIRONMENTAL COMMITMENTS

USACE shall comply with all terms and conditions of the USFWS letter dated November 21, 2016, the revised Statewide Programmatic Biological Opinion (SPBO; 2015), the Conservation Measures of the Programmatic Piping Plover Biological Opinion (PB3O; 2013), and the South Atlantic Regional Biological Opinion (SARBO; 1997), and the State's Joint Coastal Permit (JCP). The PB3O conservation measures will also minimize effects to red knots.

NESTING SEA TURTLES

- All Reasonable and Prudent Measures and the Terms and Conditions identified in the revised SPBO will be implemented. The SPBO can be accessed at the following link:

<http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branh/Environmental-Documents/>

SEA TURTLES IN THE WATER

- All Reasonable and Prudent Measures and the Terms and Conditions identified in the SARBO will be implemented. The SARBO can be accessed at the following link:

<http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branh/Environmental-Documents/>

MANATEES

- All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.
- All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a 4-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.
- Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.
- All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shut down if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.
- Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-FWCC. Collision and/or injury should also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-7313336) for north Florida or Vero Beach (1-772-562-3909) for south Florida.
- Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the permittee upon completion of the project. Awareness signs that have already been approved for this use by the Florida Fish and Wildlife Conservation Commission (FWC) must be used (see MyFWC.com). One sign, which reads *Caution: Boaters* must be posted. A second sign measuring at least 8 $\frac{1}{2}$ " by 11" explaining the requirements for "Idle Speed/No Wake" and the shutdown of in-water operations must be posted in a location prominently visible to all personnel engaged in water-related activities.

BEACH JACQUEMONTIA

- Surveys shall be performed preconstruction to determine the presence of beach jacquemontia. Surveys must be performed during the growing season (May through November) or, at a minimum, when dormant vegetation is present. Plant locations must be recorded using a Global Position System, photographs, and written descriptions of the location and extent of growth. To preclude intentional or unintentional disturbance or harm, the exact location of plants should not be marked until necessary for construction design, surveys, and implementation. Marking of plant locations must use noninvasive, temporary techniques such as pin flagging. Surveys must be performed by personnel who have training or experience in identification of beach jacquemontia.

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- All construction personnel shall be educated concerning the presence and location of beach jacquemontia and the minimization measures to be implemented to avoid all potential impacts to the plant.
- A 25-ft buffer shall be created between any existing beach jacquemontia and construction activities, equipment storage, and beach access corridors.
- Unless otherwise directed by the Service, all plant site markings must be removed post construction.
- All marked sites shall be reinspected post construction. Any disturbance or other impacts to beach jacquemontia shall be photographed and recorded in a narrative report and immediately shared with the USFWS South Florida Ecological Services Office. Based on the Service's review, remedial action may be necessary.

PIPING PLOVER

- One preconstruction winter shorebird survey will be conducted within a 10-day timeframe beginning the first Friday in February, as outlined in the Florida Shorebird Alliance's Winter Shorebird Survey (<http://flshorebirdalliance.org>). If the February preconstruction survey is not possible, two preconstruction winter shorebird surveys will be conducted as close as possible to the February dates and at least 15 days apart, and reported to the FWC (<https://public.myfwc.com/crossdoi/shorebirds/loginform.aspx>).

Preconstruction surveys will not be conducted between May 16 and July 14. If piping plovers are documented during the preconstruction survey, the Service will be contacted for potential implementation of additional conservation measures prior to construction commencement. In addition, a February winter shorebird survey will be conducted as outlined above, for 2 years post-construction. All shorebird survey data will be forwarded to the Service annually upon completion.

- The person(s) conducting the surveys must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information outlined in the Winter Shorebird Survey.

RED KNOT

- All Conservation Measures identified in the P3BO shall be implemented. The P3BO can be accessed at the following link:

<http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/>

TURBIDITY

- The Contractor shall monitor water quality (turbidity) at the dredging and beach placement sites, as required by the JCP and the 401 Water Quality Certification.

- If turbidity values at the dredging site exceed permitted values, the Contractor shall suspend all dredging activities. Dredging shall not continue until water quality meets state standards.

In addition USACE commits to the following:

- Migratory birds (adult birds, eggs and chicks) shall be protected during construction activities.
- Essential Fish Habitat conservation recommendations shall be implemented or responded to (refer to Section 6.4, and Appendix G, Attachment 3 for more info).
- In the event that cultural resources are discovered (i.e. at new or expanded upland quarries), then protective measures shall be utilized.
- Air emissions such as vehicular exhaust and dust shall be controlled.
- The contracting officer would notify the contractor in writing of any observed noncompliance with Federal, state, or local laws or regulations, permits and other elements of the contractor's Environmental Protection Plan.
- The contractor would train his personnel in all phases of environmental protection.
- The environmental resources within the project boundaries and those affected outside the limits of permanent work would be protected during the entire period of work.
- An oil spill prevention plan shall be required.

6.6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

6.6.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969

Environmental information on the project has been compiled and this Environmental Assessment has been prepared. A scoping letter on the proposed work was mailed out to all Federal, State, and local agencies and public stakeholders on May 31, 2006. The draft IFR/EA was coordinated with interested stakeholders for review and comment. A public scoping meeting was held on June 2, 2016. The project is in full compliance with the National Environmental Policy Act.

6.6.2 ENDANGERED SPECIES ACT OF 1973

This project falls under the scope of the November 25, 1991 South Atlantic Regional Biological Opinion (SARBO; amended 1997) for federally listed marine species. USACE and BOEM notified the NMFS by letter dated June 16, 2016, that all consultation responsibilities for dredging and beach placement activities associated with the Recommended Plan would be covered under the existing 1997 SARBO and/or superseding documents associated with the ongoing reinitiated SARBO consultation. USACE and BOEM determined that the sand placement activities associated with this project fall within the scope of the USFWS SPBO (2011), as amended in 2015, and the P3BO (2013). The USFWS concurred with USACE and

BOEM determinations by letter dated November 21, 2016. All correspondence can be found within Appendix H: Pertinent Correspondence. This project is in full compliance with the Endangered Species Act.

6.6.3 FISH & WILDLIFE COORDINATION ACT OF 1958

In accordance with an interagency agreement between the USFWS and USACE, coordination with the USFWS shall be conducted through the NEPA scoping process and the Endangered Species Act. The signed agreement can be found in Appendix H: Pertinent Correspondence. This project is in full compliance with the Act.

6.6.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (*INTER ALIA*)

The Proposed Action is in compliance with Section 106 of the National Historic Preservation Act, as amended (PL89-665). As part of the requirements and consultation process contained within the National Historic Preservation Act implementing regulations of 36 CFR 800, this project is also in compliance through ongoing consultation with the Archaeological and Historic Preservation Act, as amended (PL93-29), Archeological Resources Protection Act (PL96-95), American Indian Religious Freedom Act (PL 95-341), Native American Graves Protection and Repatriation Act (NAGPRA), Executive Order 11593, 13007, and 13175, the Presidential Memo of 1994 on Government to Government Relations and appropriate Florida Statutes. Consultation with the Florida SHPO, appropriate federally recognized tribes, and other interested parties has been initiated. The Florida SHPO and the Seminole Tribe of Florida concurred with the USACE determination of no effect to historic properties in letters dated May 3, 2016 and April 27, 2016 respectively.. The Proposed Action is in compliance with the goals of this Act.

6.6.5 CLEAN WATER ACT OF 1972

The Florida State Clearinghouse coordinated a review of the Draft Environmental Assessment (DEA) under the following authorities: Presidential Executive Order 12372; § 403.061(42), *Florida Statutes*; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended. Based on the information contained in the submittal, the state found that the proposed DEA consistent with the Florida Coastal Management Program (FCMP). FDEP also stated that “it is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification.” A Section 401 water quality certification (State permit) application will be submitted to the FDEP, and USACE will obtain this certification prior to construction. All state water quality requirements would be met. A Section 404(b) evaluation is included in this report as Appendix G, Attachment 1. The project shall be in full compliance with this Act.

6.6.6 CLEAN AIR ACT OF 1972

The short-term impacts from construction equipment associated with the project would not significantly impact air quality. No air quality permits would be required for this project. St. Lucie County is designated as an attainment area for Federal air quality standards under the Clean Air Act. Because the project is located within an attainment area, USEPA’s General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination is not required.

6.6.7 COASTAL ZONE MANAGEMENT ACT OF 1972

The Florida State Clearinghouse by letter dated July 8, 2016, coordinated a review of the project in response to USACE's Notice of Availability of the draft IFR/EA. The state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program. A Federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as Appendix G-2. USACE has determined that the project is consistent with the Florida Coastal Management Plan (FCMP). The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting process, in accordance with the 2006 Interagency Coordination Agreement. At this time, this project is in compliance with this Act.

6.6.8 FARMLAND PROTECTION POLICY ACT OF 1981

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable to the project.

6.6.9 WILD AND SCENIC RIVER ACT OF 1968

No designated Wild and Scenic river reaches would be affected by project related activities. This project is in compliance with this Act.

6.6.10 MARINE MAMMAL PROTECTION ACT OF 1972

USACE does not anticipate the take of any marine mammal during any activities associated with the project. Should a hopper dredge be utilized, a trained, government-certified sea turtle and marine mammal observer will be stationed on the dredge during all water-related construction activities. Appropriate actions will be taken to avoid adverse effects to listed and protected marine mammal species during project construction. Therefore, this project is in compliance with this Act.

6.6.11 ESTUARY PROTECTION ACT OF 1968

In the Estuary Protection Act of 1968, Congress declared that "many estuaries in the United States are rich in a variety of natural, commercial, and other resources, including environmental natural beauty, and are of immediate and potential value to the present and future generations of Americans." This Act is intended to protect, conserve, and restore estuaries in balance with developing them to further the growth and development of the Nation. There are no estuaries of national significance located in the study area; therefore, this project is consistent with the purposes of this Act.

6.6.12 FEDERAL WATER PROJECT RECREATION ACT

The principles of the Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1 (12), *et seq.* P.L. 89-72, do not apply to this project.

6.6.13 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

Pursuant to the 1999 Finding between USACE and NMFS, USACE's Notice of Availability of the draft IFR/EA initiated consultation under the Magnuson-Stevens Fishery Conservation and Management Act. NMFS by letter dated June 6, 2016 provided Essential Fish Habitat (EFH) Conservation Recommendations in response to USACE's request for scoping comments (May 2, 2016). USACE and BOEM requested additional time to respond to the recommendations. The response letter was issued on December 28, 2016. Refer to Section 6.4 and Appendix G, Attachment 3 for more information including EFH Conservation Recommendations and USACE responses. The NMFS issued a second letter dated January 9, 2017, which expressed additional concerns regarding the implementation of the Department of Army permit issued to St. Lucie County. Specifically, these concerns are in regard to the beach nourishment project previously constructed by St. Lucie County, and mitigation that St. Lucie County provided for impacts to hardbottom habitat (refer to Section 2.2.5 and Appendix G, Attachment 3 for more info). USACE Regulatory Division has determined that the beach placement, mitigation, and monitoring have been performed in compliance with the County's permit SAJ-2009-03448. The USACE and BOEM provided a joint response to NMFS dated April 3, 2017, which included the compliance letter also dated April 3, 2017. The project is in compliance with the Act.

6.6.14 SUBMERGED LANDS ACT OF 1953

The project would occur on submerged lands of the State of Florida. The project is being coordinated with the State, and shall be in compliance with the Act.

6.6.15 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

The Coastal Barrier Resources Act (CBRA) and the Coastal Barrier Improvement Act of 1990 (CBIA) limit federally subsidized development within the CBRA Units to limit the loss of human life by discouraging development in high risk areas, to reduce wasteful expenditures of Federal resources, and to protect the natural resources associated with coastal barriers. CBIA provides development goals for undeveloped coastal property held in public ownership, including wildlife refuges, parks, and other lands set aside for conservation ("otherwise protected areas," or OPAs). These public lands are excluded from most of the CBRA restrictions, although they are prohibited from receiving Federal Flood Insurance for new structures.

There are limits to Federal expenditures related to actions that could affect a unit. Section 6 of the CBRA provides an exception to this limitation if the Federal expenditure is for non-structural²² shoreline stabilization projects that are designed to mimic, enhance, or restore a natural stabilization system. There are a small number of privately owned parcels within the project area, and within Unit P11, which are not under any perpetual conservation designation. Federal expenditures for any alternative implementation (including beach nourishment) in this area would be prohibited by the CBRA due to the fact that such action could encourage development. A Section 6 CBRA exception would only apply if these private parcels were covered under a perpetual conservation easement which is not the case. However, non-federal funds could

²² FWS includes beach and dune features as non-structural options.

be used to nourish the beach in this area. Dollman Park, a publicly owned parcel within the project area, does meet the Section 6 exception since development is prohibited in this location; therefore, Federal funds could be used to nourish the beach adjacent to the park. The U.S. Fish and Wildlife Service, by letter dated November 2, 2016, concurred with this determination (please refer to Appendix H: Pertinent Correspondence). This project is in compliance with the Act.

6.6.16 RIVERS AND HARBORS ACT OF 1899

The proposed work would temporarily obstruct navigable waters of the United States. The proposed action will be subject to the public notice, public hearing, and other evaluations normally conducted for activities subject to the Act. The project is in compliance with this Act

6.6.17 ANADROMOUS FISH CONSERVATION ACT

This Act authorizes the Secretaries of the Interior and Commerce to enter into cooperative agreements with the States and other non-federal interests for conservation, development, and enhancement of anadromous fish and to contribute up to 50 percent as the Federal share of the cost of carrying out such agreements. As this project is not receiving funding for these purposes, this Act does not apply.

6.6.18 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

Migratory birds would be minimally affected by dredging at the proposed sand source locations. USACE will include our standard migratory bird protection requirements in the project plans and specifications and will require the Contractor to abide by those requirements. Periodic nourishment activities at the beach placement site will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. If nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The project is in compliance with these Acts.

6.6.19 MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT (OCEAN DUMPING ACT)

The term "dumping" as defined in the Act 33 U.S.C. 1402 does not apply to the disposal of material for beach nourishment or to the placement of material for a purpose other than disposal (i.e. placement of rock material as an artificial reef or the construction of artificial reefs as mitigation). Therefore, the Marine Protection, Research, and Sanctuaries Act does not apply to this project. The disposal activities addressed in this EA have been evaluated under Section 404 of the Clean Water Act (see Appendix G-1).

6.6.20 UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES ACT OF 1970.

The purpose of PL 91-646 is to ensure that owners of real property to be acquired for Federal and federally assisted projects are treated fairly and consistently and that persons displaced as a direct result of such acquisition will not suffer disproportionate injuries as a result of projects designed for the benefit of the public as a whole.

While one of the alternatives considered during plan formulation included the acquisition of real property, this is not part of the Recommended Plan. Therefore, this project does not involve any real property acquisition or displacement of property owners or tenants. Therefore, this Act is not relevant to this project.

6.6.21 EXECUTIVE ORDER (EO) 11990, PROTECTION OF WETLANDS

No wetlands would be affected by project activities. This project is in compliance with the goals of this Executive Order.

6.6.22 E.O 11988, FLOOD PLAIN MANAGEMENT

To comply with EO 11988, the policy of USACE is to formulate projects that, to the extent possible, avoid or minimize adverse effects associated with the use of the floodplain and avoid inducing development in the floodplain unless there is no practicable alternative. No activities associated with this project are located within a floodplain, which is defined by EO 11988 as an “area which has a one percent or greater chance of flooding in any given year.” The project is located within the Coastal High Hazard Area (CHHA), as defined by EO 11988 as an “area subject to inundation by one-percent-annual chance of flood, extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms.” The project shoreline is significantly developed, and further development is anticipated to be minimal.

CSRM projects are inherently located in coastal areas, and are often located in CHHAs based on the problems the project is seeking to alleviate. The primary objective of the St. Lucie County Coastal Storm Damage Reduction Project is to reduce infrastructure damage. There is no practicable alternative that could be located outside of the CHHA that would achieve this objective.

For the reasons stated above, the project shall be in compliance with EO 11988, Floodplain Management.

6.6.23 E.O. 12898, ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The Executive Order mandates that each Federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Any potential adverse effects of the proposed action would be more likely to affect those of higher socioeconomic status, such as large watercraft owners or those living in the coastal area surrounding the project. The beneficial effect of a wider, more sustainable beach would benefit all members of the public who are able to obtain transportation to access the beach. The storm damage reduction benefits are primarily benefitting the landowners in this area. There are no disproportionate adverse impacts to minority or low income populations resulting from the implementation of the project.

6.6.24 E.O. 13045, DISPARATE RISKS INVOLVING CHILDREN

On April 21, 1997, the President of the United States issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. The Executive Order mandates that each Federal agency make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

As the proposed action does not affect children disproportionately from other members of the population, the proposed action would not increase any environmental health or safety risks to children.

6.6.25 E.O. 13089, CORAL REEF PROTECTION

The EO refers to "those species, habitats, and other natural resources associated with coral reefs." There are no coral reefs in the project area. This EO does not apply.

6.6.26 E.O. 13112, INVASIVE SPECIES

The proposed action will require the mobilization of dredge equipment from other geographical regions. Dredge equipment has the potential to transport species from one region to another, introducing them to new habitats where they are able to out-compete native species. The benefits of the proposed project outweigh the risks associated with the very slight potential for introducing non-native species to this region. The action takes place primarily in Atlantic Ocean waters, minimizing risk to more sheltered coastal habitats.

6.6.27 ENVIRONMENTAL OPERATING PRINCIPLES

1. Foster sustainability as a way of life throughout the organization.

The recommended plan proposes to use the St. Lucie Shoal, a sand source which is within the local ecological system. The plan also has a long periodic nourishment interval, on average 18 years, which means the sand placed on the beach will provide benefits for an extended period of time with little to no maintenance.

2. Proactively consider environmental consequences of all USACE activities and act accordingly.

The integration of the EA into the feasibility study requires all members of the Project Delivery Team to acknowledge the impact that the proposed project will have on the environment. This helps to ensure the project is designed from the beginning with the environment as a central focus.

3. Create mutually supporting economic and environmentally sustainable solutions.

The recommended plan will provide resilience to the community during and after storm events, providing stability to the economic environment, while also providing nourishment at extended intervals for environmental habitat.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments.

This report includes all information necessary to document how the project meets USACE's corporate responsibility and accountability requirements for actions that may impact human and natural environments.

5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

The team is involved throughout the study process to ensure that environmental considerations are taken into account for the life of the project.

6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.

The entire Project Delivery Team understands the need to consider the environment during its decision-making process, and worked collaboratively with agencies to foster education and sharing of policies and best management practices.

7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

The actions taken to involve the public, resource agencies, and NGOs who may be interested in the project are outlined in Section 6.1 through 6.4 of this report.



7 RECOMMENDATIONS

I have given consideration to all significant aspects in the overall public interest including engineering feasibility, economic, social, cost and risk analysis, and environmental effects. The Recommended Plan described in this final report provides the optimum solution for coastal storm risk management benefits within the study area that can be developed with the framework of the formulation concepts. Implementation of the St. Lucie County, Florida Coastal Storm Risk Management (CSRM) Project is recommended at this time, with such modification as in the discretion of the Commander, Headquarters, U.S. Army Corps of Engineers (HQUSACE), may be advisable.

The Recommended Plan, shown in REF-2, is the National Economic Development (NED) Plan including beach and dune nourishment within the South Hutchinson Island reach. The design includes construction of a 20-foot equilibrated berm extension between R monuments R-98.5 and the R-115 plus 1000 feet, along 3.3 miles of shoreline. The project template will include maintenance of the existing dune feature, reflecting the average 2008 dune position. Tapers of a maximum length of one thousand feet will extend from the northern and southern ends of the berm extension, connecting the extension to the existing shoreline. The addition of tapers results in a maximum sand placement from R-97.5 to R-002, which is approximately 3.7 miles.

7.1 ITEMS OF LOCAL COOPERATION

Recommendations for provision of Federal participation in the Recommended Plan described in this report would require the project sponsor to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Such local cooperation shall include:

- a. Per WRDA 1986, as amended, provide 35% of initial project costs assigned to hurricane and storm damage reduction, plus 100% of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50% of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100% 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 that provides, prior to construction, 35% of design costs;
 - 2) 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, and operation and maintenance of the project;
 - 3) Provide, during construction, any additional amounts as are necessary to make their total contribution equal to 35% of initial project costs assigned to hurricane and storm damage reduction, plus 100% of initial project costs assigned to protecting undeveloped private lands and

CHAPTER 7.0: Recommendations

other private shores which do not provide public benefits; and 50% of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100% of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

- b. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, 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;
- c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-federal sponsor of responsibility to meet the non-federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;
- d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, mitigation, operation, maintenance, repair, replacement, and rehabilitation of the project and any project related betterments, except for damages due to the fault or negligence of the United States or its contractors;
- e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project 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;
- f. Perform, or cause to be performed, 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 the initial construction, periodic nourishment, 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;

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- g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;
- h. Agree 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, and repair the project in a manner that will not cause liability to arise under CERCLA;
- i. If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100 17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;
- j. 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), Department of Defense Directive 5500.11 issued pursuant thereto, as well as 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.*);
- k. Provide the non-federal share of that portion of the costs of data recovery activities associated with historic preservation that are in excess of 1% of the total amount authorized to be appropriated for the project in accordance with the cost sharing provisions of the agreement;
- l. Participate in and comply with applicable Federal floodplain management and flood insurance programs;
- m. Do not use Federal funds to meet the non-federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

- n. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;
- o. Not less than once each year inform affected interests of the extent of protection afforded by the project;
- p. Publicize floodplain information in the area concerned, provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and adopt such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;
- q. 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;
- r. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;
- s. Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project, or separable element thereof, until the non-federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
- t. 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; and
- u. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires the non-federal sponsor to participate in and comply with applicable Federal floodplain management and flood insurance programs, prepare a floodplain management plan within one year after the date of signing the project partnership agreement (PPA), and implement the plan no later than one year after project construction is complete.

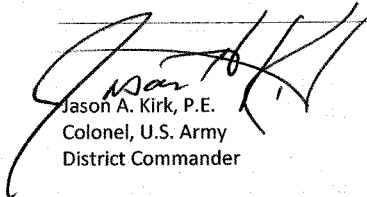
7.2 DISCLAIMER

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

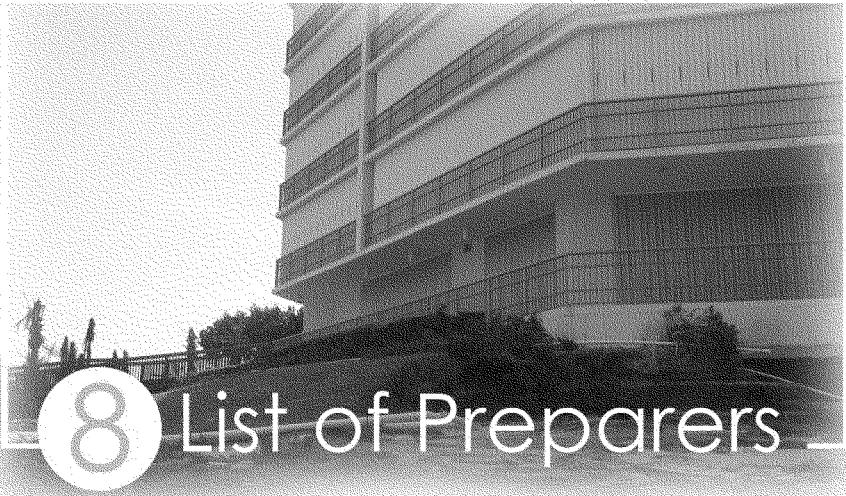
may be modified before they are transmitted to higher authority as proposals for project modification and/or implementation funding. The recommendations herein for provision of a coastal storm risk management project for St. Lucie County, Florida do not include any provisions for work which would result in any new Federal expenditures or financial assistance prohibited by the Coastal Barrier Resources Act (Public Law 97-348); nor were funds obligated in past years for this project for purposes prohibited by this act. The only exception is a 2,000-foot area within Dollman Park (R101.5 to R103.5) which is a publicly owned parcel. This parcel meets Section 6 of CBRA (16 U.S.C. § 3505, the U.S. Fish and Wildlife Service, by letter dated 2 November 2016, which determined that the Recommended Plan meets the Section 6 (G) exemption and is consistent with three purposes of CBRA.

7.3 CERTIFICATION OF PUBLIC ACCESSIBILITY

As part of the obligations established in the project partnership agreement (PPA) for the St. Lucie County, Florida, Coastal Storm Risk Management (CSRM) Project, the non-federal sponsor shall assure continued conditions of public ownership and public use of the shore upon which Federal participation is based during the economic life of the project. The non-federal sponsor shall also provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms. In the determination of the Federal interest in cost sharing, Federal participation was limited to areas where public beach access and adequate parking are available. For shoreline reaches farther than ¼ mile from public access with adequate parking, Federal participation was not provided. The maximum Federal participation allowable for each land use category is applied for cost sharing. I therefore conclude that there is reasonable public availability of the project beaches in all areas where Federal participation is provided.



Jason A. Kirk, P.E.
Colonel, U.S. Army
District Commander



8 LIST OF PREPARERS

8.1 PREPARERS

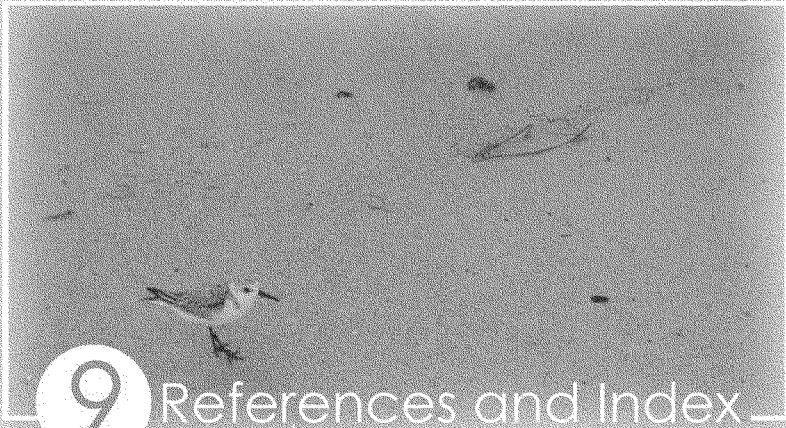
This Feasibility Study with integrated Environmental Assessment was prepared by the following U.S. Army Corps of Engineers and Bureau of Ocean Energy Personnel (BOEM) personnel:

Stacey Roth, P.E. (USACE)	Environmental Engineer
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8.2 REVIEWERS

This report was reviewed by the following personnel:

Aubree Hershorin, Ph.D.	Ecologist
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9

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ST. LUCIE COUNTY COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY & INTEGRATED ENVIRONMENTAL ASSESSMENT

FIGURE REF-1
INTRODUCTION AND
EXISTING CONDITIONS

- COASTAL BARRIER RESOURCES SYSTEM (CBRS) UNIT P11
- HARDGROUND
- FEDERAL EROSION CLASS: "NON-CRITICAL"
- FEDERAL EROSION CLASS: "CRITICAL"
- FEDERAL MONUMENTS

SURROUNDING AREA AND ADJACENT PROJECTS

ST. LUCIE COUNTY FEASIBILITY STUDY AREA

ATLANTIC INTRACOASTAL WATERWAY

SHI Reach

NHI Reach

PP Reach

A1A

Hutchinson Island

R-98

R-90

R-77

NETTLES ISLAND

ST. LUCIE COUNTY

MARTIN COUNTY

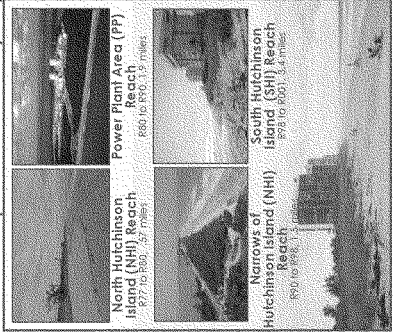
NO FID SCALE

UNIQUE CONSIDERATIONS

- The study area is largely dominated by a large, undeveloped, and relatively undisturbed Central Barrier Resources System (CBRS) unit at CBRS unit P11 (46% of the study area).
- The Coastal Barrier Resource Act of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chiles Coastal Barrier Resources System (CBRS). The system was established to provide federal recognition and financial assistance for the conservation of hurricane-prone, biologically rich, coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.



STUDY AREA (R77 TO MARTIN COUNTY LINE)



STUDY BACKGROUND

Location
The study area is located along the east coast of St. Lucie County, Florida, approximately 225 miles south of Jacksonville and 100 miles north of Miami. The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island, bordered by the Atlantic Ocean to the east, and the Indian River Lagoon (Atlantic Intracoastal Waterway) to the west. The study area extends from R77 to the Martin County line, approximately 7 miles south of the study area, in Martin County.

Nearby Federal Projects

The Fort Pierce Project spans 1.3 miles, just south of the Ft. Pierce Inlet. The Martin County Project is 1.3 miles long, and begins just south of the Martin County line.

Purpose

The purpose of this study is to investigate the feasibility of providing coastal storm risk management within the study area, including the St. Lucie County, Florida coastline, and adjacent shorelines.

Problem and Need

There is a need to reduce the damages to coastal infrastructure on the shoreline of South Hutchinson Island during hurricane and tropical storm events and in consideration of future potential sea level rise effects.



Hutchinson Island line
September 2004

Sponsor:
St. Lucie County, Florida

Authorization

Resolution Docket 2654, 11 April 2009 and
Resolution Docket 2757, 23 July 1998

RECOMMENDED PLAN

SOUTH HUTCHINSON ISLAND REACH ST. LUCIE COUNTY



NATURAL/HUMAN ENVIRONMENT

- Existing Conditions/Future With Project
- Coastal Barrier Resource System (CBRS) unit P11
 - Refer to map
 - Wildlife resources
 - Sea turtle nesting and shore bird habitat



Turtle Nesting

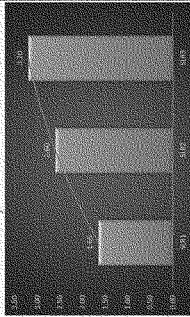
Future With Project

- Section 4 exception from U.S. Fish & Wildlife Service (FWS) for the coastal reach and CBRS unit P11
- Public lands (P10.15, P10.03.3) with natural cost sharing
- No direct impact to hardbottom resources
- Borrow Source: St. Lucie Shoals (SL4-R98) (using Florida Department of Environmental Protection (FDEP) permit) for 50 year planning horizon; adequate amount for 50 year planning horizon and compatible with native sand

PHYSICAL ENVIRONMENT

- Existing Conditions/Future With Project
- Most recent damaging hurricanes and storms: 2004 (Frances and Jeanne); 2011 (Sandy)
 - Uniform erosion across reach (~4 ft. per year)
 - SLC in 50 year planning horizon - Base: 3 feet; Intermediate: 3 feet; High: 2.4 feet

Future With Project



Note: BCR based on storm damage reduction only
Recommended plan increasingly efficient in light of sea level rise

BUILT ENVIRONMENT

Existing Conditions/Future With Project

- 2012/2013 St. Lucie County local roundment project:
 - R88 to Martin County line
- No coastal armoring
- 4 public access areas
- 4 public access trails

Future With Project

- Recommended Plan (Base Sea Level Rise)
- Initial Placement: 20-foot extension of the berm from the 2008 dune shoreline profile and maintenance of the existing dune
- 2008 dune shoreline profile
- Average Periodic Nourishment: 18 year interval with average 390,000 cubic yards of sand

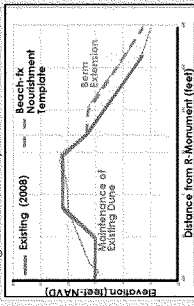


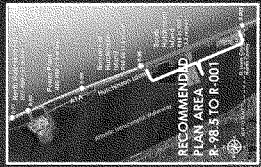
FIGURE REF-2
Recommended Plan

- FDEP COASTAL RANGE MONUMENTS
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) UNIT P11
- HARDBOTTOM
- RECOMMENDED PLAN: 3.3 MILES' 20-FT BEACH NOURISHMENT & MAINTENANCE OF THE EXISTING DUNE PLUS TAPERS UP TO 1,000 FEET NORTH AND SOUTH

TOTAL PROJECT COST*
\$53,296,000
* Includes contingency FY18 price level

BCR (FY17 discount rate and FY17 price level)
2.20

Sand Source
St. Lucie Shoals (SL4-R98, see REF-4)



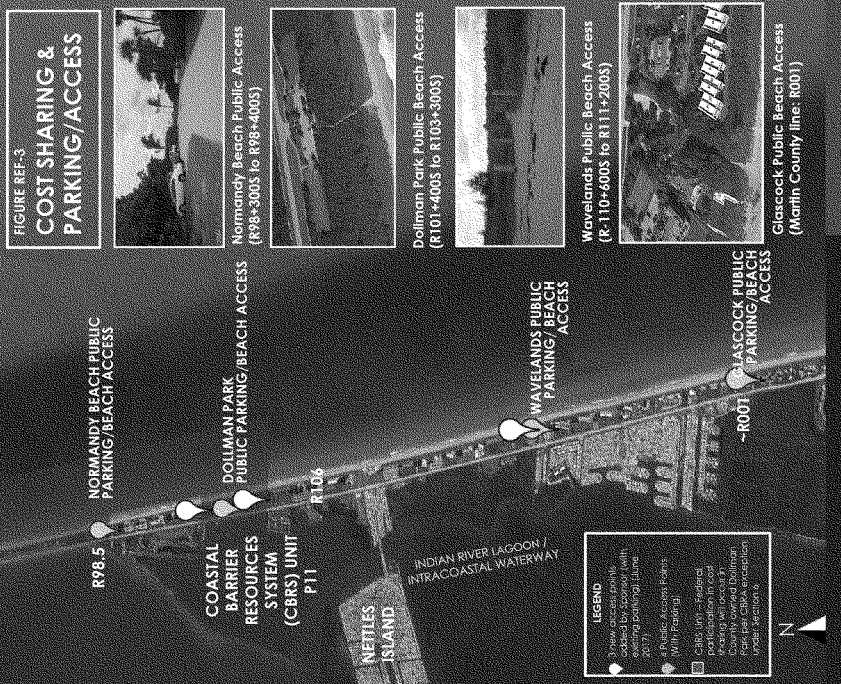
ECONOMIC ENVIRONMENT

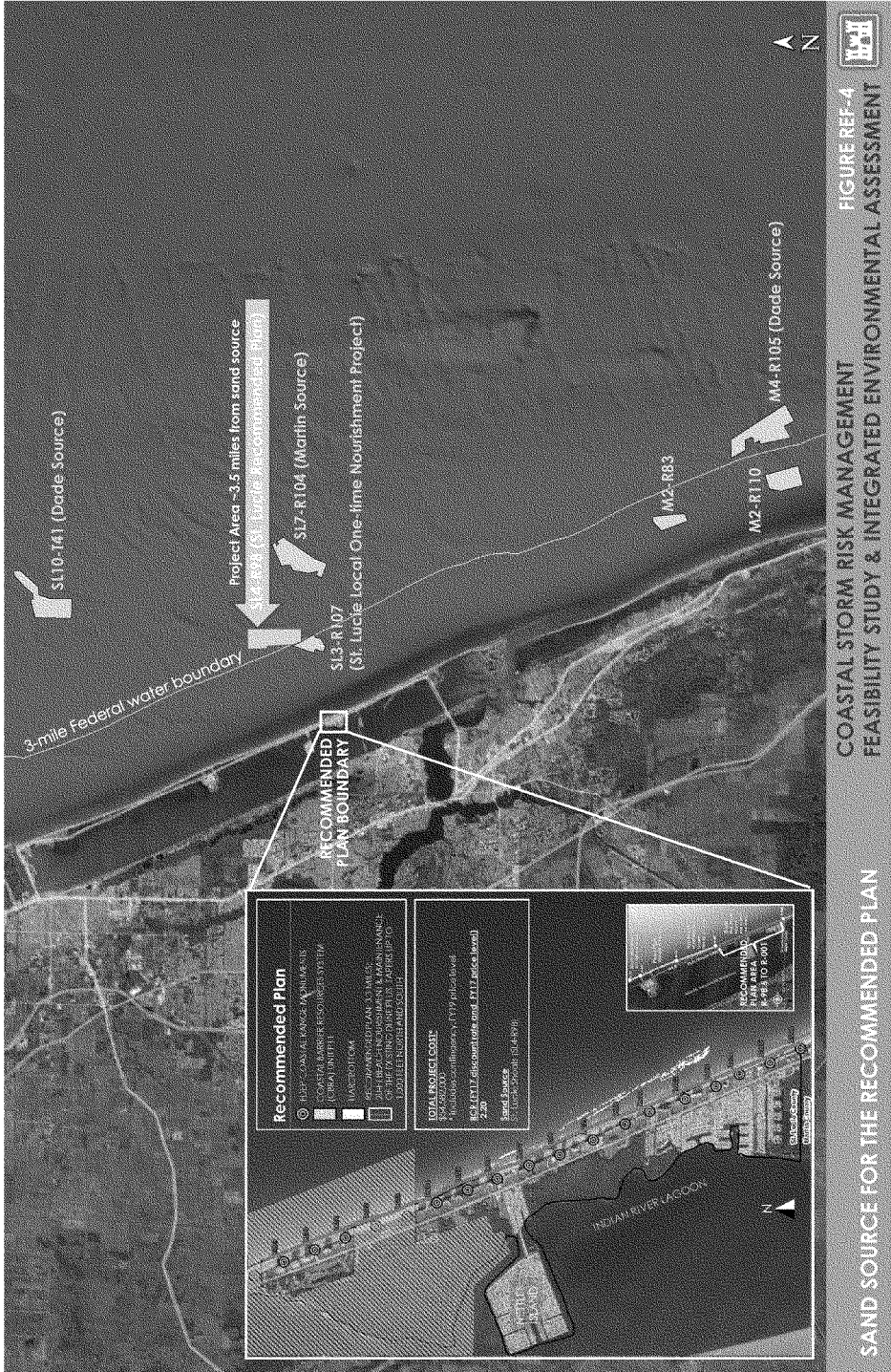
Existing Conditions/Future With Project

- 241 damageable elements in the project area
- Future With Project
 - Reduces damages by 96%
 - Increasingly efficient with Intermediate and High SLC

Category	FY 17	FY 12	FY 17
PRICE LEVEL			
FY 17 WATER RESOURCE RATE	2.875%	2.875%	2.875%
STORM RISK MANAGEMENT BENEFITS (Estimated)	\$2,145,000	\$2,145,000	\$2,145,000
UNITS BENEFITS	\$0	\$234,000	\$234,000
RECREATION BENEFITS	\$0	\$0	\$0
TOTAL BENEFITS	\$2,145,000	\$2,145,000	\$2,145,000
TOTAL COST	\$1,349,000	\$1,349,000	\$1,349,000
NET BENEFITS	\$ 896,000	\$ 896,000	\$ 896,000
BCR (FY17 discount rate and FY17 price level)	1.61	1.78	2.20

SOUTH HUTCHINSON ISLAND BEACH, ST. LUCIE COUNTY





ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX A **Engineering**



**US Army Corps
of Engineers**
Jacksonville District

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Sub-Appendix A-1: Lucie County Shore Protection Project, SBEACH Calibration and Verification

1 Background

St. Lucie County is located on the south-central east coast of Florida (Figure 1-1). The county is bounded to the north by Indian River County and to the south by Martin County. St. Lucie County has approximately 22 miles of sandy shoreline located on a coastal barrier island that varies in width from approximately 400 feet to 1.5 miles. The St. Lucie County shoreline is subject to erosion caused by both tropical and extra-tropical storms as well as other natural shoreline processes. The purpose of this study is to assess the feasibility of providing Federal Coastal Storm Risk Management (CSRM) measures to the southern portion of the St. Lucie County shoreline.

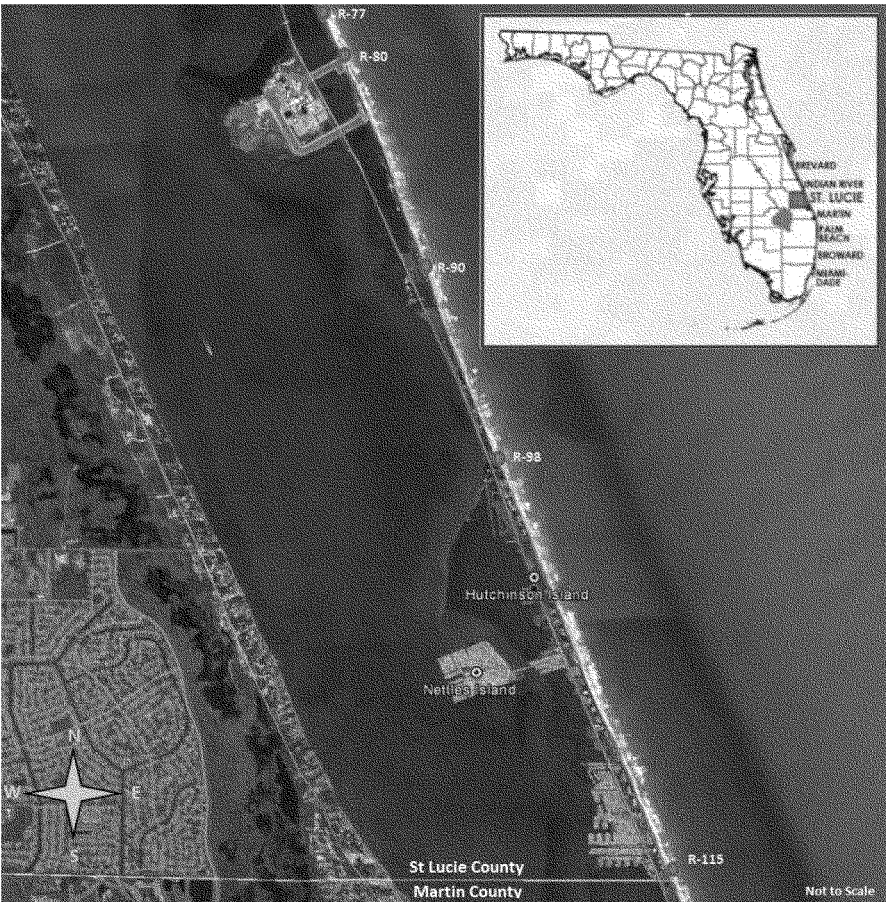


Figure 1-1. St. Lucie County Project Area

Four study reaches have been identified for St. Lucie County. The full study area extends from Florida Department of Environmental Protection (FDEP) Range Monuments R-77 to R-115 (Martin County Line) (Figure 1-1):

- North Hutchinson Island (NHI)– R-77 to R-80
- Power Plant Area (PP) – R-80 to R-90
- Narrows of Hutchinson Island (NH) – R-90 to R-98
- South Hutchinson Island (SHI) – R-98 to R-115

2 Problem Identification

In the past, beaches of St. Lucie County have generally experienced substantial erosion due to the combined effects of winds, waves, and tides. The objectives of this appendix include quantification of existing beach erosion problems in the southern portion of St. Lucie County and the design of corrective measures specific to that environment. Quantification efforts involve analysis of historical shoreline positions, estimation of longshore transport rates, and prediction of cross-shore losses of beach material due to storms. The results of those efforts serve as the basis for the design and analysis of various measures, which could be employed to reduce storm damage in the project area.

3 Natural Forces

3.1 Winds

Local winds in the project area are the primary means of generating the small-amplitude, short period waves which are the primary mechanisms of daily (non-storm related) sand transport along the south-central Florida shoreline. St. Lucie County lies near 27 degrees north latitude, at the northern boundary of the tropical trade wind zone. Winds in this region vary seasonally with prevailing winds from the northeast through the southeast. While winds from the east and southeast dominate during the winter, spring, and summer months, the greatest velocities originate from the east-northeast quadrant during the fall months (September through November).

Wind data offshore of the project area are available from the U.S. Army Corps of Engineers (USACE) Wave Information Study (WIS) Program. WIS hindcast data are generated using the numerical hindcast model WISWAVE (Hubertz, 1992). WISWAVE is driven by wind fields overlaying a bathymetric grid and produces a 33-year record extending from 1980 through 2012, consisting of a time-series of wind and wave climate at 3-hour intervals for stations located along the east and west coasts of the US, as well as the Gulf of Mexico and Great Lakes. Model output includes significant wave height, peak and mean wave period, peak and mean wave direction, wind speed, and wind direction.

There are 523 WIS stations along the Atlantic Coast. WIS Station 452 (labeled 63452), located approximately 18 miles northeast of the study area (Figure 3-1) in 216 feet of water, is representative of offshore deep water wind and wave conditions for the project area. Table 3-1 provides a summary of WIS wind data and contains average wind speeds and frequency of occurrence, broken down into eight 45 degree angle-bands. This table indicates that winds are predominantly from the east and southeast. A wind rose presented in Figure 3-2 provides a further breakdown of winds in the project area.



Figure 3-1. WIS Station #63452

Table 3-1. Average Wind Conditions

Wind Direction (from)	WIS Station #63452 (1980 – 2012)	
	Percentage Occurrence (%)	Average Wind Speed (mph)
North	9	14.8
Northeast	14	14.3
East	22	13.2
Southeast	19	11.9
South	14	12.1
Southwest	8	12.2
West	6	14.1
Northwest	8	16.1

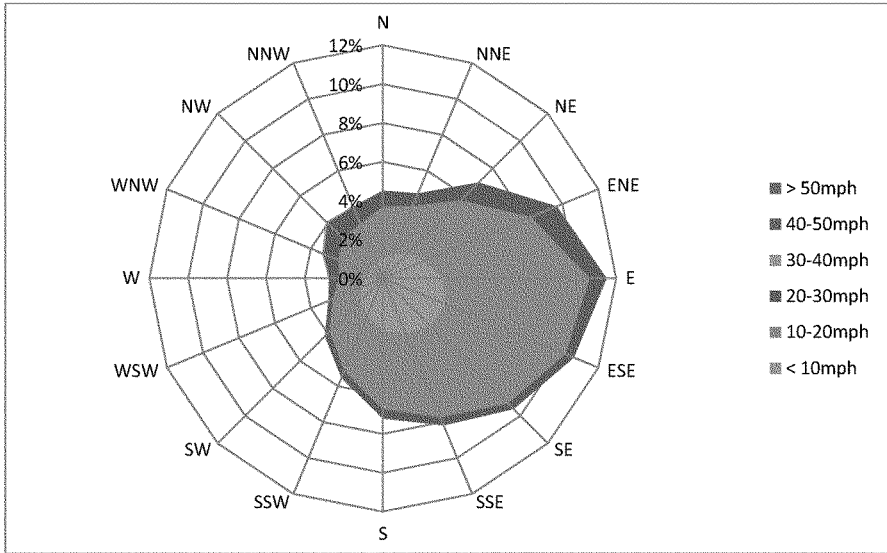


Figure 3-2. Wind Rose – WIS Station 63452

Due to the variability of wind conditions in South Florida through the year, a further breakdown of data provides a summary of seasonal conditions (Table 3-2).

In the fall and winter, frontal weather patterns driven by cold Arctic air masses can extend as far as South Florida. These fronts typically generate winds in the left-forward quadrant that rotate onto land from the northeast. This "Northeaster" behavior is responsible for the increased intensity of wind speed seen in the east and northeast sector winds during fall and winter months. Northeasters may result in wave conditions that can cause extensive beach erosion and shorefront damage.

Spring (March through May) is dominated by winds from the east. In the summer months (June through August) winds shift from east to predominantly southeast. This is partially due to trade winds and tropical weather systems traveling east to west in the lower latitudes. Additionally, daily breezes onshore and offshore result from differential heating of land and water masses. These diurnal winds typically blow perpendicular to the shoreline and have less magnitude than trade winds and Northeasters. Daily breezes can also account for the general shift to east/southeast winds during the summer months when Northeasters no longer dominate.

During the summer and fall months, tropical cyclones may develop into tropical storms and hurricanes, which can generate devastating winds, waves, and storm surge when the storm passes over or near the project area. These intense seasonal events will be discussed in greater detail in Section 3.4 (Storm Effects).

Table 3-2. Seasonal Wind Conditions

Month	WIS Station #63452 (1980 – 1999)	
	Average Wind Speed (mph)	Predominant Direction (from)
January	15.3	E
February	15.1	E
March	15.1	E
April	13.8	E
May	12.1	E
June	10.8	S
July	10.4	SE
August	10.4	SE
September	11.6	NE
October	14.1	NE
November	15.5	NE
December	15.3	E

3.2 Waves

The dissipation of energy as waves enter the nearshore zone and break is the principal driver for sediment transport. Wave height, period and direction, in combination with tides and storm surge, are the most important factors influencing the behavior of the project beach and dune system.

The St. Lucie County study area is exposed to open-ocean swells originating from north-northeast to just north of due east. Open-ocean swells originating from south of due east are blocked by two large shoals north and west of the Bahamas known as the Little Bahama Bank and the Great Bahama Bank, respectively (Figure 3-3). Water depths across the Bahama Banks average about 30 feet, so longer-period swells are reduced or eliminated by bottom friction or the presence of land masses as they traverse the Bank. The minimum fetch between the western edge of the Banks and the St. Lucie County study area is about 65 miles, which allows ample distance for the generation of shorter-period wind waves in the deep waters of the Florida Straits. During severe storm events such as hurricanes and tropical storms, high wind velocities can generate large, damaging waves over the relatively short distance between the Bahamas and Florida.

The project area experiences daily (non-storm related) sediment transport due to typical seasonal wave conditions. This results in variable, generally low level, rates of erosion and accretion dependent on incident wave direction and intensity. Prolonged periods of daily erosion can lead to the undermining of structures and roads over time. However, the main cause of damage to the St. Lucie County shoreline and upland development are the large storm waves which are produced primarily by tropical disturbances, including hurricanes, and by fall/winter “northeasters”. St. Lucie County is located in an area of considerable hurricane activity, and hurricane impacts occur on a relatively frequent basis (see Section 3.4 - Storm Effects).

The study area is exposed to the open ocean toward the northeast. This orientation makes the coastline vulnerable to wave attack from distant storms as well seasonal conditions. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast will produce large swells which are capable of causing erosion along the St. Lucie County shoreline.

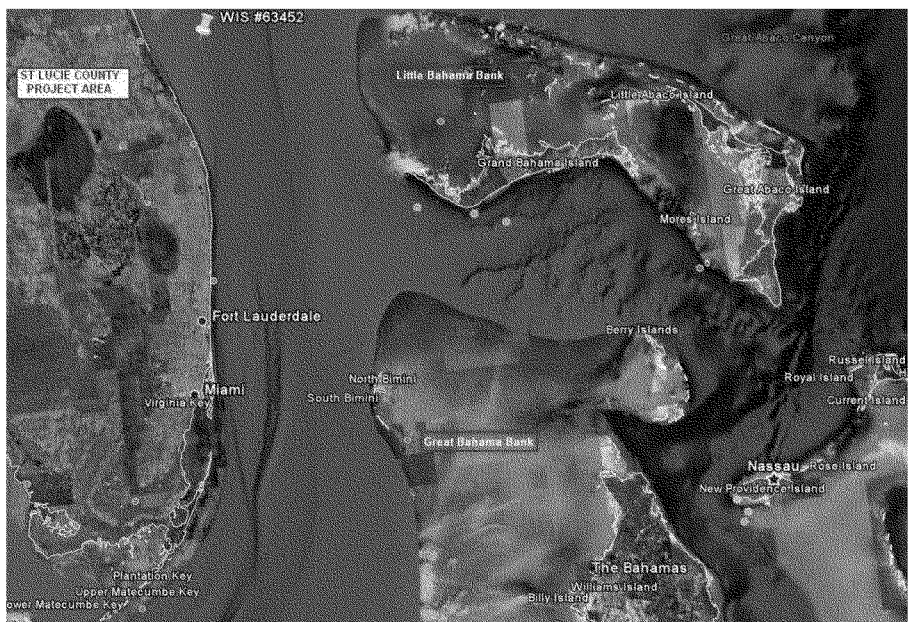


Figure 3-3. Little and Great Bahama Banks

Wave data for this report were also obtained from WIS hindcast at Station #63452. Table 3-3 summarizes the percentage of occurrence and average wave height of waves by direction for this dataset. Not surprisingly, the dominant wave direction is from the northeast and east. This reflects the blockage of open-ocean swell from the southeast quadrant. Higher average wave heights indicate the influence of northeastern activity during the winter months. This can be seen in greater detail in the wave rose presented in Figure 3-4.

Table 3-3. Average Deep Water Waves (1980 to 2012)

Wind Direction (from)	WIS Station #63452 (1980-2012)	
	Percentage Occurrence (%)	Average Wave Height (feet)
North	8	4.3
Northeast	43	4.3
East	38	2.9
Southeast	9	2.7
South	1	3.1
Southwest	0.3	2.8
West	0.2	3.1
Northwest	1	3.9

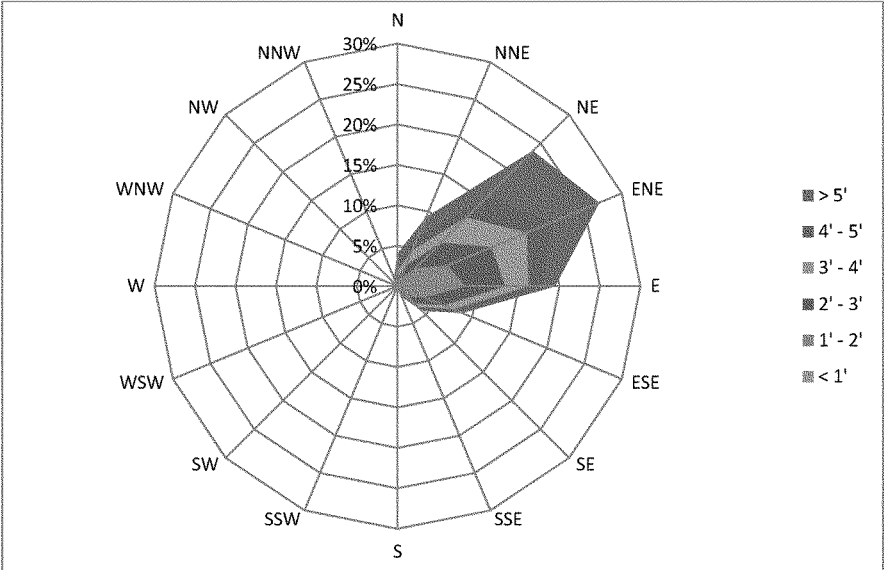


Figure 3-4. Wave Rose – WIS Station 63452

Similar to wind conditions, wave conditions in South Florida also experience seasonal variability. The seasonal breakdown of wave heights provided in Table 3-4 shows that fall and winter months have a marked increase in wave height due to Northeaster activity. The intensity and direction of these winter wave conditions are reflected in the dominant southward sediment transport and seasonal erosional patterns in the project area. Summer months, on the contrary, experience milder conditions, with smaller wave heights. Although again, waves are dominant from the northeast quadrant.

Table 3-4. Seasonal Wave Conditions

Month	WIS Station #63452 (1980-2012)	
	Average Wave Height (feet)	Predominant Direction (from)
January	4.21	NE
February	4.22	NE
March	4.37	NE
April	3.71	NE
May	3.13	NE
June	2.11	E
July	1.82	E
August	2.15	E
September	3.40	NE
October	4.69	NE
November	5.02	NE
December	4.49	NE

Wave periods have the same seasonality as wave heights. Table 3-5 provides a seasonal breakdown of percent occurrence by wave period. From this table, it can be seen that short period, locally-generated wind waves are common throughout the year. The yellow highlighted values show the dominant wave period for each month. None of these dominant periods are greater than 6.0 seconds. It can also be seen that in the summer months the shortest period waves occur more frequently. During the winter months a shifting towards more frequent higher-energy, longer-period storm swells occur. Note that the percentage of waves with period greater than 12.0 seconds increases from a low of 0.5% in July to a high of 7.2% in December.

Table 3-5. Wave Period – Percent Occurrence – WIS Station 63452

Wave Period (Sec)	Percent Occurrence by Wave Period Band											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
< 4.0	11.9	12.9	11.6	17.0	21.3	34.8	53.1	41.9	16.8	5.2	8.2	10.4
4.0 - 4.9	30.5	26.9	28.3	28.1	28.6	22.2	18.4	18.3	21.9	18.3	22.6	25.4
5.0 - 5.9	28.5	33.3	30.4	27.9	23.5	18.8	9.5	16.7	23.9	34.5	31.7	33.6
6.0 - 6.9	6.5	6.1	6.8	5.4	3.3	4.8	2.6	4.7	6.2	8.9	8.8	5.9
7.0 - 7.9	3.9	2.9	3.8	2.9	2.3	3.9	3.9	5.3	3.9	6.4	4.9	2.9
8.0 - 8.9	2.6	2.2	2.4	2.2	3.7	3.0	4.2	2.8	4.0	5.2	4.9	2.4
9.0 - 9.9	3.5	4.2	3.0	3.7	5.1	4.8	3.7	2.3	5.2	6.4	5.4	3.8
10.0 - 10.9	3.3	4.1	3.7	3.6	4.7	4.3	2.6	2.6	4.5	6.0	4.3	5.1
11.0 - 11.9	3.3	4.0	4.2	4.2	4.5	2.8	1.6	2.3	6.4	3.8	3.6	3.4
> 12.0	6.1	3.4	5.9	5.0	3.1	0.9	0.5	3.1	7.2	5.5	5.7	7.2

3.3 Tides and Currents

Astronomical tides are created by the gravitational effects of the moon and sun and are well understood and predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for selected locations along the coastlines of the United States and selected locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in the St. Lucie County area are semidiurnal: two high tides and two low tides per tidal day (24 hours 50 minutes). Two measures of tidal range are commonly used: the mean tide range is defined as the difference between Mean High Water (MHW) and Mean Low Water (MLW), and represents an average range during the entire lunar cycle (27.3 days). The range of tidal elevations between successive high and low tides is typically greater at any location during periods of a new or full moon. The spring tide range is the average semidiurnal range which occurs semimonthly when the moon is new or full.

Tide ranges are relatively low along the St. Lucie County region of Florida's east coast. The nearest tide station to the study area is NOAA Tide Station #8722212, located at the Ft. Pierce Inlet south jetty, about 12 miles north of the center of the study area. Table 3-6 presents the tidal datums computed from this station, referenced to MHW and North American Vertical Datum 1998 (NAVD88). The mean tide range at this station is found to be 2.56 feet and the spring tide range is 3.59 feet (based on 2010 averages).

Table 3-6. Tidal Datums

Tidal Datum	Elevation (feet relative to:)	
	MHW	NAVD88
Mean Higher-High Water (MHHW)	0.22	0.28
Mean High Water (MHW)	0.00	0.06
North American Vertical Datum 1998 (NAVD88)	-0.06	0.00
Mean Diurnal Tide Level (DTL)	-1.27	-1.21
Mean Tide Level (MTL)	-1.28	-1.22
Mean Sea Level (MSL)	-1.24	-1.18
Mean Low Water (MLW)	-2.56	-2.50
Mean Lower-Low Water (MLLW)	-2.76	-2.70

The primary ocean current in the project area is the Florida Gulf Stream. With the exception of intermittent local reversals, it flows northward. The average annual current velocity is approximately 28 miles per day, varying from an average monthly low of 17 miles per day in November to an average monthly high of approximately 37 miles per day in July. The Gulf Stream lies approximately 25 miles offshore of the project area.

The near-shore currents in the project vicinity are not directly influenced by the Gulf Stream, but may be influenced indirectly via interaction with incident waves. Littoral currents affect the supply and distribution of sediment on the sandy beaches of St. Lucie County. Longshore currents, induced by oblique wave energy, generally determine the long-term direction and magnitude of littoral transport. Cross-shore currents may have a more short term impact, but can result in both temporary and permanent erosion. The magnitude of these currents is determined by the wave characteristics, angle of waves from offshore, local tides, configuration of the beach and the nearshore profile. For St. Lucie County beaches, the net sediment transport is from north to south.

Influence of Ft. Pierce Inlet and St. Lucie Inlet ebb and flood currents on local currents is negligible. In both cases the distance between the inlet and the project area (8 miles and 7 miles, respectively) places the project outside the influence of inlet tidal fluctuations.

3.4 Storm Effects

The beaches of St. Lucie County are influenced by tropical systems during the summer and fall and by Northeasters during the winter and spring. Although hurricanes typically generate larger waves and storm surge, Northeasters often have a greater impact on the shoreline because of longer storm duration and greater frequency of occurrence.

Periodic and unpredictable hurricanes and coastal storms, with their energetic breaking waves and elevated water levels, can change the width and elevation of beaches and accelerate erosion. Storms erode and transport sediment from the beach into the active zone of storm waves. Once caught in the waves, this sediment is carried along the shore and re-deposited farther down the beach, or is carried offshore and stored temporarily in submerged sand bars. After storms pass, gentle waves usually return sediment from the sand bars to the beach, which is restored gradually to its pre-storm configuration. While the beach profile typically recovers from storm energy impacts as described,

extreme storm events may cause sediment to leave the beach system entirely, sweeping it into inlets or far offshore into deep water where waves cannot return it to the beach. This may cause a permanent increase in the rate of shoreline recession.

St. Lucie County is located in an area of considerable hurricane activity, resulting in relatively frequent hurricane impacts. Figure 3-5 shows historic tracks of hurricanes and tropical storms from 1851 to 2010, as recorded by the National Hurricane Center (NHC) and available from the National Oceanic and Atmospheric Administration. The circle in the center of this figure indicates a 50 mile radius from the center of the study area. Based on NHC records, 55 hurricanes and tropical storms have passed within this 50-mile radius over the 159-year period of record. Statistically, an average of one storm every 2.8 years.

The 50-mile radius was chosen for display purposes in Figure 3-5 because any tropical disturbance passing within this distance, even a weak tropical storm, would be likely to produce some damage along the shoreline. Stronger storms are capable of producing significant damage to the coastline from far greater distances. For example, Hurricane Andrew made landfall in southern Dade County in 1992 as a Category 5 storm. This storm produced significant coastal erosion along St. Lucie County, over 120 miles north of the storm track.

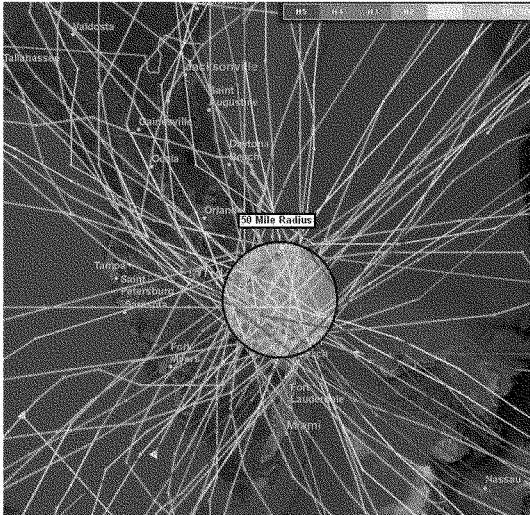


Figure 3-5. Historic storm tracks – Hurricanes and Tropical Storms (1851 – 2010)

In recent years, a number of named storms have significantly impacted the project area, including hurricanes Mitch (1998), Irene (1999), and Tropical Depression #4 (2000). However, the most severe storm events in recent years are due to the multiple storms of the 2004 and 2005 hurricane seasons. In August 2004 the study area was impacted by Hurricane Charley, followed by Hurricanes Frances, Jeanne, Ivan, and a strong Northeaster in September 2004. Of these storms, hurricanes Frances and Jeanne were considered to be 100-year storm events, and caused considerable erosion along this coastline. Hurricanes Frances and Jeanne made landfall only three weeks apart and within 2 miles of each other.

This season marked the first time that Florida (or any individual state) has been impacted by four hurricanes in one tropical season since weather records began in 1851. In 2005 the St. Lucie County area was again impacted, by Hurricanes Dennis (July), Katrina (August), Ophelia (September), Rita (September), and Wilma (October).

Damages to coastal projects from these combinations of storms in 2004 and 2005 included substantial erosion and damage from wind, wave, and water action beyond that which would ordinarily be expected by an individual storm. This is due, in part, to the fact that protective beach fill initially moved offshore by a storm did not have ample time to return onshore before the beach was impacted by the next storm. The large size of these hurricanes also contributed to damage levels along the St. Lucie County coastline as several storms inflicted damages far from their landfall points.

Since the study area is exposed to the open ocean toward the northeast, the coastline is vulnerable to wave attack from distant storms as well. Most hurricanes and tropical storms traversing northward through the Atlantic within several hundred miles of the east coast are capable of producing large swells which are capable of causing erosion along the St. Lucie County shoreline.

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure which accompanies storms also contributes to a rise in water surface elevation. The combination of extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong Northeasters) can produce very high, damaging water levels. In addition to wind speed, direction and duration, storm surge is also influenced by water depth, length of fetch (distance over water), and frictional characteristics of the nearshore sea bottom. An estimate of storm surge is required for a complete assessment of shoreline response and coastal storm risk. An increase in water depth may increase the potential for coastal flooding and allow larger waves to attack the shore.

The St. Lucie County CSRM study area is a low, flat barrier island that is particularly susceptible to overtopping from storm surges. Topographic surveys show that much of the island is less than 5 ft-NAVD88 in elevation. Maximum elevations of 10-15 ft-NAVD88 occur, but are almost exclusively along the oceanfront dune line. A series of hurricane storm-surge maps have been produced by the Florida Division of Emergency Management of all of Florida's coastal counties, and the map for St. Lucie County is shown in Figure 3-6. An examination of this map shows that virtually the entire study area would be inundated during even a Category 1 hurricane, and even the highest regions along the dune line would be flooded during a Category 3 storm. In the event of a hurricane, only three evacuation routes from the barrier island exist: the Highway (Hwy) A1A bridge near the south end of the barrier island (3 miles north of St. Lucie Inlet), the Hwy 732 bridge near the south end of the study area, and the Hwy A1A bridge at Ft. Pierce Inlet, at the north end of the barrier island. The only continuous road extending along the length of the barrier island is Hwy A1A, which is located landward of the dune line, generally at an elevation of 5 ft-NAVD88 or less.

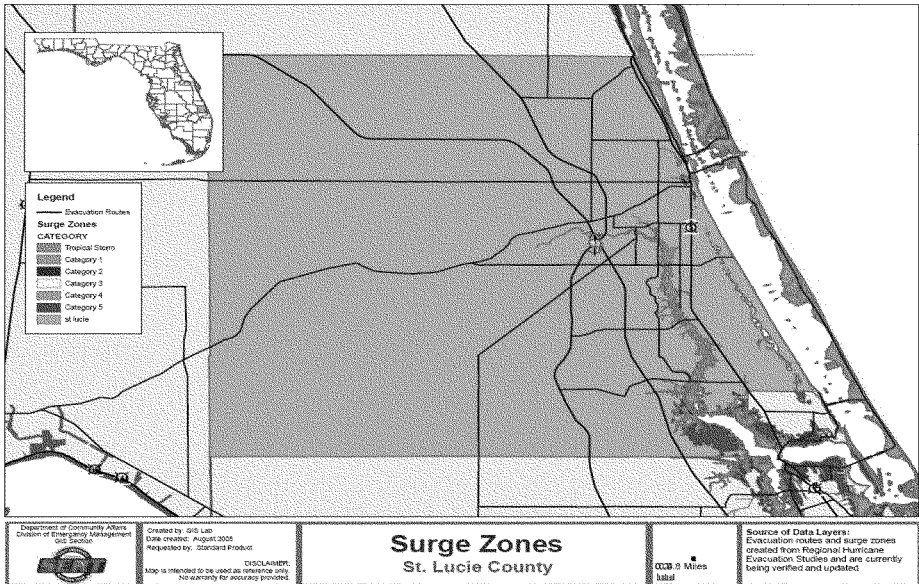


Figure 3-6. Storm Surge Zones, St. Lucie County (Florida Division of Emergency Management).

3.5 Sea Level Change

3.5.1 Relative Sea Level Change

Relative sea level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will continue to rise over the life of the project, possibly at higher rates than presently measured. To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of coastal projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form an Engineering Regulation, ER 110-2-8162 (USACE, 2013).

ER 110-2-8162 provides both a methodology and a procedure for determining a range of sea level change estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a Baseline (or "Low") estimate representing the minimum expected sea level change, an Intermediate estimate (NRC Curve I), and a High estimate (NRC Curve III) representing the maximum expected sea level change. All three scenarios are based on the following eustatic sea level change equation:

$$E(t) = 0.0017t + bt^2$$

Where $E(t)$ is the eustatic sea level change (in meters); t represents years, starting in 1992 (the midpoint of the current National Tidal Datum Epoch of 1983-2001), and b is a constant equal to $2.71\text{E-}5$ (NRC Curve I), $7.00\text{E-}5$ (NRC Curve II), and $1.13\text{E-}4$ (NRC Curve III). This equation assumes a global mean sea level change rate of $+1.7\text{mm/year}$.

In order to estimate the eustatic sea level change over the life of the project, the eustatic sea level change equation is modified as follows:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

Where t_1 is the time between the project's construction date and 1986 and t_2 is the time between the end of the project life and 1992. In order to estimate the required Baseline, Intermediate, and High Relative Sea Level (RSL) changes over the life of the project, the eustatic sea level change equation is further modified to include site specific sea level change as follows:

$$RSL(t_2) - RSL(t_1) = (e+M)(t_2 - t_1) + b(t_2^2 - t_1^2)$$

Where $RSL(t_1)$ and $RSL(t_2)$ are the total RSL at times t_1 and t_2 , and the quantity $(e + M)$ is the local sea level change in mm/year. Local sea level change accounts for the eustatic change (0.0017mm/year) as well as uplift or subsidence and is generally available from the nearest tide gage with a tidal record of at least 40 years. The constant b is equal to 0.0 (Baseline), $2.71\text{E-}5$ (Intermediate), and $1.13\text{E-}4$ (High).

The St. Lucie project area is located approximately 101 miles from the NOS gage #8723170 at Miami Beach, Florida, and approximately 132 miles from NOS gage #8721120 at Daytona Beach Shores, Florida. Due to the distance, the historic sea level change at St. Lucie was approximated by a linear interpolation between the Miami and Daytona gages. The historical relative, local sea level change rates $(e+M)$ taken from NOS gage #8721120 at Daytona Beach Shores, Florida and NOS gage #8723170 at Miami Beach, Florida were determined to be 2.32 mm/year (0.0076 ft/year) and 2.39 mm/year (0.0078 ft/year), respectively. The resulting averaged historical sea level change rate for St. Lucie County then equals 2.36 mm/yr .

Given a project base year of 2020 and a project life of 50 years, a table of sea level change rates was produced for each of the three required scenarios.

Table 3-7 shows the sea level change rates in five year increments, starting from the base year of 2020. Figure 3-7 provides a graphic representation of the three levels of projected future sea level change for the life of the project.

The local rate of vertical land movement is found by subtracting regional MSL trend from local MSL trend. The regional mean sea level trend is assumed equal to the eustatic mean sea level trend of 1.7 mm/year . Therefore in St. Lucie County, there is 0.66 mm/year of local sea level change.

3.5.2 Beach Responses to Sea Level Change

Sea level change scenarios outlined in the preceding section can affect future shoreline behavior in the project area. On an open coast, sandy beach affects would be in the form of change in shoreline position and beach volume. Evaluation of affects are based on the assumption that sea level change would cause a change in the horizontal and vertical position of the beach profile. This phenomenon was first outlined

by Per Bruun (1962). The theory states that an increase in water level causes the beach profile to shift upward and landward in response, in order to maintain an equilibrium shape. This shift causes both a shoreline change and a volumetric change as described in the following paragraphs. Additional information on incorporating sea level change into the evaluation of coastal flood management alternatives for St. Lucie County is provided in Section 5.3.2 - Applied Shoreline Change.

Table 3-7. Relative Sea Level vs Year-St. Lucie County

	Baseline (Historic)			Intermediate (Curve I)			High (Curve III)		
	Year	mm	ft	Year	mm	ft	Year	mm	ft
Base Year	2020	0.0	0.00	2020	0.00	0.00	2020	0.00	0.00
	2025	11.8	0.04	2025	18.8	0.06	2025	41.5	0.14
	2030	23.6	0.08	2030	38.9	0.13	2030	88.7	0.29
	2035	35.3	0.12	2035	60.4	0.20	2035	141.6	0.46
	2040	47.1	0.15	2040	83.3	0.27	2040	200.1	0.66
25 Year	2045	58.9	0.19	2045	107.5	0.35	2045	264.2	0.87
	2050	70.7	0.23	2050	133.0	0.44	2050	334.0	1.10
	2055	82.4	0.27	2055	159.9	0.52	2055	409.5	1.34
	2060	94.2	0.31	2060	188.2	0.62	2060	490.6	1.61
	2065	106.0	0.35	2065	217.8	0.71	2065	577.3	1.89
50 Year	2070	117.8	0.39	2070	248.8	0.82	2070	669.7	2.20

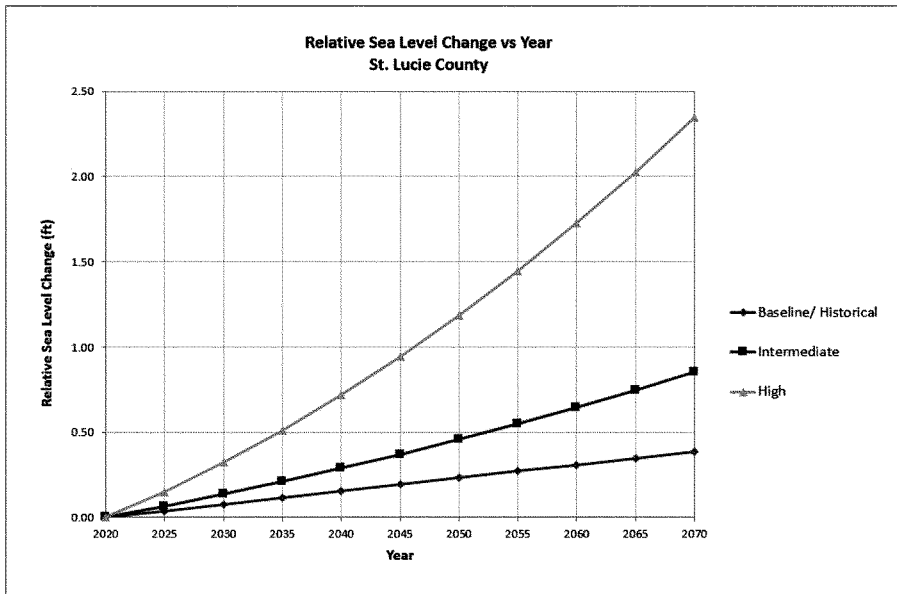


Figure 3-7. Relative Sea level Change, St. Lucie County

Shoreline Change

Per Bruun (1962) proposed a formula for estimating the rate of shoreline recession based on the local rate of sea level change. This methodology also includes consideration of the local topography and bathymetry. Bruun’s approach assumes that with a change in sea level, the beach profile will attempt to reestablish the same bottom depths relative to the surface of the sea that existed prior to sea level change. That is, the natural profile will be translated upward and shoreward to maintain equilibrium. If the longshore littoral transport in and out of a given shoreline is equal, then the quantity of material required to re-establish the nearshore slope must be derived from erosion of the shore. Shoreline recession, X, resulting from sea level change can be estimated using Bruun’s Rule, as defined below:

$$X = \frac{-SW_*}{(h_* + B)}$$

Where S is the rate of sea level change; B is the berm height (approximately 7.0 feet NAVD88); h* is depth of closure (estimated to be -18.7 feet NAVD88); and W* is the width of the active profile (approximately 1,800 feet). Figure 3-8 provides the resulting shoreline recession versus year for each of the three sea level change scenarios.

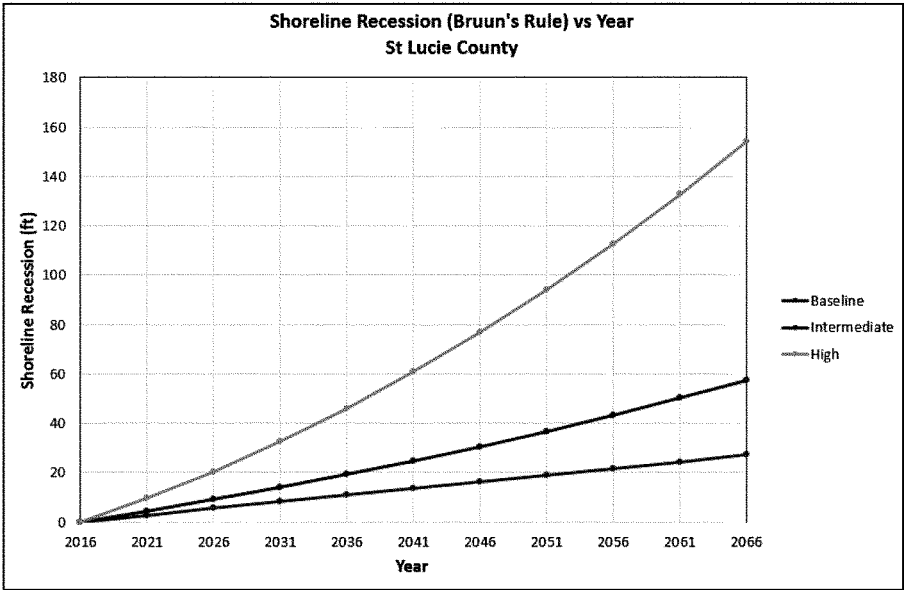


Figure 3-8. Shoreline Recession versus Year

The Bruun Rule is applicable to long straight sandy beaches with an uninterrupted supply of sand. Little is known about the rate at which profiles respond to changes in water level; therefore, this procedure should only be used for estimating long-term changes. The procedure is not a substitute for the analysis for historical shoreline and profile changes. If little or no historical data is available, then historical analysis may be supplemented by this method to provide an estimate of the long-term erosion rates

attributable to sea level change. The offshore contours in the project area are not entirely straight and parallel; however, Bruun's Rule does provide an estimate of the potential shoreline changes within the project area attributable to a projected change in sea level.

Volumetric Change

Engineering Manual (EM) 1110-2-3301 (USACE, 1995) provides guidance on how to calculate beach volume based on berm height, depth of closure, and translation of the shoreline (in this case, shoreline recession). Assuming that as an unarmored beach erodes, it maintains approximately the same profile above the seaward limit of significant transport the volume can be determined as:

$$V = (B + h_s)X$$

Where B is the berm height, h^* is the depth of closure, and X is the horizontal translation of the profile. Figure 3-9 provides the resulting volume lost versus year for each of the three sea level change scenarios.

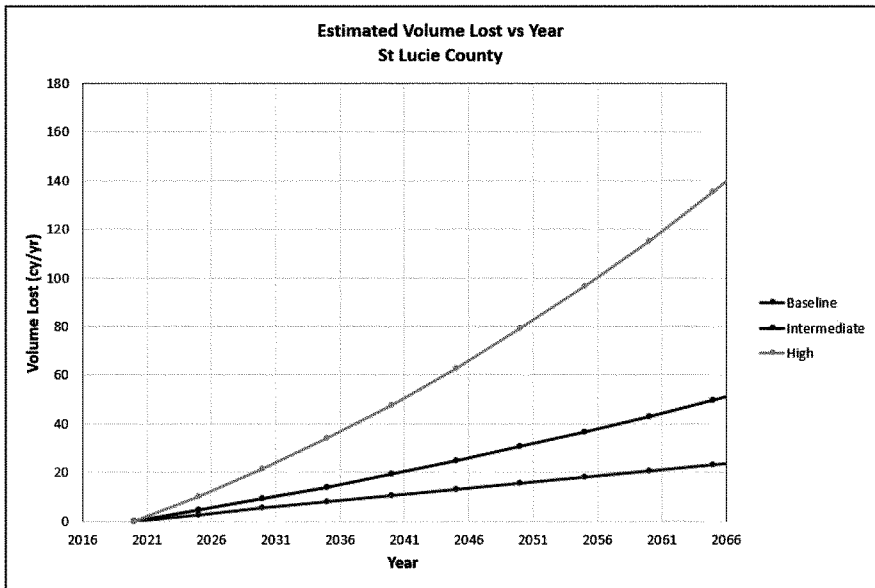


Figure 3-9. Volume Lost Versus Year

4 Historic Shoreline Change

Changes in mean high water (MHW) position provide a historical view of the behavior of the shoreline along the length of the study area (R-77 to R-115). A number of beach profiles (and more recently, LIDAR surveys) have been performed by the State of Florida Department of Environmental Protection (FDEP), the local sponsor, and the U.S. Army Corps of Engineers. Available beach surveys go back as far

as 1882. However, the reliability of such historical profiles may be questionable. Based on a review of all available surveys, it was determined that profiles taken prior to 1970 would not be included in the MHW analysis.

MHW shoreline positions were measured at each FDEP survey monument (formerly known as a DNR monument) location, for each survey, along the proper azimuth (70 degrees, measured from north, clockwise). Resulting differences in MHW position, between available surveys, are tabulated in Table 4-1. Note that MHW position changes are only computed at locations of actual profile data; no interpolated profile data was used in this analysis.

Table 4-1. Mean High Water Shoreline Position Change

DNR Monument	MHW Shoreline Position Change in Feet												
	Jan70-Jan72	Jan72-Feb83	Feb83-Jun84	Jun84-Feb87	Feb87-Dec87	Dec87-Jan94	Jan94-Jul97	Jul97-Jun01	Jun01-Jul02	Jul02-May04	May04-Nov04	Nov04-Aug06	Aug06-Aug08
R-77	4								-26	3	-111	55	8
R-78	13								-6	-10	4	-94	47
R-79	-20								-20	4	-6	-79	22
R-80	20								-9	9	1	-90	21
R-81	21								3	-6	15	-65	-6
R-82	-1								15	-16	4	-62	8
R-83	20								29	-35	14	-40	10
R-84	14								17	-33	6	-36	21
R-85	32								20	-24	-9	-45	47
R-86	40								19	-21	-10	-30	29
R-87	65								-16	16	-5	-40	25
R-88	41								9	2	-10	-24	8
R-89	54								13	-10	4	-17	2
R-90	37								18	-15	14	-26	6
R-91	60								13	-3	7	-18	-8
R-92	39								8	17	1	-27	-8
R-93	55								7	11	23	-49	-9
R-94	19								13	1	6	-34	-18
R-95	15								2	1	-16	-38	14
R-96	16								12	-6	-2	-29	8
R-97	-18								-1	5	-7	-17	2
R-98	7								-3	-12	10	-21	7
R-99	10								1	-28	10	0	4
R-100	8								-14	-5	8	4	-3
R-101	0								-13	2	-1	4	9
R-102	8								-13	5	9	-11	10
R-103	8								-5	3	2	-10	7
R-104	7								8	-3	-2	-6	18
R-105	-28								-24	15	4	2	9
R-106	-29								-11	-6	6	3	5
R-107	-31								-26	5	15	8	-30
R-108	-14								-9	-6	9	19	-25
R-109	-41								-22	-15	18	0	-15
R-110	-8								2	-7	-6	12	-12
R-111	8								5	-1	-4	11	1
R-112	-27								-51	37	24	-58	35
R-113	-14								-14	16	4	-38	40
R-114	-8								-18	-13	13	-25	35
R-115	0								-21	-9	12	-26	27
Average	10	-12	6	-9	-8	1	8	-2	-4	4	-28	10	10

In order to better interpret the shoreline change, the data was put into a graphical format as shown in Figure 4-1. Shoreline changes during each survey interval are shown on this graph. As seen in this figure, shoreline changes are highly variable over time along the study area. The only exception is during the survey interval, May 2004 through November 2004, which coincides with the highly active 2004 hurricane season. During this period, five storms impacted the study area: Hurricanes Charley, Frances, Jeanne, and Ivan, and the strong Northeaster of September 20. Of these storms, Hurricanes Frances and Jeanne had the strongest impacts, each making landfall near the study area as 100-year storm events. The cumulative erosion caused by these five major storm events is evident in the shoreline response between May 2004 and November 2004 as shown in Figure 4-1.

Figure 4-2 provides a summary of all measured shoreline changes (January 1970 to August 2008) as well as a summary of shoreline changes prior to the influences of 2004 hurricane season (January 1970 to May 2004). This figure shows the cumulative changes based on the data presented in Table 4-1. The

erosive trend shown by the January 1970 to August 2008 line, particularly in the northern project area (R-77 to R-99) is due largely to the storms of the 2004 hurricane season as discussed above and indicates that recovery in this area has been relatively slow.

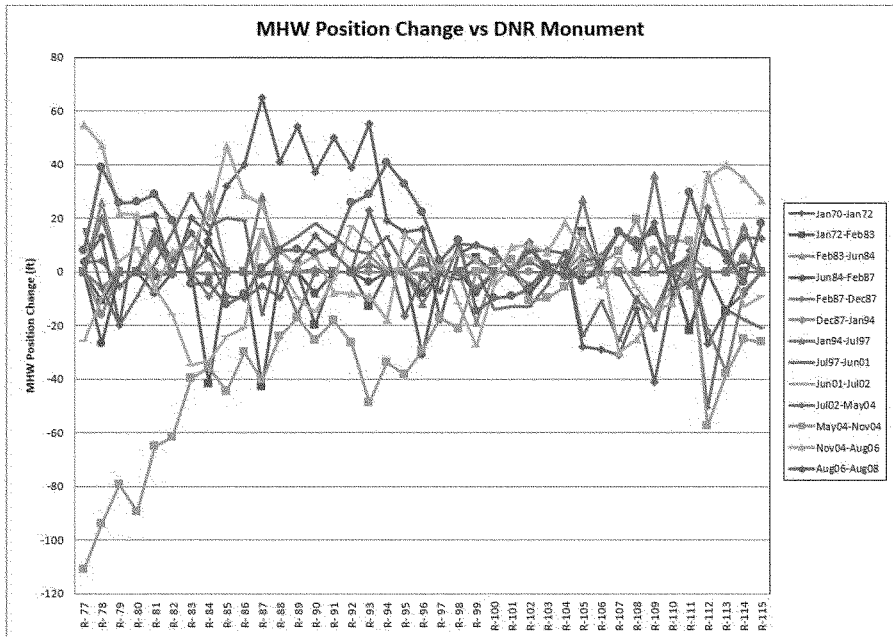


Figure 4-1. MHW Changes along St. Lucie County Study Area.

Due to a combination of geographic and natural factors, the St. Lucie County shoreline experiences regions of both erosion and accretion. Based on all available survey data (January 1970 to August 2008), the northern (less developed) portion of the project (R-77 to R-99) experiences an annual erosion rate of -0.31 feet per year, while the southern (significantly developed) portion of the project (R-100 to R-115) experiences an annual erosion rate of -0.18. The most developed, southernmost portion of the project which is not in the CBRA restricted zone (R-104 to R-115) has experienced an average annual erosion rate of -0.12 feet per year during this time period. Overall, the project area (R-77 to R-115), has an annual erosion rate of -0.26 feet per year.

Prior to the 2004 hurricane season, the northern and southern portions of the project experienced an average annual shoreline change rates of +0.18 feet per year and -0.36 feet per year, respectively. The southernmost portion of the project had an annual shoreline change rate of -0.38 feet per year for the same time period. The overall average annual erosion rate for the same time period was -0.04 feet per year. This indicates that prior to the impact of severe storms, the northern portion of the project experienced mild accretion while the southern portions of the project have been historically erosional.

Both the north and south portions of the project experienced dramatic erosion due to the 2004 and 2005 storm seasons. This has been followed by significant post-storm recovery.

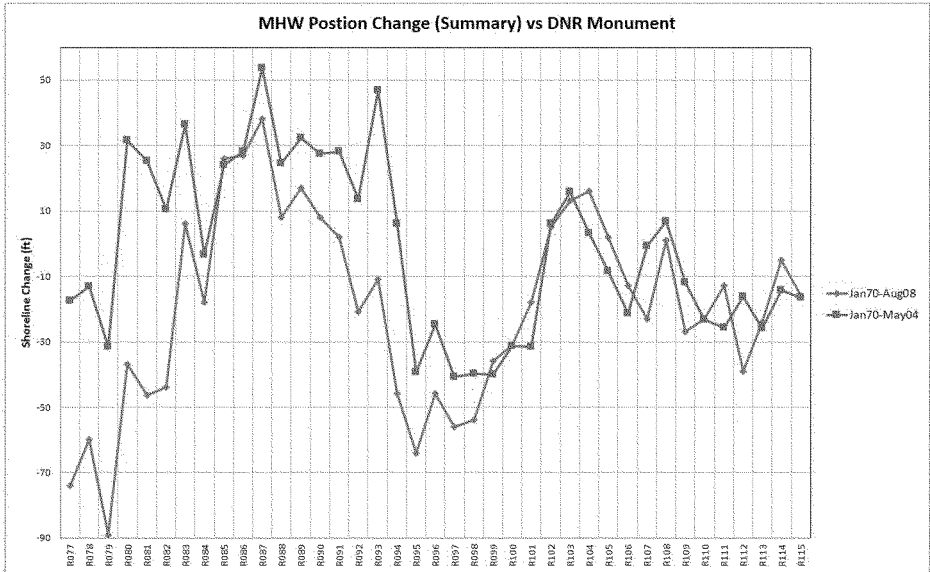


Figure 4-2. Summary of MHW Changes.

4.1 Effects of Other Shore Protection/Navigation Projects

4.1.1 General

To date, no large-scale Federal beach renourishment projects have been constructed along the study area (R-77 to R-115). However, several beach fill placements have been made on either side of the study area. To the north of the study area, several large-scale placements of material have been made under the authority of the Federal shore protection project at Ft. Pierce. Additionally, numerous placements of smaller volumes of material dredged from the Federal navigation project at Ft. Pierce Inlet have been made along this same reach of shoreline over the past 26 years. These two Federal projects result in the periodic placement of large volumes of material along the shoreline about 12 miles north of the study area of this report. Due to the predominant southward littoral transport of material along this region of coast, these fill placements may provide indirect nourishment of the study area. A detailed history of all beach fill placements completed under the authority of the Ft. Pierce SPP and the Ft. Pierce Inlet navigation project is provided in Sections 4.1.2 (Ft. Pierce Shore Protection Project) and 4.1.3 (Ft. Pierce Inlet).

South of the study area, the Martin County Shore Protection project extends from St. Lucie Inlet northward to the Martin County/St. Lucie County line, which is the southern limit of this study. Material placed along northern Martin County near the county line can be transported northward from the fill area by diffusion (end) losses, and may provide a source of nourishment along the southernmost reach of the St. Lucie County study area. A detailed history of all beach fill placements completed under the

authority of the Martin County SPP is provided in Section 4.1.4 (Martin County Shore Protection Project).

In addition to the large-scale Federal projects at Ft. Pierce and Martin County, several small-scale shore protection projects have been implemented along the study area. In 1990, a beach-scraping project was performed along the southern reach of the project. Several privately-funded shore protection measures have also been constructed in front of individual properties. Each of these small-scale projects are described in Section 4.1.5 (Small Scale Shore Protection Projects).

4.1.2 Ft. Pierce Shore Protection Project

The Ft. Pierce SPP was authorized in 1965 and initial construction was completed, with the placement of 718,000 cubic yards of material from an offshore borrow site, in 1971. The initial fill extended from the south jetty at Ft. Pierce Inlet southward 1.3 miles to the southern boundary of Kimberly Bergalis Park (R-41). The first renourishment took place in 1980, with the placement of 346,000 cubic yards. Between first renourishment and 2014, eight additional renourishments (from offshore borrow sources) were completed (Taylor, 2008): 1999 (830,000 cubic yards), 2003 (336,000 cubic yards), 2004 (406,000 cubic yards), 2005 (616,000 cubic yards), 2007 (503,800 cubic yards), April-May 2009 (189,600 cubic yards), 2011 (480,200 cubic yards), and 2014 (290,100 cubic yards).

At the time of initial authorization, data indicated that the authorized project would require periodic nourishment at intervals of about five years. Based on performance, however, the renourishment interval was re-authorized to two years. Presently, design alternatives are being considered that would extend the renourishment interval to four years. Based on the data presented above, a total of 4,716,000 cubic yards of offshore borrow material have been placed over the 43-year period from 1971 to 2007. Based on this data the average actual renourishment rate (from offshore sources) has been approximately 110,000 cubic yards per year.

4.1.3 Ft. Pierce Inlet

Ft. Pierce Inlet is a deep-draft navigation channel located near survey monument R-34, approximately 8 miles north of the north end of the study area. Maintenance dredging of this Federal project occurs once every two years on average. Any beach-compatible material is typically placed south of the inlet, within the limits of the Ft. Pierce SPP, supplementing the Ft. Pierce SPP renourishment events. Seven placements of channel material were made between 1971 and 2007 (Table 4-2) (Taylor, 2008). Between 2007 and 2013, no maintenance material was placed on Ft. Pierce Beach. In July 2014, one additional placement was made, 431,000 cubic yards from the Federal Navigation Project.

Including the supplemental beach material added from maintenance dredging of the Ft. Pierce Inlet and two emergency truck haul fill events (14,400 cubic yards in 1993 and 54,400 cubic yards in 1995), a total of 4,204,900 cubic yards of material was placed at Ft. Pierce between 1971 and 2007. This equates to an average total renourishment rate of 116,800 cubic yards per year.

Table 4-2. Beach Placement of Ft. Pierce Inlet Dredge Material

Date	Volume (cubic yards)
July 1978	49,800
December 1987	29,800
January 1989	47,800
March 1990	55,700
November 1993	7,200
January 1995	166,700
January 1998	23,300

4.1.4 Martin County Shore Protection Project

The Martin County Shore Protection Project was authorized in 1990. Initial construction of the project was performed between December 1995 and April 1996, with the placement of 1.34 million cubic yards of fill extending from survey monuments R-1 (St. Lucie/Martin County line) southward to R-25, a distance of 4.0 miles. The source of fill was a borrow site offshore of the Stuart public beach. The first nourishment of the project was performed in 2001, with the placement of 178,000 cubic yards along the southern half of the project only (R-16.2 – R-22.3). Since that time, there have been three additional renourishment events. 126,000 cubic yards of material were placed in 2002, 895,000 cubic yards were placed in 2005, and 613,000 cubic yards were placed in 2013.

4.1.5 Additional Shore Protection Projects

Walton Rocks, St. Lucie County R80-R90.3: This 1.9 mile segment of shoreline in southern St. Lucie County includes St. Lucie Nuclear Power Plant facilities, Walton Rocks Bounty Park, and private condominium developments. This area was severely impacted by Hurricanes Frances and Jeanne in 2004. In 2007, dune restoration was conducted from R88 to R90 in the stretch of beach known as Sand Dollar Shores. This restoration included 1,900 linear feet of dune, using 15,000 tons of sand trucked in from an upland borrow site (EAI, 2009).

South St. Lucie County Beaches, R98-R115+1000 (County Line): This 3.4 mile segment of shoreline in southern St. Lucie County includes predominantly private residential condominium developments. This area was severely impacted by Hurricane Irene (1999) and Hurricanes Frances and Jean (2004). In 2005 and 2006, a locally funded dune restoration project was constructed from R97.7 to R114 using 160,000 cubic yards of sand. The dune project was impacted by Hurricane Sandy. Storm repairs, in conjunction with a locally sponsored, full beach restoration project were completed in May 2013. The project placed 635,000 cubic yards of sand from R98 to the south county line (R115 + 1000'). (FDEP, 2015).

4.1.6 Inlet Effects

Ft. Pierce Inlet

Ft. Pierce Inlet is a federal navigation project located in northern St. Lucie County in the proximity range monuments R-33 and R-34. Following completion of the initial dredging of the Ft. Pierce navigation project by local interests in 1930, severe scouring occurred along the channel across the Indian River,

leading to an increase in the volume of littoral material and a resulting pattern of accretion along most of the shoreline adjacent to the inlet. After the inlet channel stabilized (1930-1935), erosion began to occur along the shoreline south of the inlet. Research conducted in support of the Ft. Pierce SPP has determined that there is no evidence that the navigation works have significantly affected sediment transport processes further south of the inlet than 14,000 feet (R-48) (USACE, 2000).

St. Lucie Inlet

St. Lucie Inlet is a Federal navigation project located in northern Martin County (just south of St. Lucie County) in the proximity of range monuments R-44 and R-45. Initially excavated in 1892, St. Lucie Inlet separates Hutchinson Island to the north and Jupiter Island to the south. The introduction of a north jetty in the late 1920, worsened erosional patterns already present due construction of the inlet. The north jetty trapped south moving sand, stabilizing the northern shoreline (southern Hutchinson Island) while causing shoreline erosion on Jupiter Island. Due to the predominantly southern transport of material, inlet impacts are to the south of the inlet channel, along approximately 5.8 miles of Jupiter Island shoreline (FDEP, 1995).

5 Beach-fx Life-Cycle Shore Protection Project Evolution Model

Federal participation in projects is based on a favorable economic justification in which the benefits of the project outweigh the costs. Determining the Benefit to Cost Ratio (BCR) requires both engineering analysis (project cost, performance, and evolution) and economic analyses (plan formulation, plan selection, and quantification of project benefits). The interdependence of these functions has led to the development of the life-cycle simulation model Beach-fx. Beach-fx combines the evaluation of physical performance and economic benefits and costs of shore protection projects (Gravens et. al., 2007), particularly beach nourishment, to form the basis for determining the justification for Federal participation. This section describes the engineering aspects of the Beach-fx model.

5.1 Background & Theory

Beach-fx is an event-driven life-cycle model. USACE guidance (USACE, 2006) requires that flood damage reduction studies include risk and uncertainty. The Beach-fx model satisfies this requirement by fully incorporating risk and uncertainty throughout the modeling process (input, methodologies, and output). Over the project life-cycle, typically 50 years, the model estimates shoreline response to a series of historically based storm events applied for each of the three sea level change scenarios (Section 3.5 Sea Level). These plausible storms, the driving events, are randomly generated using a Monte Carlo simulation. The corresponding shoreline evolution includes not only erosion due to the storms, but also allows for storm recovery, post-storm emergency dune and/or shore construction, and planned nourishment events throughout the life of the project. Risk based damages to structures are estimated based on the shoreline response in combination with pre-determined damage functions for all structure types within the project area. Uncertainty is incorporated not only within the input data (storm occurrence and intensity, structural parameters, structure and contents valuations, and damage functions), but also in the applied methodologies (probabilistic seasonal storm generation and multiple iteration, life cycle analysis). Results from the multiple iterations of the life cycle are averaged over a range of possible values.

The project site itself is represented by divisions of the shoreline referred to as “Reaches”. Because this term may also be used to describe segments of the shoreline to which project alternatives are applied, Beach-*fx* reaches will be referred to in this appendix as “Model reaches”. Model reaches are contiguous, morphologically homogenous areas that contain groupings of structures (residences, businesses, walkovers, roads, etc...), all of which are represented by Damage Elements (DEs). DEs are grouped within divisions referred to as Lots. Figure 5-1 shows a conceptual representation of the model setup. For further details about the specifics of Lot extents and DE grouping (see the Economics Appendix).

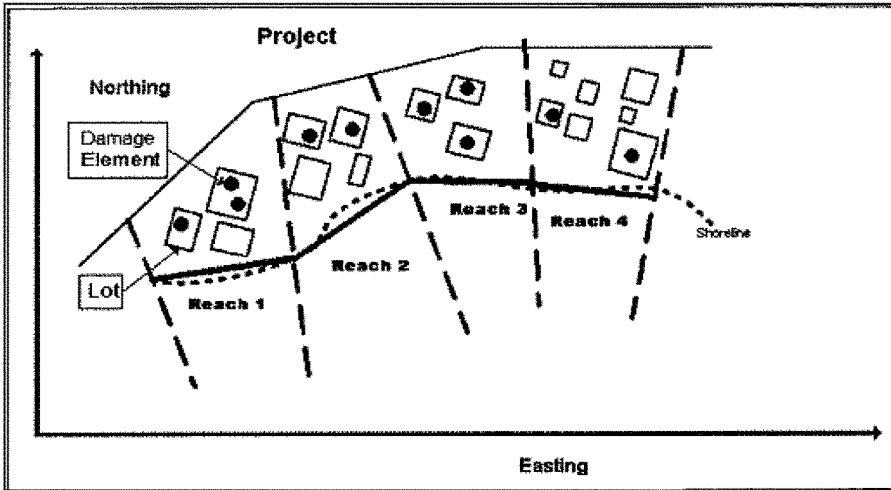


Figure 5-1. Beach-*fx* Model Setup Representation

Each model reach is associated with a representative beach profile that approximates the cross-shore profile and beach composition of the reach. Multiple model reaches may share the same representative beach profile while groupings of model reaches may represent a single design reach. For St. Lucie, the project area consists of four design reaches, divided into thirty-nine model reaches. Table 5-1 provides design and model reach identifiers as well as corresponding Beach-*fx* representative profiles (see Section 5.3.1.1 – Representative Profiles) and FDEP R-monument coverage. Figure 5-2 to Figure 5-4 shows design reach and model reach locations graphically.

Implementation of the Beach-*fx* model relies on a combination of meteorology, coastal engineering, and economic analyses and is comprised of four basic elements:

- Meteorologic driving forces
- Coastal morphology
- Economic evaluation
- Management measures

The subsequent discussion in this section addresses the basic aspects of implementing the Beach-fx model. For a more detailed description of theory, assumptions, data input/output, and model implementation, refer to Gravens et al. 2007; Males et al., 2007, and USACE 2009.

Table 5-1. Model Reaches

Design Reach	Beach-fx Model Reaches	Representative Profile	FDEP R-monuments
North Hutchinson Island (NHI)	R077 to R080	P1	R-77 to R-80
Power Plant Area(PP)	R081 to R083	P1	R-81 to R-83
	R084 to R090	P2	R-84 to R-90
Narrows of Hutchinson Island (NH)	R091 to R098	P1	R-91 to R-98
South Hutchinson Island (SHI)	R099 to R102	P1	R-99 to R-102
	R103 to R104	P3	R-103 to R-104
	R105 to R106	P4	R-105 to R-106
	R107 to R110	P5	R-107 to R-110
	R111	P6	R-111
	R112	P7	R-112
	R113 to R115	P8	R-113 to R-115

5.2 Meteorologic Driving Forces

The predominant driving force for coastal morphology and associated damages within the Beach-fx model is the historically based set of storms that is applied to the life-cycle simulation. Because the eastern coast of Florida is subject to seasonal storms, tropical storms (hurricanes) in the summer months and extra-tropical storms (Northeasters) in the winter and fall months, the “plausible storms” dataset for St. Lucie County is made up of both types. Derived from the historical record of the region, the plausible storm set is based on 30 tropical storms, occurring between 1887 and 2004 and 57 extra-tropical storms, occurring between 1994 and 2005.

Because tropical storm events tend to be of limited duration, passing over a given site within a single portion of the tide cycle, it is assumed that any of the historical storms could have occurred during any combination of tidal phase and tidal range. Therefore, each of the 30 tropical storms surge hydrographs was combined with possible variations in the astronomical tide. This was achieved by combining the peak of each storm surge hydrograph with the astronomical tide at high tide, mean tide falling, low tide, and mean tide rising for each of three tidal ranges corresponding to the lower quartile, mean, and upper quartile tidal ranges. This resulted in 12 distinct combinations for each historically based tropical storm and a total of 360 tropical storm conditions in the plausible storm dataset.

Due to their generally extended durations, extra-tropical storms in the historical record tend to occur over complete tide cycles. Therefore, it can be assumed that the storm hydrograph of each of the 56 historical extra-tropical storms is sufficient without combining with possible variations of the astronomical tide. The entire plausible storm suite therefore consists of a total of 416 tropical and extra-tropical storms.

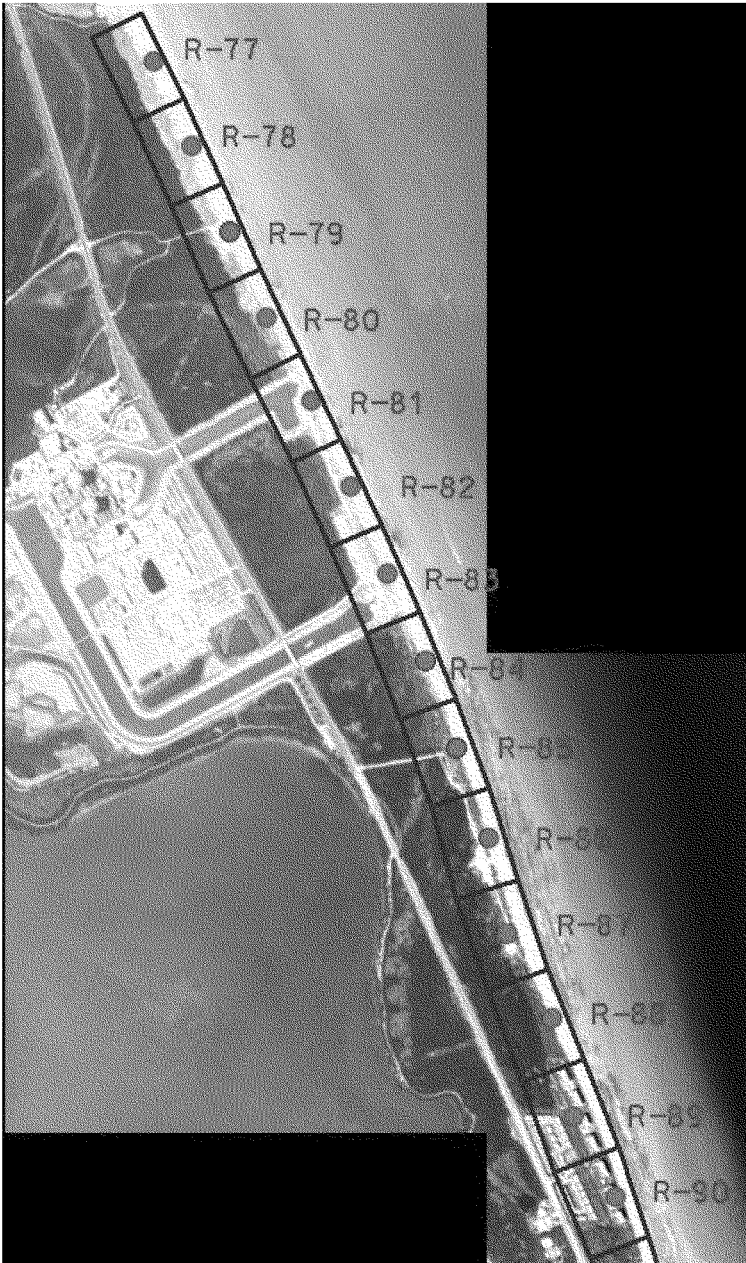


Figure 5-2. North Hutchinson Island and Power Plant Model Reaches Relative to FDEP R-monuments

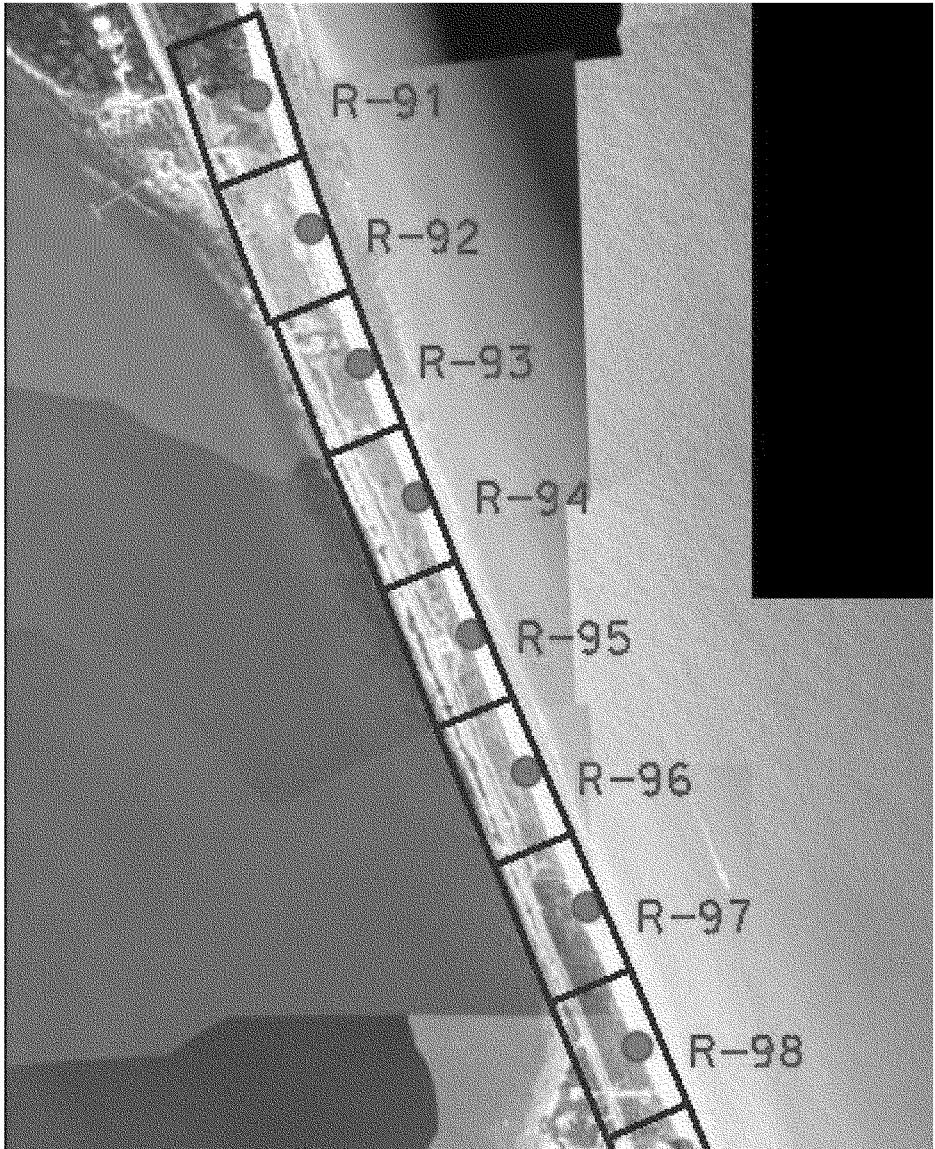


Figure 5-3. Narrows of Hutchinson Island Model Reaches Relative to FDEP R-monuments

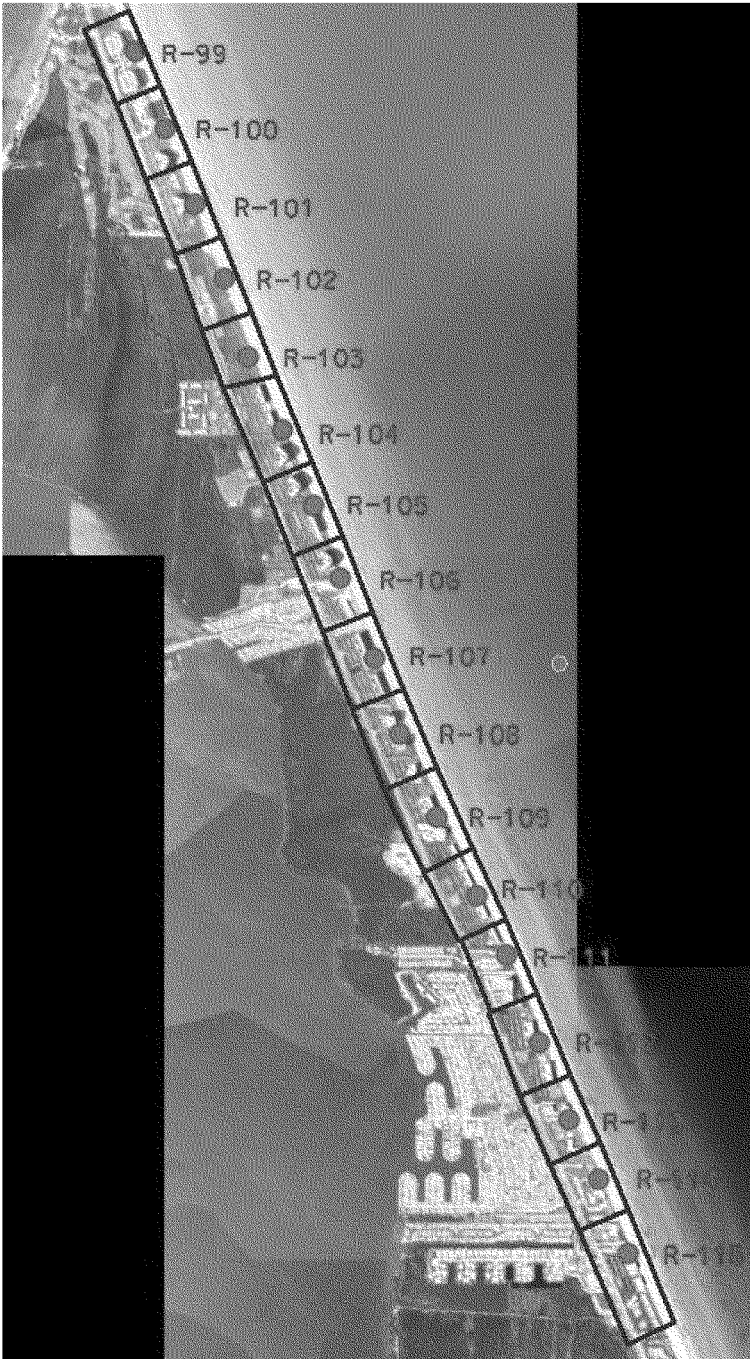


Figure 5-4. South Hutchinson Island Model Reaches Relative to FDEP R-monuments

In addition to the plausible storm dataset, the seasonality of the storms must also be specified. The desired storm seasons are based on the assumption that each plausible storm takes place within the season in which the original historical storm occurred. The probability of both tropical and extra-tropical storms is defined for each season through the Probability Parameter. The Probability Parameter is determined for each season and storm type by dividing the number of storms by the total number of years in the storm record (extra-tropical or tropical). Four storm seasons were specified for St. Lucie County (Table 5-2).

Table 5-2. St. Lucie County Beach-*fx* Storm Seasons

Storm Season	Start Date	End Date	Probability Parameter Extra-Tropical Storm	Probability Parameter Tropical Storm
Extratrop Winter/Spring	Nov 1	May 31	3.33	0.00
Tropical Early Summer	June 1	Jul 31	0.08	0.03
Tropical Peak	Aug 1	Sep 30	0.67	0.19
Extratrop/Tropical	Oct 1	Oct 31	0.67	0.03

The combination of the plausible storm dataset and the specified storm season allows the Beach-*fx* model to randomly select from storms of the type that fall within the season currently being processed. For each storm selected, a random time within the season is chosen and assigned as the storm date. The timing of the entire sequence of storms is governed by a pre-specified minimum storm arrival time. A minimum arrival time of 7 days was specified for St. Lucie County. Based on this interval, the model attempts to place subsequent storm events outside of a 14 day window surrounding the date of the previous storm (i.e. a minimum of 7 days prior to the storm event and a minimum of 7 days following the storm event). However, due to the probabilistic nature of the model the minimum arrival time may be overridden as warranted during the course of the life cycle analysis.

5.3 Coastal Morphology

The Beach-*fx* model estimates changes in coastal morphology through four primary mechanisms:

- Shoreline storm response
- Applied shoreline change
- Project-induced shoreline change
- Post-storm berm recovery

Combined, these mechanisms allow for the prediction of shoreline morphology for both with and without project conditions.

5.3.1 Shoreline Storm Response

Shoreline storm response is determined by applying the plausible storm set that drives the Beach-*fx* model to simplified beach profiles that represent the shoreline features of the project site. For this study, application of the storm set to the idealized profiles was accomplished with the SBEACH coastal

processes response model (Larson and Kraus 1989). SBEACH is a numerical model which simulates storm-induced beach change based on storm conditions, initial profiles, and shoreline characteristics such as beach slope and grain size. Output consists of post-storm beach profiles, maximum wave height and wave period information, and total water elevation including wave setup. Pre- and post-storm profiles, wave data, and water levels can be extracted from SBEACH and imported into the Beach-*fx* Shore Response Database (SRD). The SRD is a relational database used by the Beach-*fx* model to pre-store results of SBEACH simulations of all plausible storms impacting a pre-defined range of anticipated beach profile configurations.

5.3.1.1 Representative Profiles

In order to develop the idealized SBEACH profiles from which the SRD was derived, it was necessary to first develop representative profiles for the project shoreline. The number of representative profiles developed for any given project depends on the natural variability of the shoreline itself. Typically, historical profiles at each FDEP R-monument are compared over time, aligned, and then averaged into a composite profile representative of the shoreline shape at a given R-monument location. Composite profiles are then compared and separated into groupings according to the similarity between the following seven dimensions:

- Upland elevation
- Dune slope
- Dune height
- Dune width
- Berm height
- Berm width
- Foreshore slope

In order to ensure that emergency nourishment efforts in response to the 2004 and 2005 hurricane season (completed in May 2013) did not influence the outcome of the ongoing feasibility study, it was agreed that the representative “without project” shoreline for the study would be established using survey data collected in the summer of 2006. However, subsequent analysis of the data showed that the 2006 survey did not provide adequate foreshore and offshore coverage of the project area to complete the Beach-*fx* analysis. A comparison of the available portions of the 2006 survey and a comprehensive shoreline survey taken in August 2008 showed insignificant difference in shoreline dimensions between the two. Therefore, the 2008 shoreline was determined to be a good representation of the “without project” condition.

From the 2008 survey data, eight groupings of similarly dimensioned beach profiles were identified. Within each grouping, the composite profiles were averaged into a single (without project) profile representative of a portion of the project shoreline. Using these representative profiles, idealized profiles representing the major dimensions of the profile were defined (Figure 5-5 through Figure 5-12). Representative profiles are not referenced to a specific R-monument location and are shown with generic “X-Distances” for scaling purposes. Note that determination of the final idealized profile dimensions (which are meant to represent entire model reaches) also considers survey data, such as topographic lidar, that cover a larger extent than the single cross-shore transects taken at R-monument locations. In some cases, analysis of topographic contours of the upland result in final idealized representative profile dimensions that differ from those that would have resulted from using the

average measured cross-shore profiles alone. Table 5-3 provides dimensions for each of the idealized without project Beach-*fx* profiles.

5.3.1.2 SBEACH Methodology

SBEACH simulates beach profile changes that result from varying storm waves and water levels. These beach profile changes include the formation and movement of major morphological features such as longshore bars, troughs, and berms. SBEACH is a two-dimensional model that considers only cross-shore sediment transport; that is, the model assumes that simulated profile changes are produced only by cross-shore processes. Longshore wave, current, and sediment transport processes are not included in SBEACH and are computed externally when required.

Table 5-3. Dimensions of Idealized Without Project Representative Profiles

Profile	R-monuments Represented	Upland Elevation (ft-NAVD88)	Dune Height (ft-NAVD88)	Dune Width (ft)	Dune Slope (V:H, ft)	Berm Elevation (ft-NAVD88)	Berm Width (ft)	Foreshore Slope (V:H,ft)
P1	R-77 to R-80, R-84 to R-102	4.5	11.0	55	1:7	7.0	0.0	1:9
P2	R-81 to R-83	5.0	13.0	35	1:6	7.0	0.0	1:10
P3	R-103 to R-104	5.0	11.0	50	1:6	7.0	0.0	1:8
P4	R-105 to R-106	3.0	11.0	120	1:6	7.0	0.0	1:9
P5	R-107 to R-110	3.0	11.0	40	1:6	7.0	0.0	1:9
P6	R-111	5.0	11.0	60	1:6	7.0	0.0	1:9
P7	R-112	5.0	14.0	25	1:5	7.0	0.0	1:8
P8	R-113 to R-115	4.0	13.0	50	1:5	7.0	0.0	1:9

SBEACH is an empirically based numerical model, which was formulated using both field data and the results of large-scale physical model tests. Input data required by SBEACH describes the storm being simulated and the beach of interest. Basic requirements include time histories of wave height, wave period, water elevation, beach profile surveys, and median sediment grain size.

It should be noted that SBEACH is the USACE recommended model for shoreline response. The Beach-*fx* model, also developed by USACE, is specifically designed to import and process output files exported directly from the SBEACH model.

SBEACH simulations are based on six basic assumptions:

- Waves and water levels are the major causes of sand transport and profile change
- Cross-shore sand transport takes place primarily in the surf zone
- The amount of material eroded must equal the amount deposited (conservation of mass)
- Relatively uniform sediment grain size throughout the profile,
- The shoreline is straight and longshore effects are negligible
- Linear wave theory is applicable everywhere along the profile without shallow-water wave approximations

Once applied, SBEACH allows for variable cross shore grid spacing, wave refraction, randomization of input waves conditions, and water level setup due to wind. Output data consists of a final calculated profile at the end of the simulation, maximum wave heights, maximum total water elevations plus setup, maximum water depth, volume change, and a record of various coastal processes that may occur at any time-step during the simulation (accretion, erosion, over-wash, boundary-limited run-up, and/or inundation).

5.3.1.3 SBEACH Calibration and Verification

Calibration of the SBEACH model was performed using wave height, wave period, and water level information from Hurricanes Frances and Jeanne (2004) (Figure 5-13). Calibration of the model is required to ensure that the SBEACH model is tuned to provide realistic shore responses that are representative of the specific project location. Calibration is determined by comparing modeled post-storm beach profiles with measured post-storm profile data.

Measured pre- and post-storm shoreline profiles were obtained from FDEP. Using the pre-storm profiles, SBEACH was then run with a range of values for an array of calibration parameters. Table 5-4 provides the relevant beach characteristic and sediment transport calibration parameters as well as their final calibrated values. Calibration parameters were verified using wave height, wave period, and water level information from a combination of two storm events occurring in September 2007 (unnamed) and October 2007 (Hurricane Noel).

For details of the SBEACH calibration and verification procedure and results see Sub-Appendix A-1: St Lucie County Shore Protection Project, SBEACH Calibration and Verification.

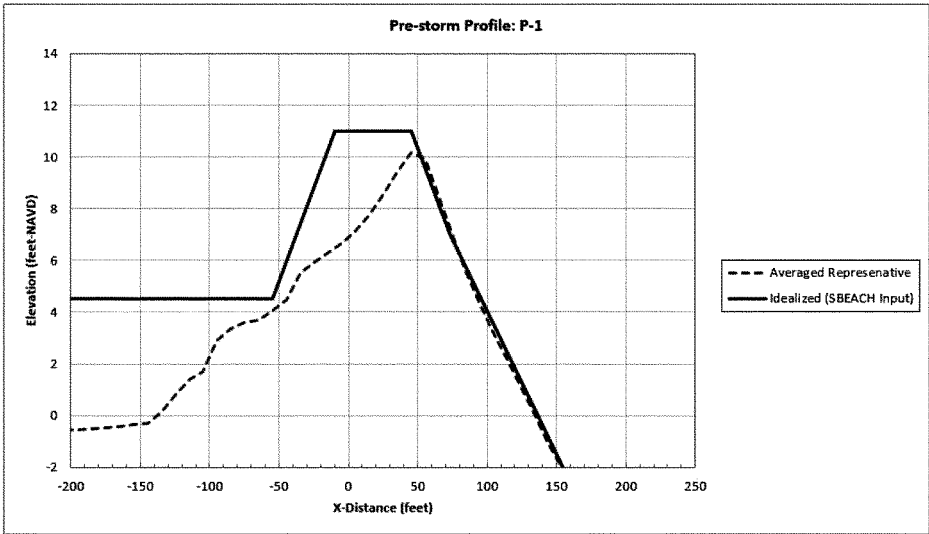


Figure 5-5. Average Measured and Idealized Beach Profiles: P1 Grouping

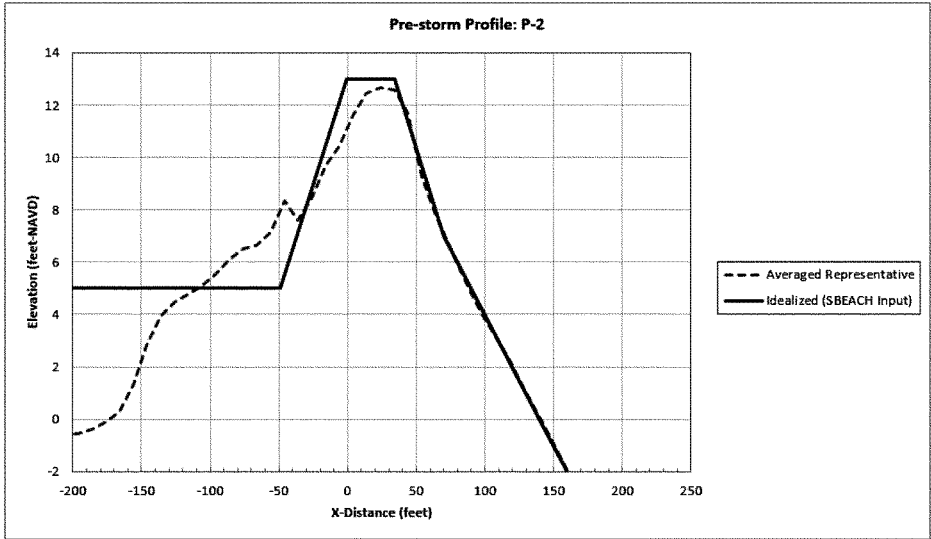


Figure 5-6. Average Measured and Idealized Beach- f_x Profiles: P2 Grouping

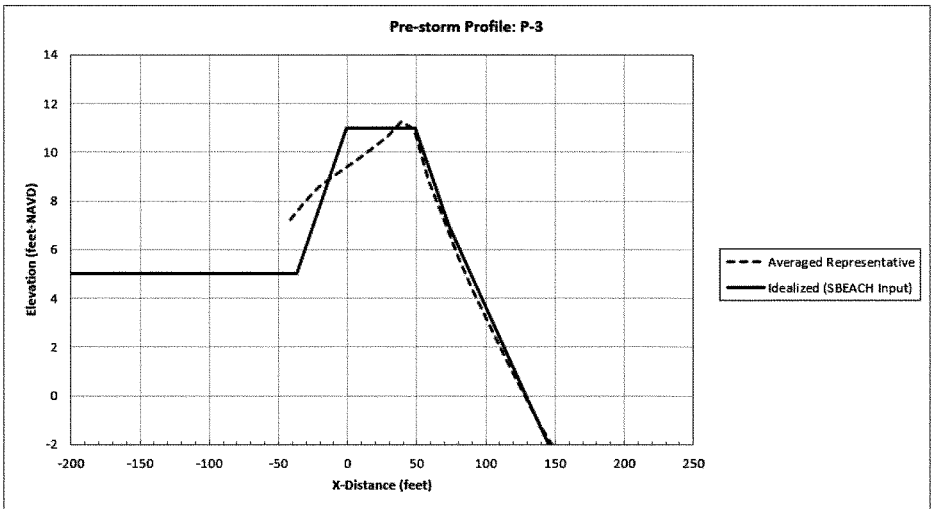


Figure 5-7. Average Measured and Idealized Beach- f_x Profiles: P3 Grouping

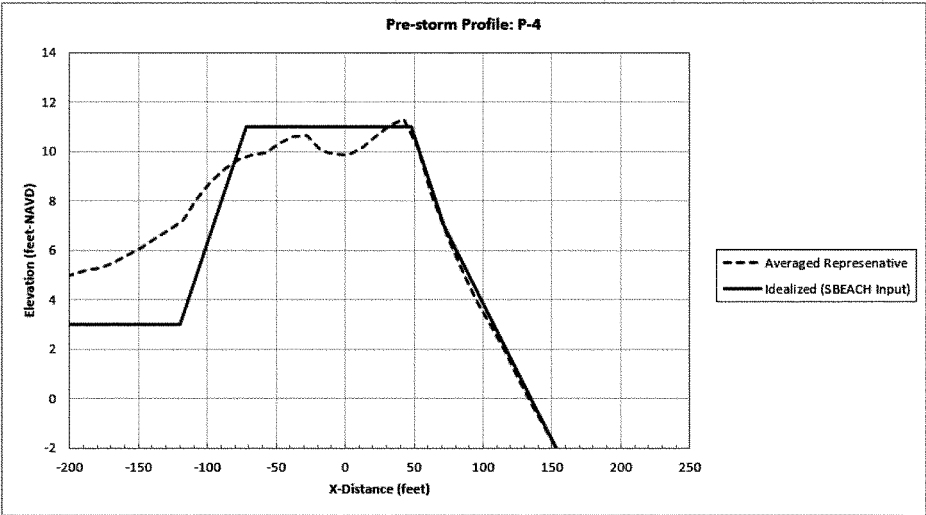


Figure 5-8. Average Measured and Idealized Beach-*fx* Profiles: P4 Grouping

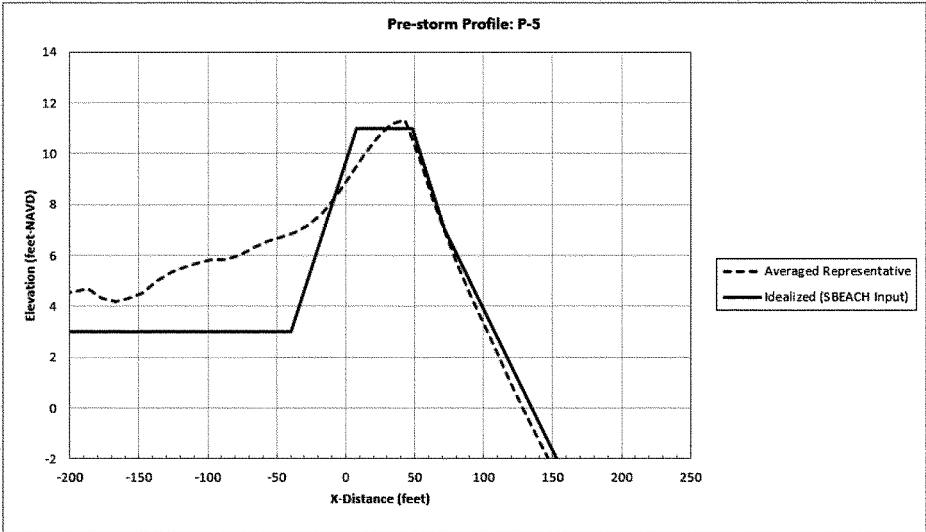


Figure 5-9. Average Measured and Idealized Beach-*fx* Profiles: P5 Grouping

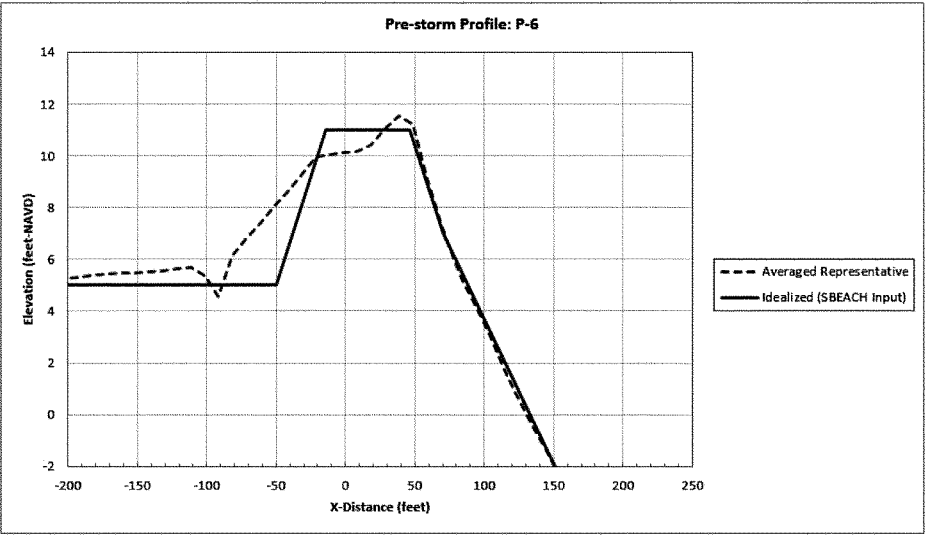


Figure 5-10. Average Measured and Idealized Beach-fx Profiles: P6 Grouping

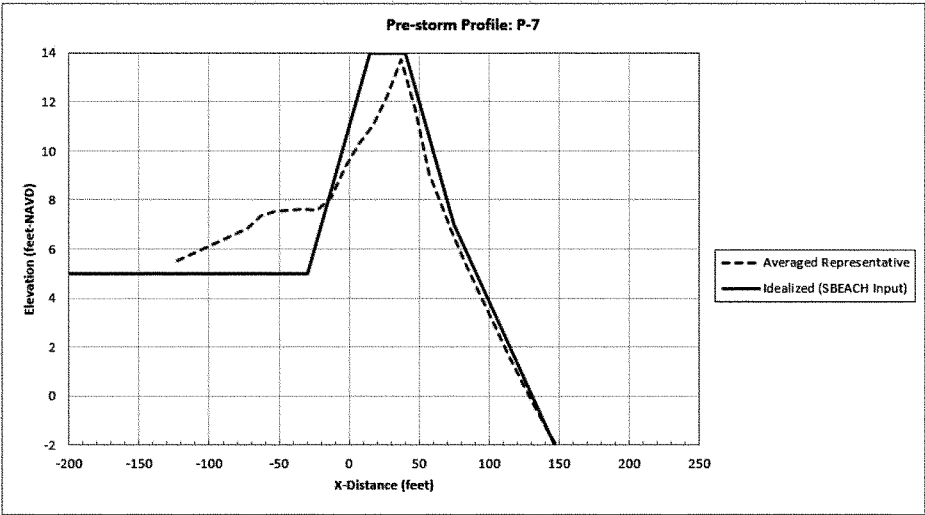


Figure 5-11. Average Measured and Idealized Beach-fx Profiles: P7 Grouping

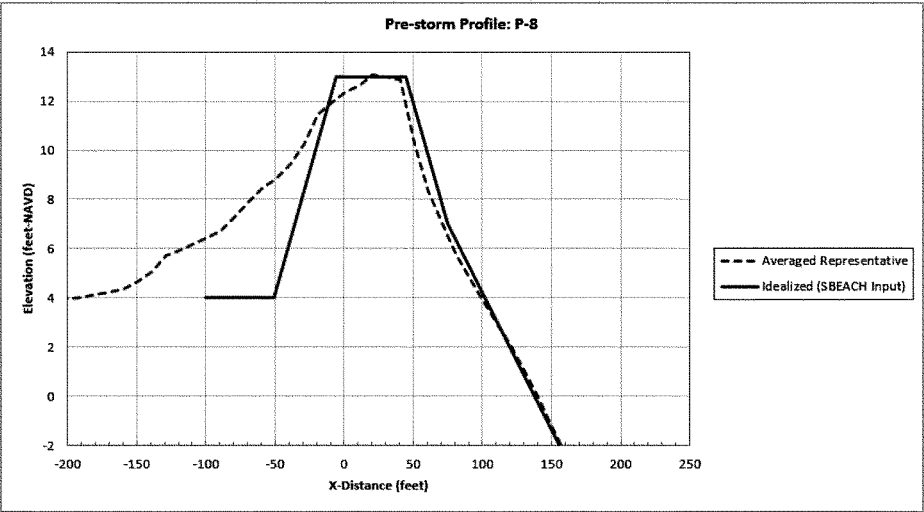


Figure 5-12. Average Measured and Idealized Beach-*fx* Profiles: P8 Grouping

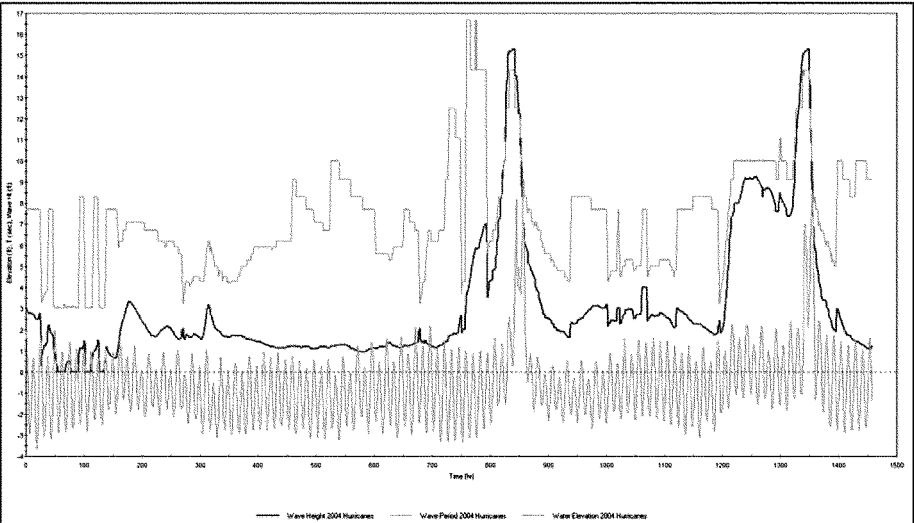


Figure 5-13. Hurricane Frances and Jeanne Wave and Water Level Data for SBEACH Calibration

5.3.1.4 SBEACH Simulations

Calibrated St. Lucie County SBEACH simulations were completed for each of the without project and with-project idealized profiles in combination with each of the tropical and extra-tropical storms in the plausible storm database. From these profiles, changes in the key profile dimensions were extracted and stored in the St. Lucie County Beach-fx SRD.

Table 5-4. SBEACH Calibrated Beach Characteristic and Sediment Transport Parameters

Beach Characteristic		Sediment Transport	
Parameter	Calibrated Value	Parameter	Calibrated Value
Landward Surf Zone Depth	1.0 m	Transport Rate Coefficient	2.3e-006 (m4/N)
Effective Grain Size	0.45 mm	Overwash Transport Parameter	0.001
		Coefficient for Slope-Dependent Term	0.002
Maximum Slope Prior to Avalanching	30	Transport Rate Decay Coefficient Multiplier	0.2
		Water Temperature	30degC

5.3.2 Applied Shoreline Change

The applied shoreline change rate (in feet per year) is a Beach-fx morphology parameter specified at each of the model reaches. It is a calibrated parameter that, combined with the storm-induced change generated internally by the Beach-fx model, returns the historical shoreline change rate for that location. Calibration is essential to insure that the morphology behavior is appropriate and representative of the study area.

The target shoreline change rate is an erosion or accretion rate derived from the historical MHW rate of change (from January 1970 to August 2008) determined at each R-monument location. Although the MHW rate of change represents the historical behavior of the project shoreline, when it is calculated at single point locations, such as R-monuments, there is a high degree of variability between consecutive locations. This variability results in a similar variability in the Beach-fx results, specifically in project costs and predicted damages. Because this does not reflect actual shoreline behavior and leads to inconsistencies between adjacent economic reaches, the target shoreline change rate is determined by averaging adjacent MHW change rates to allow for smoother transitions along the length of the project shoreline. Figure 5-14 shows the smoothed target shoreline change rates along with the original MHW shoreline change rates (January 1970 to August 2008) from which they were derived.

During Beach-fx calibration, applied erosion rates were adjusted for each model reach and the Beach-fx model was run for hundreds of iterations over the 50-year project life cycle. Calibration is achieved when the rate of shoreline change, averaged over hundreds of life cycle simulations, is equal to the target shoreline change rate.

It is through the applied erosion rates that sea level change is incorporated into the Beach-fx shoreline change simulations. The calibrated applied erosion rates, based on historical shoreline change and the existing measured sea level rate of change, represents the baseline (Low) sea level change condition. By

adding the change in shoreline recession for the Intermediate and High sea level change scenarios, as predicted by Bruun’s Rule (Section 3.5.2 Beach Responses to Sea Level Change), to the calibrated applied erosion rates at each Model Reach, adjusted applied erosion rates can be determined. Figure 5-15 shows target erosion rates, corresponding calibrated applied erosion rates (Baseline sea level change), and resulting adjusted applied erosion rates (Intermediate and High) sea level change.

5.3.3 Project Induced Shoreline Change

The placement of additional sand on a beach will increase the rate of erosion of that beach since the beach fill material represents a perturbation in the shoreline that is diffused by incident waves. Beach-*fx* requires with-project shoreline change rates in order to represent the planform diffusion of the beach fill alternatives in the Beach-*fx* model simulations. The USACE one-dimensional shoreline change model GenCade was applied to evaluate St. Lucie County beach nourishment alternatives (detailed in Section 5.6: Beach-*fx* Project Design Alternatives). The difference in shoreline change rate for each with-project alternative versus the without-project calculated within GenCade represents the diffusion rate of each alternative that is applied to the Beach-*fx* model.

The GenCade model (Frey et al., 2012) was developed by combining the USACE project-scale, shoreline change model GENESIS and the regional-scale, transport model Cascade. The GENESIS component of the GenCade model was used for the project analysis that is detailed herein. GenCade can be set up and executed within the Surface-Water Modeling System (SMS) or executed as a stand-alone model through the MS-DOS interface and calculates both shoreline change and alongshore sand transport due to wave forcing.

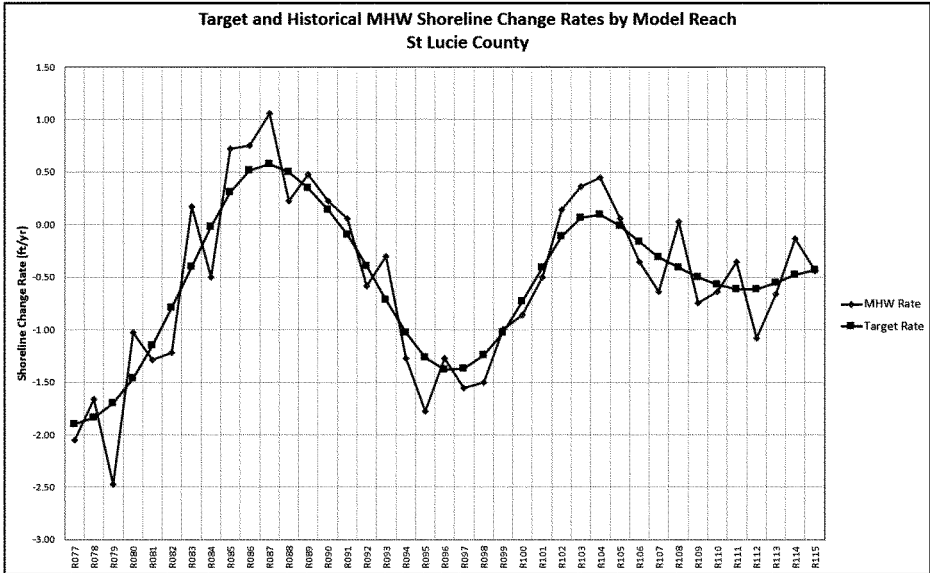


Figure 5-14. Target MHW Shoreline Change Rate

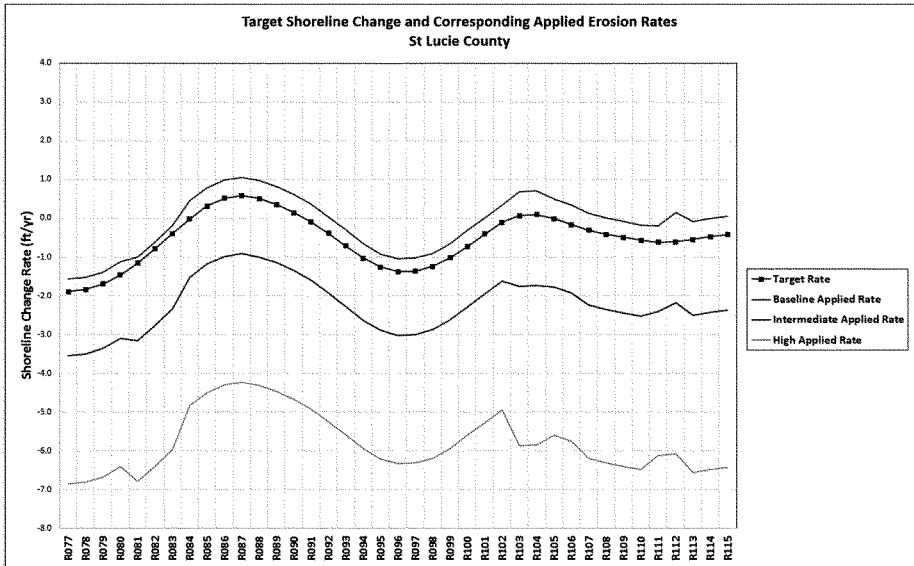


Figure 5-15. Target MHW Shoreline Change and Applied Erosion Rates

5.3.3.1 CMS Wave Model

The GenCode model requires breaking wave heights as a model input to calculate sediment transport rates which are then used to calculate shoreline change. Since breaking wave heights are rarely measured and are not readily available, the GenCode model package includes an internal wave model that transforms waves from a given offshore depth to breaking depth using linear wave theory. Alternatively, if the local bathymetry is complex, an external wave model such as STWAVE or CMS Wave can be used. The contours off of St. Lucie County are generally straight and parallel; however, the nearshore region contains scattered hardbottom formations and shoals, which can significantly influence the shoaling and refraction of incident waves. To account for this influence, the wave transformation model within the Coastal Modeling System (CMS Wave) was used to shoal and refract the hindcast waves over the irregular bathymetry to a location seaward of the breaking depth. The transformed wave data output from the CMS-Wave model were then input into GenCode.

The CMS Wave model uses wave conditions at the offshore boundary to drive the model. The most complete hindcast wave data available for St. Lucie County covers the period from 1980-2012 and is produced by USACE Wave Information Studies (WIS). The WIS wave hindcast is developed using the WISWAVE model, a discrete spectral wave model that solves the energy balance equation for the time and spatial variation of a 2-D wave spectrum from wind forcing (See Section 3.2: Waves). The WIS program archives the wave hindcast at discrete stations that are located approximately every 0.10 degrees of latitude (approximately every 4.5 nautical miles) along the shoreline of the U.S. The WIS station used for this analysis is 63452, which is located at 27.33° latitude and -80.00° longitude—approximately 18 nautical miles east of the center of the study area. The water depth is approximately 66m (216 feet) at WIS Station 63452.

For the this study, a CMS grid was created that extended 22 miles in the alongshore, centered at the project site and extended 15 miles offshore, approximately 3 miles offshore of the WIS station. It was oriented with an azimuth of 293°, measured counter-clockwise from due north (0°) so that the y-axis of the wave grid was aligned with the study area shoreline (Figure 5-16).



Figure 5-16. CMS Modeling Grid Layout

The CMS model runs were driven at the offshore boundary using WIS wave data for the entire hindcast period of 1980—2012. These data were pre-processed using procedures to assimilate measured and hindcast wave data into wave climatology statistics and representative data subsets (Connell and Permenter, 2013; Permenter et al., 2013). Resulting wave statistics are then used as input into CMS. This process accurately represents the overall wave climate while drastically reducing the number of CMS wave simulations that are needed to represent the wave climate, thereby saving considerable time and effort.

5.3.3.2 GenCade Model Setup

In order to fully capture the shoreline changes within St. Lucie County and to minimize any boundary effects to the study area, the GenCade model domain was extended to include approximately 3 miles north of the project (vicinity of R-60) and 2.5 miles south of the St. Lucie County line (R-15 of Martin County). The model grid was located sufficiently landward so that the modeled shoreline never intersects with or recedes landward of the grid. Additionally, the grid was oriented so that it was approximately parallel to the St. Lucie County shoreline. The project site does not include any shore protection structures (seawalls, revetments, etc.) that required inclusion in the model.

Shoreline change modeling with GenCade includes model calibration, which tunes the model to approximate site specific conditions, model verification over a different time period in order to verify that the model adequately represents other time periods, and finally production runs which evaluate the diffusion rates of the different beach nourishment alternatives.

The computation time step was set at a one hour interval and modeled shoreline data were output were at 168 hours (1 week). Grid cell sizes were set at 100 meters (~328 feet). As discussed previously, the GenCade grid extends 50 cells north of the study area and 43 cells south of the southern study limit in order to limit model error associated with model boundaries. The CMS Wave breaking wave data were used to drive the GenCade model.

Beach profile surveys were analyzed through time to find the average berm height (6.9 feet; 2.1 meters) and depth of closure (15 feet; 4.6 meters) for the study area; these values are required model input and define the zone of sediment movement in the model. Geotechnical investigation of the beach sediments in St. Lucie County indicate that the median grain size (d50) is 0.45 mm, which was used for all GenCade calibration, verification and production model runs. The lateral boundary condition at the north and south ends of the model grid were set to “pinned” for all model runs, meaning the shoreline doesn’t change position at the model limits.

5.3.3.3 GenCade Calibration

The calibration procedure optimizes site specific model parameters for a given study area by comparing model predicted shoreline change with measured shoreline change from survey data. For St. Lucie County, calibration of model parameters was achieved through analysis of the modeled versus measured shoreline change for the time period from 1 August 2006 to 7 October 2012.

In order to preserve dominant regional shoreline characteristics, GenCade allows the use of a regional shoreline. If an open coast shoreline doesn’t have specified sediment sources, sinks, or structures (such as the St. Lucie County shoreline), the nature of the one-line model means that model simulations over long time periods will result in a straight coastline, which may not be representative of underlying geology that dictates a curved shoreline. By providing a regional contour, the modeled shoreline will be guided in its evolution and eventually will assume a shape parallel to the regional contour, if simulated over long enough time periods. The regional contour was varied during calibration to isolate one that provided the best overall model fit to the measured data, as outlined below. Once that contour was established during calibration, it was not varied for model verification so that a minimal number of model alterations would be made during final verification.

The calibration process began with the sediment transport coefficients K1 and K2 set to model default values of 0.50 and 0.25, respectively. The root mean square error (RMSE) of the modeled vs. measured shorelines for this initial run was 8.6 meters (28.2 feet). The model was relatively insensitive to smoothing of the 2006 regional contour as well as to changes in K1 and K2. Based on the initially poor calibration values and insensitivity to the K-parameters, the next step was the substitution of a regional contour based upon the 2012 MHW shoreline to see if the addition of a regional contour would improve the model calibration significantly. This reduced the RMSE of modeled vs. measured to 5.0 meters (16.4 feet) with a standard deviation of 4.9. This indicated that the changes were significantly improving model performance. Smoothing of this contour across three cells reduced the RMSE to 2.54 meters (8.33 feet) with K1=0.25 and K2=0.25 and a standard deviation of 2.11; this change brought the model

into acceptable agreement with the measured shoreline values. The rest of the calibration process fine-tuned the sediment transport parameters to minimize the error.

First, the K1 was raised to 0.35, resulting in an increase of RMSE to 2.77 meters (9.10 feet). K1 was then lowered to 0.2 and K2 kept at 0.25 which resulted in an RMSE of 2.47 meters (8.10 feet). K2 was then lowered to 0.10, which resulted in an RMSE of 2.46 meters (8.07 feet). Finally, the K1 was reduced to 0.10 (K2 remained at 0.10) and the RMSE increased to 2.66 meters (8.72 feet). The final outcome of the calibrated model was therefore a regional contour based on the 2012 MHW contour, smoothed and offset 300 meters (984 feet) offshore with a K1 of 0.20 and K2 of 0.10. Table 5-5 summarizes relevant GenCade calibration settings and statistics.

Table 5-5. GenCade Calibration Settings and Statistics

Regional Contour Applied	Calibration Parameters		Root Mean Square Error (RMSE)	
	K1	K2	Meters	Feet
2006	0.50	0.25	8.60	28.21
2012	0.25	0.25	5.00	16.40
2012 smooth	0.25	0.25	2.54	8.33
2012 smooth	0.35	0.25	2.77	9.09
2012 smooth	0.20	0.25	2.47	8.10
2012 smooth	0.20	0.10	2.46	8.07
2012 smooth	0.10	0.10	2.66	8.72
Highlighted values carried forward for verification model runs				

5.3.3.4 GenCade Verification

Along with the parameters from the final calibration run, waves from the period between 1 August 1997 and 1 August 2002 (verification period) were input along with the corresponding MHW shoreline data from those two years. As with the calibration period, the final modeled shoreline position was compared with the final measured shoreline. Verification runs started with the calibrated model parameters of K1=0.20 and K2=0.10 and a regional contour derived from the 2012 MHW shoreline.

The verification process included fine tuning of the calibration settings. This involved changes to K1 while maintaining the regional contour and the secondary K2 variable. Comparison of the modeled and measured shorelines from 1997 to 2002 indicated an RMSE of 4.98 meters (16.33 feet) with K1=0.2 and K2=0.1. An increase of K1 to 0.30 resulted in a reduction of RMSE to 4.86 meters (15.94 feet). A slight reduction to K1=0.25 then resulted in an RMSE increase to 4.90 meters (16.07 feet). Based on these results, the optimum K1 value was determined to be 0.30 for the verification period.

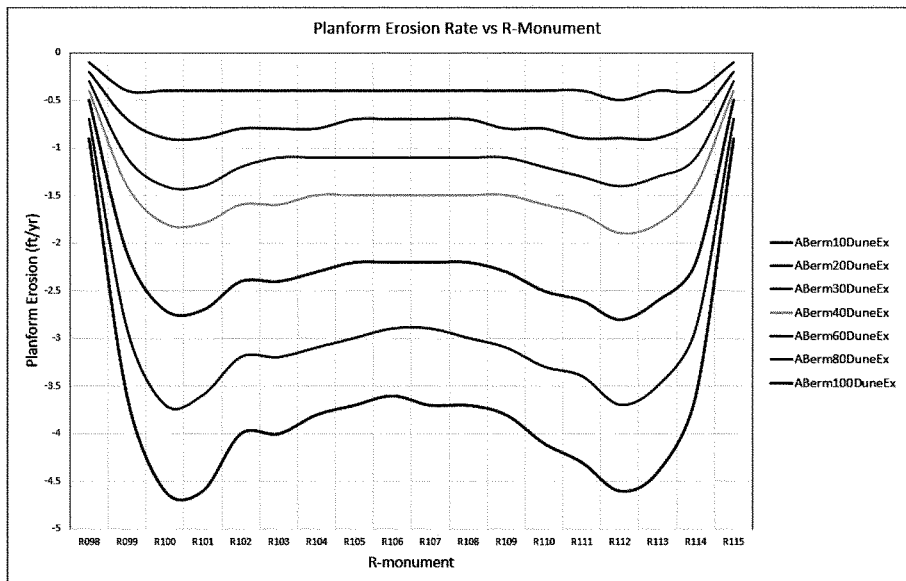
To verify the optimized parameters, a recheck of the calibration period of 2006 to 2012 time period with K1=0.30, K2=0.10, and the 2012 regional contour was made. This resulted in an RMSE of 2.64 meters (8.66 feet), a nominal increase from the calibration value of 2.46 meters (8.07 feet). From this analysis it was determined that the production runs would use the optimized model parameters K1=0.30 and K2=0.10. Table 5-6 summarizes relevant Gencade verification settings and statistics.

Table 5-6. GenCade Verification Settings and Statistics

Regional Contour Applied	Calibration Parameters		Root Mean Square Error (RMSE)	
	K1	K2	Meters	Feet
2012 smooth	0.20	0.25	4.98	16.33
2012 smooth	0.30	0.10	4.86	15.94
2012 smooth	0.25	0.10	4.90	16.07
Highlighted values show optimized parameters for production runs				

5.3.3.5 Model Results

The calibrated and verified GenCade model for St. Lucie County provides a means to evaluate proposed shoreline protection measures so that the most economically beneficial alternative can be determined. In order to compare proposed alternatives, an input shoreline condition with no modifications was first used to project the future background conditions. This model run represented the future without-project condition. Following the without project condition run, each of the proposed alternatives (see Section 5.6: Beach-fx Project Design Alternatives for alternative details) were then added to the initial shoreline. These constituted the future with-project condition runs. Future with-project simulations shoreline changes were compared with the changes observed from the future without project run to determine the planform shoreline change rates that would be expected from a constructed project. Figure 5-17 provides example of the final project planform rates for one series of FWP alternatives.

**Figure 5-17. Example of Planform Rate Results for a Single Series of FWP Alternatives**

The project induced shoreline change rates calculated by Gencade do not take into account the improved performance of beach nourishment projects that comes with project maturation. That is, theory and beach nourishment experience has shown that dispersion losses at a beach nourishment project tend to decrease with the number of project nourishments. Neither does Beach-*fx* factor in this phenomena. In order to prevent underestimating project performance and benefits, early Beach-*fx* users from within the coastal engineering community of practice determined that based on the behavior of previous storm damage reduction projects along the east coast of Florida, it can be assumed for the sake of this study that there will be a 20% reduction in shoreline change rates following each consecutive renourishment cycle.

5.3.4 Post Storm Berm Recovery

Post storm recovery of eroded berm width after passage of a major storm is a recognized process. Although present coastal engineering practice has not yet developed a predictive method for estimating this process, it is an important element of post-storm beach morphology. Within Beach-*fx*, post-storm recovery of the berm is represented in a procedure in which the user specifies the percentage of the estimated berm width loss during the storm that will be recovered over a given recovery interval. It is important to note that the percentage itself is not a “stand alone” parameter that is simply applied during the post storm morphology computations. The percentage of berm recovery is estimated prior to model calibration and becomes a tunable calibration parameter to ensure model convergence (when the model reproduces the target erosion rates as discussed in Section 5.3.2 Applied Shoreline Change).

Based on recommendations by the model developer regarding east coast Florida shorelines, review of available historical FDEP profiles that would qualify as pre- and post- storm, and successful model calibration a recovery percentage of 90% over a recovery interval of 21 days was determined to be appropriate for St. Lucie County.

5.4 Economic Evaluation

The Beach-*fx* model analyzes the economics of shore protection projects based on the probabilistic nature of storm associated damages to structures in the project area. Damages are treated as a function of structure location and construction, the intensity and timing of the storms, and the degree of protection that is provided by the natural or constructed beach. Within the model, damages are attributed to three mechanisms:

- Erosion (through structural failure or undermining of the foundation)
- Flooding (through structure inundation levels)
- Waves (through the force of impact)

Although wind may also cause shoreline damage, shore protection projects are not designed to mitigate for impacts due to wind. Therefore, the Beach-*fx* model does not include this mechanism.

Damages are calculated for each model reach, lot, and damage element following each storm that occurs during the model run. Erosion, water level, and maximum wave height profiles are determined for each individual storm from the lookup values in the previously stored SRD. These values are then

used to calculate the damage driving parameters (erosion depth, inundation level, and wave height) for each damage element.

The relationship between the value of the damage driving parameter and the percent damage incurred from it is defined in a user-specified “damage function”. Two damage functions are specified for each damage element, one to address the structure and the other to address its contents. Damages due to erosion, inundation, and wave attack are determined from the damage functions and then used to calculate a combined damage impact that reduces the value of the damage element. The total of all damages is the economic loss that can be mitigated by the shore protection project.

A thorough discussion of the economic methodology and processes of Beach-*fx* can be found in the **Economics Appendix**.

5.5 Management Measures

Shoreline management measures that are provided for in the Beach-*fx* model are emergency nourishment and planned nourishment.

5.5.1 Emergency Nourishment

Emergency nourishments are generally limited beach fill projects conducted by local governments in response to storm damage. St. Lucie County does not have a consistent history of emergency nourishment in response to storm related erosion. Response to storm damage has been limited to isolated dune restoration projects, each having a different template, range, and volume. The Beach-*fx* model assumes emergency fill events have a single profile template, a consistent length of coverage, and occur when specific post-storm shoreline conditions are met. The lack of consistency in the timing, location, volume, and dimensions of the post-storm shoreline prior to the historic fills, makes assigning realistic emergency fill triggers and specifications within Beach-*fx* impossible. Therefore, this management measure was not included in the St. Lucie Beach-*fx* analysis.

5.5.2 Planned Nourishment

Planned nourishments are handled by the Beach-*fx* model as periodic events based on nourishment templates, triggers, and nourishment cycles. Nourishment templates are specified at the model reach level and include all relevant information such as order of fill, dimensions, placement rates, unit costs, and borrow-to-placement ratios. Planned nourishments occur when user defined nourishment triggers are exceeded and a mobilization threshold volume is met. At a pre-set interval, all model reaches which have been identified for planned nourishment are examined. In reaches where one of the nourishment threshold triggers is exceeded, the required volume to restore the design template is computed. If the summation of individual model reach level volumes exceeds the mobilization threshold volume established by the user, then nourishment is triggered and all model reaches identified for planned nourishment are restored to the design template.

5.5.2.1 Nourishment Templates

Beach-*fx* planned nourishment templates are defined by three dimensions, the template dune height, template dune width, and template berm width. Berm elevations and dune and foreshore slopes

remain constant based on the existing profiles. For St. Lucie County, each model reach level template was developed based on a combination of three dune extensions (extension of the dune and beach, from dune crest to depth of closure): 0-foot, 10-foot, and 20-foot extension and five berm widths: 20-foot, 40-foot, 60-foot, 80-foot, and 100-foot. Template dune heights in each case were set to the elevation of the existing Beach-*fx* profile. Nourishment templates were developed for each representative profile within the model reaches. Table 5-7 provides dimensions for each of the design templates. Note that each dune and berm extension is referenced to the idealized “existing” (2008) representative profiles (See Section 5.3.1.1: Representative Profiles).

5.5.2.2 Nourishment Distance Triggers and Mobilization Threshold

Beach-*fx* planned nourishment templates have three nourishment distance triggers (1) berm width, (2) dune width, and (3) dune height. Each distance trigger is a fractional amount of the corresponding nourishment template dimension. When the template dimensions fall below the fraction specified by the trigger, a need for renourishment is indicated. For any project template, the berm width trigger can be set such that a minimum berm width (what has been traditionally referred to as a “design berm”) can be maintained, allowing the remainder of the template to act as sacrificial fill (traditional “advance fill”). St. Lucie study alternatives included five maintained berm options: 0-foot, 20-foot, 40-foot, 60-foot, and 80-foot. Because the width of the berm governs for these alternatives, the dune width and dune height triggers were set to allow minimal erosion to the dune. For all cases that include a berm, the dune width and dune height triggers were set to 0.99 (1% loss of height allowed) and 0.90 (10% loss of height allowed), respectively.

The mobilization threshold (minimum nourishment volume required to trigger a nourishment cycle) was set to be approximately 10,000 cubic yards less than the volume of the sacrificial portion of the nourishment template. This ensures that both the berm width trigger and mobilization threshold act together to maintain the desired “design berm” for each alternative. Distance Triggers and Mobilization thresholds for St. Lucie project alternatives will be presented in greater detail under Section 5.6: Beach-*fx* Project Design Alternatives.

5.6 Beach-*fx* Project Design Alternatives

In order to determine the most effective and cost efficient protective beach design for St. Lucie County, alternatives were developed by combining the design reaches and nourishment templates discussed previously (Table 5-7). Additionally, for each template a series of minimum desired (“design”) berm widths (as described in the previous section) was specified. Table 5-8 provides each of the project design alternatives as well as corresponding distance triggers and design thresholds.

Alternative names are descriptive, consisting of the total nourishment template berm width and the width of the dune extension, if any. For example, Berm20DuneEx represents an alternative with a 20 foot template berm width (Berm20) and no extension of the existing dune (DuneEx). Berm80Dune20 represents an alternative with an 80 foot template berm width and a 20 foot dune extension. Also, each “design berm” option has been given a designation: maintaining a 0-foot berm (A), a 20-foot berm (B), a 40-foot berm (C), a 60-foot berm (D), and an 80-foot berm (E). Therefore a combined alternative of CBerm80Dune10 consists of an 80 foot berm template with a 10 foot extension of the existing dune that will maintain a berm of 40 feet between renourishments.

Table 5-7. St. Lucie County Beach-fx Nourishment Design Templates

Design Reach	Beach-fx Model Reaches	Representative Profile	Template Dune Height (ft-NAVD88) Existing (2008) Dune Height	Template Dune Width (feet)			Template Berm Width (feet)					
				Dune Extension Increments			Berm Extension Increments					
				+0'	+10'	+20'	+0'	+20'	+40'	+60'	+80'	+100'
North Hutchinson Island	R077 to R080	P1	11	55	65	75	0	20	40	60	80	100
	R081 to R083	P1	11	55	65	75	0	20	40	60	80	100
Power Plant Area	R084 to R090	P2	13	35	45	55	0	20	40	60	80	100
	R091 to R098	P1	11	55	65	75	0	20	40	60	80	100
South Hutchinson Island	R098 to R102	P1	11	55	65	75	0	20	40	60	80	100
	R103 to R104	P3	11	50	60	60	0	20	40	60	80	100
	R105 to R106	P4	11	120	130	140	0	20	40	60	80	100
	R107 to R110	P5	11	40	50	60	0	20	40	60	80	100
	R111	P6	11	60	70	80	0	20	40	60	80	100
	R112	P7	14	25	35	35	0	20	40	60	80	100
	R113 to R115	P8	13	50	60	70	0	20	40	60	80	100

Table 5-8. Beach-fx Distance Triggers and Threshold Volumes

Alternative	Fill Volume (Idealized)										Distance Triggers and Threshold Volumes										Threshold Triggers and Threshold Volumes									
	Berm		Dune		Total		Trigger at Existing Dune (A)				Trigger at 20' Berm (B)				Trigger at 40' Berm (C)				Trigger at 60' Berm (D)				Threshold Trigger at 80' Berm (E)				Threshold Trigger at 100' Berm (F)			
	(cy)	(cy)	(cy)	(cy)	(cy)	(cy)	Berm	Dune	Volume	Vol. (cy)	Berm	Dune	Volume	Vol. (cy)	Berm	Dune	Volume	Vol. (cy)	Berm	Dune	Volume	Vol. (cy)	Berm	Dune	Volume	Vol. (cy)	Berm	Dune	Volume	Vol. (cy)
Berm20DuneEx	292,551	0	0.99	0.99	292,551	0	0.00	0.99	280,000	0.90	0.50	0.99	0.90	285,000	0.67	0.99	0.90	283,800	0.75	0.99	0.90	290,000	0.80	0.99	0.90	290,000	0.80	0.99	0.90	290,000
Berm40DuneEx	585,102	0	0.99	0.99	585,102	0	0.00	0.99	570,000	0.90	0.50	0.99	0.90	575,000	0.67	0.99	0.90	573,600	0.75	0.99	0.90	580,000	0.80	0.99	0.90	580,000	0.80	0.99	0.90	580,000
Berm60DuneEx	877,653	0	0.99	0.99	877,653	0	0.00	0.99	860,000	0.90	0.50	0.99	0.90	865,000	0.67	0.99	0.90	863,200	0.75	0.99	0.90	870,000	0.80	0.99	0.90	870,000	0.80	0.99	0.90	870,000
Berm80DuneEx	1,170,204	0	0.99	0.99	1,170,204	0	0.00	0.99	1,160,000	0.90	0.50	0.99	0.90	1,165,000	0.67	0.99	0.90	1,163,200	0.75	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000
Berm100DuneEx	1,462,756	0	0.99	0.99	1,462,756	0	0.00	0.99	1,450,000	0.90	0.50	0.99	0.90	1,455,000	0.67	0.99	0.90	1,453,200	0.75	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000
Dune10	0	165,291	Variable ¹	Variable ¹	165,291	0	0.00	Variable ¹	150,000	0.90	0.50	0.99	0.90	155,000	0.67	0.99	0.90	153,200	0.75	0.99	0.90	158,000	0.80	0.99	0.90	158,000	0.80	0.99	0.90	158,000
Berm20Dune10	292,551	165,291	0.99	0.99	457,842	0	0.00	0.99	280,000	0.90	0.50	0.99	0.90	285,000	0.67	0.99	0.90	283,800	0.75	0.99	0.90	290,000	0.80	0.99	0.90	290,000	0.80	0.99	0.90	290,000
Berm40Dune10	585,102	165,291	0.99	0.99	750,394	0	0.00	0.99	570,000	0.90	0.50	0.99	0.90	575,000	0.67	0.99	0.90	573,600	0.75	0.99	0.90	580,000	0.80	0.99	0.90	580,000	0.80	0.99	0.90	580,000
Berm60Dune10	877,653	165,291	0.99	0.99	1,042,945	0	0.00	0.99	860,000	0.90	0.50	0.99	0.90	865,000	0.67	0.99	0.90	863,200	0.75	0.99	0.90	870,000	0.80	0.99	0.90	870,000	0.80	0.99	0.90	870,000
Berm80Dune10	1,170,204	165,291	0.99	0.99	1,335,496	0	0.00	0.99	1,160,000	0.90	0.50	0.99	0.90	1,165,000	0.67	0.99	0.90	1,163,200	0.75	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000
Berm100Dune10	1,462,756	165,291	0.99	0.99	1,628,047	0	0.00	0.99	1,450,000	0.90	0.50	0.99	0.90	1,455,000	0.67	0.99	0.90	1,453,200	0.75	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000
Dune20	0	330,583	Variable	Variable	330,583	0	0.00	Variable	320,000	0.90	0.50	0.99	0.90	325,000	0.67	0.99	0.90	323,200	0.75	0.99	0.90	328,000	0.80	0.99	0.90	328,000	0.80	0.99	0.90	328,000
Berm20Dune20	292,551	330,583	0.99	0.99	623,134	0	0.00	0.99	280,000	0.90	0.50	0.99	0.90	285,000	0.67	0.99	0.90	283,800	0.75	0.99	0.90	290,000	0.80	0.99	0.90	290,000	0.80	0.99	0.90	290,000
Berm40Dune20	585,102	330,583	0.99	0.99	915,685	0	0.00	0.99	570,000	0.90	0.50	0.99	0.90	575,000	0.67	0.99	0.90	573,600	0.75	0.99	0.90	580,000	0.80	0.99	0.90	580,000	0.80	0.99	0.90	580,000
Berm60Dune20	877,653	330,583	0.99	0.99	1,208,236	0	0.00	0.99	860,000	0.90	0.50	0.99	0.90	865,000	0.67	0.99	0.90	863,200	0.75	0.99	0.90	870,000	0.80	0.99	0.90	870,000	0.80	0.99	0.90	870,000
Berm80Dune20	1,170,204	330,583	0.99	0.99	1,500,787	0	0.00	0.99	1,160,000	0.90	0.50	0.99	0.90	1,165,000	0.67	0.99	0.90	1,163,200	0.75	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000	0.80	0.99	0.90	1,170,000
Berm100Dune20	1,462,756	330,583	0.99	0.99	1,793,338	0	0.00	0.99	1,450,000	0.90	0.50	0.99	0.90	1,455,000	0.67	0.99	0.90	1,453,200	0.75	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000	0.80	0.99	0.90	1,460,000

¹ Dune width triggers for Dune10 and Dune20 alternatives are dependent on the dune widths of individual representative profiles

It should be noted that for the two dune extension only alternatives (Dune10 and Dune20), the dune distance trigger rather than the berm distance trigger is the primary renourishment trigger. In each of these case, the dune distance trigger, which is dependent on the dimensions of the representative profile, is the fraction of the total dune template that would remain once the dune extension has eroded. For example, the total dune template width for the Dune10 alternative at representative profile P1 is 65 feet (55 foot existing dune + 10 foot extension). Allowing 10 feet of erosion of the 65 foot dune would leave 85% of the total template dune width remaining. Therefore, the dune width distance trigger for Dune10 and profile P1 is 0.85. Table 5-9 provides dune width triggers for each of the representative profiles for the Dune10 and Dune20 alternatives.

Table 5-9. Dune Distance Triggers for Dune Extension Only Alternatives

Representative Profile	Dune10		Dune 20	
	Template Dune Width (ft)	Dune Distance Trigger	Template Dune Width (ft)	Dune Distance Trigger
P1	65	0.85	75	0.87
P2	45	0.78	55	0.82
P3	60	0.83	70	0.86
P4	130	0.92	140	0.93
P5	50	0.80	60	0.83
P6	70	0.86	80	0.88
P7	35	0.71	45	0.78
P8	60	0.83	70	0.86

Preliminary Beach-fx runs, along with assessment of potential benefits, allowed the initial array of 47 alternatives to be screened down to those most likely to provide an effective and justified Federal project. Initially, three of the original alternatives detailed previously in Table 5-8 comprised the final array. These consisted of the 10 foot dune extension only alternative (Dune10) and two berm templates constructed without extension of the existing dune (ABerm20DuneEx and ABerm40DuneEx). In order to ensure that the most economical template was isolated and based on economic incremental analyses (See **Economics Appendix** and **Main Text** for details), four additional refined alternatives were included in the final Beach-fx assessment (Table 5-10). The additional refined alternatives were:

- 1) Berm10DuneEx - A 10 foot berm with the existing dune extending over reaches R98 to R115
- 2) Berm30DuneEx - A 30 foot berm with the existing dune extending over reaches R98 to R115
- 3) Berm20DuneEx_R104 - A 20 foot berm with the existing dune extending over reaches R104 to R115
- 4) Berm30DuneEx_R104 - A 30 foot berm with the existing dune extending over reaches R104 to R115

Each of the alternatives that include berm features called for maintaining only the existing dune between nourishments (e.g. a 0 foot “design berm”). The complete final array of alternatives is presented in Table 5-11.

Table 5-10. Additional Alternatives

Alternative	Fill Volume (Idealized)			Distance Triggers and Threshold Volumes			
	Berm (cy)	Dune (cy)	Total (cy)	Trigger at Existing Dune (A)			Threshold Volume
				Berm	Dune	Dune Ht	
Berm10DuneEx	146,276	0	146,276	0	0.99	0.90	140,000
Berm30DuneEx	438,827	0	438,827	0	0.99	0.90	430,000
Berm20DuneEx_R104	206,507	0	206,507	0	0.99	0.90	200,000
Berm30DuneEx_R104	309,760	0	309,760	0	0.99	0.90	300,000

Table 5-11. Refined Array of Project Alternatives

Alternative	Description	Dune Extension (ft)	Maintained ("Design") Berm (ft)	Sacrificial ("Advance") Berm (ft)
Dune10	10' extension of the existing dune and beach profile	10	0	0
ABerm10DuneEx	0' extension of the existing dune and beach profile with a 10' berm template (0' design + 10' advance)	0	0	10
ABerm20DuneEx	0' extension of the existing dune and beach profile with a 20' berm template (0' design + 20' advance)	0	0	20
ABerm20DuneEx_R104	0' extension of the existing dune and beach profile with a 20' berm template (0' design + 20' advance) from R104 to R115	0	0	20
ABerm30DuneEx	0' extension of the existing dune and beach profile with a 30' berm template (0' design + 30' advance)	0	0	30
ABerm30DuneEx_R104	0' extension of the existing dune and beach profile with a 30' berm template (0' design + 30' advance) from R104 to R115	0	0	30
ABerm40DuneEx	0' extension of the existing dune and beach profile with a 40' berm template (0' design + 40' advance)	0	0	40

6 Protective Beach Design

Based on Beach-fx model results and economic evaluation, project alternative ABerm20DuneEx (a 20 foot berm template designed to maintain the existing dune between renourishments) was identified as the Recommended Plan for nourishment of St. Lucie County. Note that during economic incremental analysis it was found that reach R98 for this alternative was not economically justified. It was therefore removed. A description of this shore protection plan is provided in the following sections.

6.1 Project Length

The full study area (7.4 miles), extending from FDEP monument R-77 to the Martin County line, was initially considered during project evaluation using Beach-fx. The selected alternative, ABerm20DuneEx, covers approximately 3.2 miles of the study area. The beach fill will be placed from FDEP monument R-99 to the Martin County line with tapers extending approximately 1,000 feet to the north of R-99 and approximately 1,000 feet south of the Martin County line. As Martin County, south of St. Lucie is part of an authorized Federal project, future nourishment events may be timed to tie into the southern project, negating the need for a taper.

6.2 Project Design

The project design can be described by three factors, the dimensions of the dune, dimensions of the berm, and shoreline slopes.

6.2.1 Project Dune

Existing dune elevations in the project area are between 11 and 14 ft-NAVD88. Evaluation of the design alternatives has shown that the existing elevations, when combined with a berm and/or dune extension, provide sufficient protection. No additional elevation is included in the selected design plan.

Existing dune widths in the project area are variable, with average widths between 25 feet and 120 feet between R-99 and the Martin County line (see Table 5-3). No additional elevation is included in the project design plan.

6.2.2 Project Berm

The design berm elevation in the project area is 7 ft-NAVD88, which approximates the natural berm elevation. Restricting the design berm elevation to the natural berm elevation minimizes scarping of the beach fill as it undergoes readjustment. Vertical scarps can hinder the beach access of nesting sea turtles, and may also pose safety problems related to recreational beach use. Other reasons for mimicking the natural berm elevation are related to storm damage protection. A berm constructed at a lower elevation may increase the probability of overtopping, thereby offering less protection to upland development and/or existing dunes, by allowing more wave energy (which increases with depth) to reach the dune. A higher berm may also be more susceptible to wind-induced erosion.

The project berm template consists of 20 feet of sacrificial fill (traditionally referred to “advance” fill) designed to protect and maintain the existing dune between renourishment events.

6.2.3 Project Beach Slopes

After adjustment and sorting of the placed material by wave action, the material is expected to adjust to an equilibrium beach slope, similar to the native beach. In St. Lucie County, the native beach slopes in the project area are approximately 1 (vertical) on 6 (horizontal) at the dune, 1 on 10 from the berm to MLW (-2.5 ft-NAVD88), and 1 on 40 to 1 on 70 below MLW. The estimate of the slope of the material after adjustment is based on averaging the beach profile slopes of the native beach from the mean low water datum to the approximate location of the 15 foot depth contour. Sand from the project borrow

site was determined to be a near match to the gradation and shell content of the existing beach. This will allow the beach fill to equilibrate to a shape similar to the existing profile.

It is unnecessary and impractical to artificially grade beach slopes below the low water elevation since they will be shaped by wave action. For this reason, the front slope of the beach fill placed at the time of construction or future renourishment may differ from that of the natural profile. The angle of repose of the hydraulically placed material depends on the characteristics of the fill material and the wave climate in the project area. With steep initial slopes, the material will quickly adjust to the natural slopes.

6.2.4 Project Volumes

Traditionally, beachfill designs have been presented as a set of three cross-sectional templates, the design template, which is based on an equilibrium profile translated seaward by the desired width of the berm or MHW extension; the advanced nourishment template, which represents the volume of material that is expected to erode between successive renourishment intervals; and the construction template, which includes both the design and advanced fill quantities, but incorporates the wider berm and steeper slope that reflects the capabilities of the construction equipment. Beach-fx does not automatically incorporate “design” and “advance” features. Instead, the user can loosely establish these separate features within the nourishment template through the use of renourishment triggers and the threshold volume. The traditional “design berm” becomes the minimum width past which further erosion will trigger an assessment of the project’s volume requirements compared against the volume threshold. By default, the portion of the nourishment template allowed to erode as sacrificial fill prior to triggering the volume assessment fulfills the role of the traditional “advance fill”. This allows the user to optimize the total nourishment template based on a risk based, comprehensive assessment of the complete project.

Beach-fx begins with a designated nourishment template. Each life-cycle simulation then applies randomly generated storms, storm erosion, and natural background shoreline change rates. At one year intervals the model evaluates the resulting shoreline against two criteria (1) whether shoreline position at one or more reaches has exceeded one or more planned nourishment triggers and (2) whether the total volume presently required to fill the original nourishment template exceeds the mobilization threshold. If both criteria are met then a renourishment event is initiated. There are three planned nourishment triggers in Beach-fx: berm width, dune width, and dune height. Each trigger indicates what percentage of the design template berm width, dune width, or dune height must be present to prevent a renourishment (for example, a 0.90 dune width trigger means that 90% of the total template dune width must remain intact. If 10% or more of the template dune width is eroded, the first criteria for initiating a planned renourishment event has been met). Should the allowable erosion be exceeded in one or more reaches, then Beach-fx computes the volume required (over all of the *triggered* nourishment reaches) required to fill the original design template and compares that volume to the mobilization threshold. If the mobilization threshold is exceeded a renourishment over *all* planned nourishment reaches occurs and the model continues through the remainder of the life-cycle.

For St. Lucie County ABerm20DuneEx_R104, the berm width, dune width, and dune height planned nourishment triggers were set at 0, 0.91, and 0.9, respectively. The mobilization threshold was set to 280,000 cubic yards. Together, the triggers and the mobilization threshold allow for the optimization of the beach fill based on the physical dimensions of the project as well as assumptions regarding tolerable

erosion limits and reasonable fill volumes (See Section 5.5.2.2: Nourishment Distance Triggers and Mobilization Threshold).

Each complete Beach-*fx* model run consists of 100 iterations, each iteration representing the life of the project (50 years for St. Lucie). Based on the ABerm20DuneEx alternative (100 iteration runs), a range of volumes was determined for each initial fill event and each subsequent renourishment event. Model runs were made for each of the three sea level rise cases, Base, Intermediate, and High. Table 6-1 provides minimum, maximum, and average fill volumes (for both initial and renourishment events) and renourishment intervals over the life of the project. Based on the 100 Beach-*fx* life-cycle iterations from which this data is drawn, the 90% confidence interval for each parameter was determined and is also presented in Table 6-1.

Table 6-1. Project Volumes

Project Volumes (Over 100 Beach- <i>fx</i> Life-cycle Iterations)				
Sea level change Case	Volume Description	Initial Fill Volume (cubic yards)	Renourishment Interval (years)	Average Volume per Interval (cubic yards)
Base	Min - Max	329,100 – 842,700	1 – 38	282,900 – 705,200
	Average	422,000	18	390,000
	90% Confidence Interval	406,700 – 437,400	17 - 19	315,300 – 412,600
Intermediate	Min - Max	355,900 – 549,400	1 – 10	291,600 – 737,600
	Average	364,400	8	391,900
	90% Confidence Interval	359,600 – 369,200	7 - 8	372,400 – 411,300
High	Min - Max	422,800 – 631,100	1 - 4	319,300 – 773,400
	Average	434,900	4	418,000
	90% Confidence Interval	429,700 – 440,100	4 - 4	406,200 – 429,800

Note that the 90% confidence interval indicates a 90% confidence that the average parameter (volume, interval) will fall within the indicated range of values. Average values are generally used for design purposes and project volumes within the 90% confidence interval are available (over the life of the project) from the identified borrow site (See the Geotechnical Appendix for borrow site specifics). However, for a better understanding of the risk level(s) associated with the minimum and maximum values indicated in Table 6-1 a more detail statistical presentation is required.

Figure 6-1 provides the frequency distribution of initial fill volumes over the 100 iterations of the 50 year life of the project for the Base SLC scenario. From this figure it can be seen that majority (95%) of initial fill volumes fall between 350,000 cubic yards and 550,000 cubic yards with minimal occurrences (5% or less) of volumes greater or less than these values.

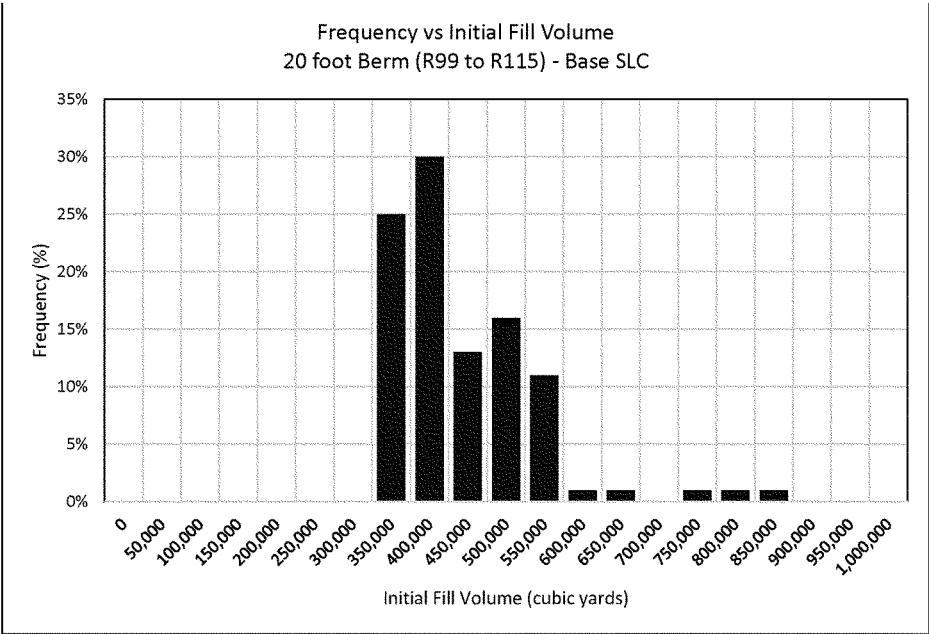


Figure 6-1. Frequency Distribution: Initial Fill Volume

Figure 6-2 provides the frequency distribution of renourishment fill volumes over the 100 iterations of the 50 year life of the project for the Base SLC scenario. In this case the majority (94%) of the renourishment fill volumes fall between 300,000 cubic yards and 550,000 cubic yards with minimum occurrences (5% or less) of volumes greater or less than these values.

To determine the risk associated with a given volume requirement, cumulative distributions were estimated for both the initial fill and renourishment fill volumes. Table 6-2 provides a look-up table for both the frequency and cumulative frequency distributions. For each volume the cumulative frequency indicates the probability that the volume required to complete a fill will exceed the volume indicated. For example, in Table 6-2 the probability of the initial fill volume exceeding a volume of 350,000cy is 75% while the probability of the initial fill volume exceeding 550,000 cubic yards is only 5%. Similarly, the probability that the renourishment volume will exceed 300,000 cubic yards is 90% while the probability that the volume will exceed 550,000 cubic yards is only 6%.

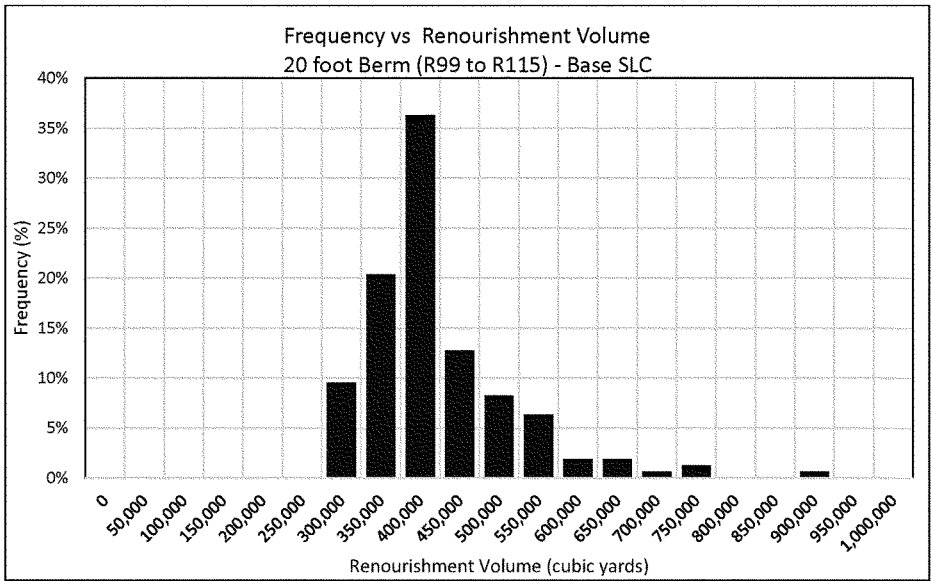


Figure 6-2. Frequency Distribution: Renourishment Fill Volume

6.3 Project Construction

The Recommended Plan for St. Lucie County results in a protective berm that extends the entire (2008) beach profile (7 ft-NAVD88 to depth of closure) 20 feet seaward from the existing dune. Due to erosion, foot traffic, and intermittent repairs and maintenance, the project shoreline does not have a smooth, consistent dune feature. In order for the nourishment project to provide the maximum benefit and perform as predicted during the Beach-fx shoreline analysis, it is necessary to establish a smooth, relatively straight base construction reference line and to ensure that the dune is free of gaps and low points that would allow storm surge to penetrate at elevations inconsistent with the representative dune height(s) specified for the model reaches.

Beach-fx estimates that initial construction of the ABerm20DuneEx template will require between 329,100 and 842,700 cubic yards of material. The wide difference between the minimum and maximum estimate is due to the probabilistic nature of the Beach-fx model. At the time of initial construction, the total volume required to complete the project template depends upon how much of the shoreline has eroded between the start of the simulation and the projected date of project completion. During the 100 iterations of the 50 year lifecycle that were modeled for each alternative design, randomly generated storm activity varied from mild to intense. This allowed for light and heavy degrees of erosion to occur between the model start date (2019) and the model base year (2020). The minimum predicted initial placement volume reflects mild storm activity prior to construction, while the maximum predicted initial placement volume reflects intense storm activity. The average initial construction volume over all iterations was determined to be 422,000 cubic yards.

Table 6-2. Frequency Distribution Tabulated Values

Volume (cubic yards)	Frequency Distribution		Cumulative Frequency Distribution	
	Initial Fill	Renourishment	Initial Fill	Renourishment
0	0%	0%	100%	100%
50,000	0%	0%	100%	100%
100,000	0%	0%	100%	100%
150,000	0%	0%	100%	100%
200,000	0%	0%	100%	100%
250,000	0%	0%	100%	100%
300,000	0%	10%	100%	90%
350,000	25%	20%	75%	70%
400,000	30%	36%	45%	34%
450,000	13%	13%	32%	21%
500,000	16%	8%	16%	13%
550,000	11%	6%	5%	6%
600,000	1%	2%	4%	4%
650,000	1%	2%	3%	3%
700,000	0%	1%	3%	2%
750,000	1%	1%	2%	1%
800,000	1%	0%	1%	1%
850,000	1%	0%	0%	1%
900,000	0%	1%	0%	0%
950,000	0%	0%	0%	0%
1,000,000	0%	0%	0%	0%
1,050,000	0%	0%	0%	0%
1,100,000	0%	0%	0%	0%
1,150,000	0%	0%	0%	0%
1,200,000	0%	0%	0%	0%
1,250,000	0%	0%	0%	0%
1,300,000	0%	0%	0%	0%
1,350,000	0%	0%	0%	0%
1,400,000	0%	0%	0%	0%

6.4 Renourishment Events

Traditionally, renourishment events take place based on both an economically optimized renourishment interval and the physical performance of the project. Project performance, in the past, has been determined by assessing the condition of the design template. Should the design template be breached, the project is no longer providing the required level of protection and is considered for renourishment. Part of this consideration is how close the project may be to the designated renourishment interval.

While the basic principles of renourishment still apply, due to the probabilistic nature of Beach- f_x and the way in which the model assesses renourishment requirements, a new means of assessing project performance must be employed. The former concepts of “design template” and “advance fill” are only loosely applicable. As shown in Figure 6-3 the entire 20 foot berm and beach profile extension template acts as the “advance fill”, while the existing beach profile is the minimum acceptable profile (making it akin to what was formerly the “design template”).

Assessing the performance of the project fill now has two stages. First, a survey of the project area (such as a monitoring or post-storm survey) will be assessed to determine if the shoreline at any of the R-monument locations within the project have receded past the pre-project (2008) condition. If recession beyond the pre-project condition has occurred at one or more of the R-monuments, then a summation of the volume required to restore those profiles to the initial construction template will be made. If the total volume required to restore the receded profiles exceeds the threshold volume

(280,000 cubic yards), then a renourishment event is recommended. The decision to renourish may then be made based on traditional concerns, including such factors as budget cycle and available funding.

6.5 Project Construction

As previously discussed, the front slope of the beach fill placed at the time of construction or future renourishment may differ from that of the natural profile. This reflects the capabilities of the construction equipment that will be used to build the shore protection project. Within the first year or two after placement of the beachfill, the construction profile will be reshaped by waves into an equilibrium profile, causing the berm to retreat to a position more characteristic of the project design template.

Based on the estimated **average** initial fill volume and constructability considerations, a construction template applicable to ABerm20DuneEx was determined. The construction template (shown in Figure 6-3) consists of a variable width berm with a 1 on 100 slope and foreshore fill extending to approximately -5.0 ft-NAVD88 with a slope of 1 on 5. This template, dimensioned for constructability, will then equilibrate into the project (20 foot berm and profile extension) template. The volume of material in the equilibrated profile (between the template and the “existing” condition) represents the material that is expected to erode between successive nourishment events.

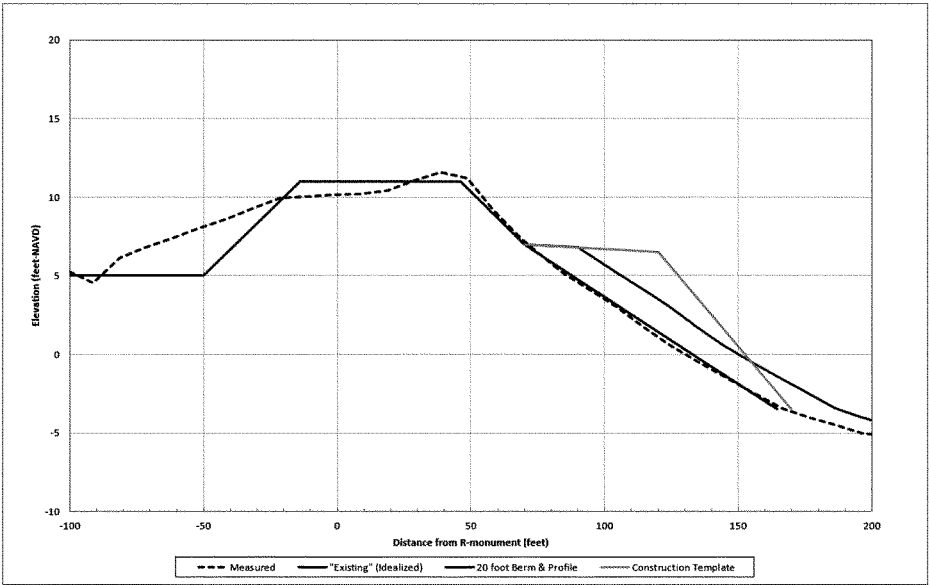


Figure 6-3. Typical Profile Sketch

6.6 Project Construction Line

The project construction reference line was established based on the 2008 “existing” dune and profile survey. The seaward toe of the dune (intersection between the dune and berm) was determined. Table 6-3 provides the location of the construction reference line relative to each FDEP R-monument. The elevation of the construction reference line is a consistent +7 ft-NAVD88 (the nourishment template berm elevation). Initial project construction will complete the entire beach-fx nourishment template for the ABerm20DuneEx plan. This will include restoration and/or leveling of the 2008 dune behind the construction reference line as well as extension of the berm.

Table 6-3. St. Lucie Project Construction Reference Line

FDEP R-Monument	Distance Relative to R-mon (feet)
R-99	14
R-100	8
R-101	22
R-102	25
R-103	114
R-104	75
R-105	62
R-106	95
R-107	63
R-108	132
R-109	120
R-110	68
R-111	33
R-112	93
R-113	116
R-114	65
R-115	82

6.7 Project Monitoring

Physical monitoring of the project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year project life. The monitoring plan will be directed primarily toward accomplishing systematic measurements of the beach profile shape. Profile surveys should provide accurate assessments of dune and beach fill volumes and a basis for assessing post-construction dune and beach fill adjustments, as well as variation in the profile shape due to seasonal changes and storms. Monitoring will play a vital role in determining if project renourishment is necessary. Post construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. The cost for this post construction monitoring is included in the cost shared total project cost.

Other monitoring efforts include bathymetric mapping of the borrow site, which will be done as part of the pre-construction engineering and design (PED) phase prior to each nourishment.

Measured wind, wave, and water level information will be obtained from the best available existing data sources. This data will be applied in support of previously discussed monitoring efforts. It will also be used to periodically assess the state of sea level rise and to determine if reassessment of the project volumes and/or renourishment intervals based on an intermediate of high SLR case is required.

7 Project Summary

This appendix summarizes the engineering design of a shore protection project proposed for construction in St. Lucie County, Florida. The project consists of beach nourishment/renourishment along approximately 3.2 miles of shoreline between FDEP monuments R-99 and the Martin County line. The design beach fill template is characterized by a 20 foot berm extension (+7 ft-NAVD88 to Depth of Closure) from the existing dune. Beach fill material required under the Base SLR case includes an average of 422,000 cubic yards for initial construction of the design beach profile and two to three renourishment events averaging 390,000 cubic yards each (Table 6-1). Total cost of initial project construction (based on average volume requirements) is estimated at \$20.2 Million. Those costs would include the plans and specifications surveys of the project area and borrow site for construction, and the cost of a volumetric survey after initial construction for payment. Future periodic nourishment costs are estimated at \$33 Million, with periodic nourishment expected at approximately 18 year intervals. Assuming that the Base SLR case applies, an estimate of the total cost incurred over the 50-year project life is \$53.3 Million.

8 References

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ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX B

Cost Engineering and Risk Analysis



**US Army Corps
of Engineers**
Jacksonville District

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B. COST ESTIMATES

B1. 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, 30 June 2016
- 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 (Amendment 3: Tables revised 30 September 2013), Civil Works Construction Cost Index System, 31 March 2012
- CECW-CP Memorandum For Distribution, Subject: Initiatives To Improve The Accuracy Of Total Project Costs In Civil Works Feasibility Studies Requiring Congressional Authorization, 19 Sep 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, October 2010

The goal of the cost estimates for the St. Lucie County CSRM Project Draft Feasibility Study and Integrated EA 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 a series of alternative plan formulation cost estimates for decision making. 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 the Micro-Computer Aided Cost Estimating System (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 full cost and schedule risk analysis was performed to establish the project contingency for the Recommended Plan's cost items.

B.1.1. Plan Formulation Cost Estimates

For the plan formulation cost estimates, unit prices for dredging related work were developed in CEDEP and then entered into MCACES/MII. Unit prices for the remaining major or variable construction elements were developed in MCACES/MII based on input from the PDT. Design

details, information and assumptions were provided in the Engineering Appendix. Plan formulation alternatives were run through Beach-fx for calculation of the Benefit-to-Cost Ratio (BCR). Cost Engineering provided estimates for the initial construction on all alternatives that were input into Beach-fx. 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.

B.1.2. Recommended Plan

The Recommended Plan was chosen by the Project Delivery Team (PDT) according to the plan formulation described above. The Economics Appendix fully describes the plan selection. The scope of work for the Recommended Plan is found in the Engineering Appendix. The MCACES/MII cost estimate for the Recommended Plan 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. These include pricing at the Fiscal Year 2017 price level (1 October 2016-30 September 2017). For project justification purposes, the estimate costs are categorized under the appropriate CWWBS code and include both construction and non-construction costs.

The construction costs fall under the following feature code:

- 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

B.1.3. Construction Cost

For the construction costs, unit prices for dredging related work were developed in the Cost Engineering Dredge Estimating Program (CEDEP) and then entered into MCACES/MII. These costs include all major project components categorized under the appropriate CWWBS to the sub-feature level. The Total Project Cost Summary (TPCS) on the Recommended Plan contains contingencies that were determined as a result of the cost and schedule risk analysis, which is covered under another paragraph.

B.1.4. 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. PED costs are for the preparation of contract plans and specifications (P&S) and include itemized costs that were provided by the project manager, as well as costs for Post-Construction Monitoring, Life Cycle Updates, Planning During Construction (PDC), and Engineering During Construction (EDC). Construction Management costs are for the

supervision and administration of a contract. This cost was provided by the project manager and is 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).

B.1.5. Construction Schedule

A construction schedule was prepared utilizing input from the PDT and reflects all project construction components. The schedule considers not only durations of construction, but also the timing of construction contracts based on funding and construction windows. The construction schedule was combined with the project schedule to create an overall schedule that was used for the generation of the TPCS. The construction schedule will change as the project moves through the various project lifecycle phases.

B.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; Planning Engineering and Design; Construction Management; Contingency; and Inflation.

B2. PLAN FORMULATION COST ESTIMATES

There were several alternatives the PDT evaluated during plan formulation in order to identify the Recommended Plan. All alternatives that were evaluated at various stages in the study can be found in the Economics Appendix and are also outlined in the Main Report.

The Final Array of Alternatives looked at the initial construction costs for one (1) reach, South Hutchison Island (R-99 to R-115/Martin County Line), as described in the Main Report and Engineering Appendix. The final array considered five (5) separate conditions (varying beach widths); altogether there were five beach replenishment alternatives estimated, evaluated, and compared in the final array to determine the Recommended Plan.

The alternatives in the final array considered varying dune or beach widths constructed via dredging and hydraulic pumpout and truck haul; costs for dune plantings were also included where applicable. All fill densities and volumes were provided in spreadsheet format by Engineering. The volumes were calculated by Beach-fx. Average distances to borrow sites were estimated using GoogleEarth (truck haul) or were provided by Engineering (dredging). Quantities for dune plantings were calculated based on acreages and FDEP planting requirement information.

The various alternatives were as follows:

- Dune10 (Truck Haul)
 - This alternative is a 10-foot extension of the existing dune with vegetation.
- ABerm10DuneEx (Truck Haul)

- This alternative is a 10-foot extension of the existing berm constructed with the existing dune.
- ABerm20DuneEx (Hopper Dredging)
 - This alternative is a 20-foot extension of the existing berm constructed with the existing dune.
- ABerm30DuneEx (Hopper Dredging)
 - This alternative is a 30-foot extension of the existing berm constructed with the existing dune.
- ABerm40DuneEx (Hopper Dredging)
 - This alternative is a 40-foot extension of the existing berm constructed with the existing dune.

All dredging unit costs were calculated in CEDEP and transferred to MII to determine the total initial construction costs for each alternative. All truck haul unit costs were based upon input from various, permitted sand mine vendors. A contingency was applied to each alternative based upon design level.

Once the total initial construction costs for each alternative were developed in MII, the costs were broken down into a spreadsheet provided by the PDT. The table listed, separately, costs for mobilization and demobilization, a cost/cubic yard, and associated general items related to the construction operation. For the dredging alternatives, the unit cost was for dredging work only. For the truck haul alternatives, the unit cost was for beach fill (purchase, delivery, placement, and spreading of sand) only. Associated General Items included (where applicable) tilling, all necessary during-construction monitoring (environmental and non), and maintenance of traffic.

See also the Economics Section in the Main Report.

B3. RECOMMENDED PLAN (NED) COST ESTIMATE

The recommended design, ABerm20DuneEx covers approximately 3.4 miles of shoreline between FDEP monuments R-99 to R-115/Martin County line (R-001). The construction template consists of a 50-foot wide berm with a 1 on 100 slope and foreshore fill extending to approximately -3.5 ft-NAVD88 with a slope of 1 on 5. This template, dimensioned for constructability, will then equilibrate into the project (20-foot berm and profile extension) template. It should be noted that modification of this design may occur during the detailed design phase of the study.

The Recommended Plan estimate was prepared for the Total Project Cost, not just the initial construction costs.

See the MCACES/MIJ Printout in Addendum A.

B4. SCHEDULE

The project schedule covers the lifecycle phases of the recommended plan (Planning Phase, Preconstruction, Engineering and Design (PED) Phase and the Construction Phase). Refer to the Schedule on the next page.

B5. RISK AND UNCERTAINTY ANALYSIS

A Cost and Schedule Risk Analysis was conducted according to the procedures outlined in the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated 30 June 2016.
- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated 30 September 2008.

B.5.1 Risk Analysis Methods

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 the desired level of cost confidence.

The entire PDT participated in a risk analysis brainstorming session to identify risks associated with the Recommended Plan. The risks were listed in the risk register, which is a tool commonly used in project planning and risk analysis, and evaluated by the PDT. The actual risk register is provided in Attachment A. 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 order to establish a contingency to apply to the project costs.

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.

B.5.2 Risk Analysis Results

Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation.

Based on the risks that were assessed for the project, the resultant contingency was 28%. The complete breakdown of results can be viewed in the Cost and Schedule Risk Analysis report provided in Addendum C.

B6. TOTAL PROJECT COST SUMMARY

The Total Project Cost Summary (TPCS) addresses inflation through project completion (accomplished by escalation to mid-point of construction 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 CWWBS and uses Civil Works Construction Cost Indexing System (CWCCIS) 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 contingencies set by the risk analysis and the official project schedule.

B.6.1 Total Project Cost Summary Spreadsheet

Refer to the Total Project Cost Summary Spreadsheet in Appendix D.

B7. DISTRICT QUALITY CONTROL CERTIFICATION

The recommended plan estimate, formal cost and schedule risk analysis and total project cost summary spreadsheet underwent internal cost review and will be certified by the Walla Walla Mandatory Center of Expertise before final report approval.

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

SAJ - PN 112339
St Lucie County, FL
Coastal Storm Risk Management Project

The St Lucie County, FL Coastal Storm Risk Management Project, as presented by the Jacksonville District, has undergone a successful update for the Cost Agency Technical Review (Cost ATR) of remaining costs, performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the cost products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of October 21, 2016, the Cost MCX certifies the estimated total project cost:

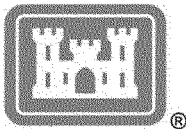
INITIAL

FY18 Project First Cost:	\$ 20,276,000
Fully Funded Costs:	\$ 22,894,000

PERIODIC

FY18 Project First Cost:	\$33,020,000
Fully Funded Costs:	\$ 91,900,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.



CALLAN.KIM.C.1231558221

Kim C. Callan, PE, CCE, PM
Chief, Cost Engineering MCX
Walla Walla District

ADDENDUMS TO APPENDIX B

ADDENDUM A: Recommended Plan Cost Estimate – No Contingency

A-1

RECOMMENDED NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN ESTIMATE IS IN SUPPORT OF THE REVISED DRAFT FEASIBILITY REPORT
AND INTEGRATED ENVIRONMENTAL ASSESSMENT (EA) FOR ST LUCIE COUNTY.

Estimated by CESAJ-EN-TC
Designed by CESAJ PDT
Prepared by CESAJ-EN-TC
Preparation Date 10/1/2016
Effective Date of Pricing 10/1/2016
Estimated Construction Time Days

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Designed by

CESAJ PDT
Estimated by
CESAJ-EN-TC
Prepared by
CESAJ-EN-TC

Direct Costs

LaborCost
EQCost
MatCost
SubBldCost
ShipCost
CEDEP-L
CEDEP-M
PDT
Comparable

Design Document St
Lucie-EngApp-Draft-25May16-NED-PostATR_A
Berm20
Document Date 5/25/2016
District SAJ
Contact Brian Blake, x1003
Budget Year 2019
UOM System Original

Timeline/Currency

Preparation Date 10/1/2016
Escalation Date 9/30/2016
Eff. Pricing Date 10/1/2016
Estimated Duration 0 Day(s)
Currency US dollars
Exchange Rate 1.000000

Labor Rates

LaborCost1
LaborCost2
LaborCost3
LaborCost4

Costbook CBI5EngA: MII English Cost Book 2015 Rev A

Labor LFL2015: Labor_Florida_2015

Note: All labor rates now meet the new 2015 Federal Minimum Wage (\$10.10/hour)

03 SOUTHEAST

Sales Tax 8.60
Working Hours per Year 1,530
Labor Adjustment Factor 0.88
Cost of Money 1.88
Cost of Money Discount 25.00
Tire Recap Cost Factor 1.50
Tire Recap Wear Factor 1.80
Tire Repair Factor 0.15
Equipment Cost Factor 1.00
Standby Depreciation Factor 0.50

Fuel

Electricity 0.095
Gas 2.360
Diesel Off-Road 2.780
Diesel On-Road 2.980

Shipping Rates

Over 0 CWT 16.27
Over 240 CWT 14.82
Over 300 CWT 12.69
Over 400 CWT 10.64
Over 500 CWT 5.85
Over 700 CWT 5.85
Over 800 CWT 9.79

Direct Cost Markups

Productivity	Category	OT Factor	Working
Overtime	Productivity		
Standard	Overtime	Hours/Shift	Shifts/Day
Actual		8.00	1.00
		8.00	1.00
Day			
Monday		OT Factor	Working
Tuesday		1.50	Yes
Wednesday		1.50	Yes
Thursday		1.50	Yes
Friday		1.50	Yes
Saturday		1.50	No
Sunday		2.00	No

Sales Tax	TaxAdj
Matl Cost	
Marine Insurance	
CEDEF-M	MiscDirect
EQ Cost	

Contractor Markups

P JOOH %	Category
S JOOH %	JOOH
P JOOH (Small Tools)	JOOH
P JOOH	Allowance
F JOOH	JOOH
S JOOH	JOOH
P Profit	Profit
S Profit	Profit
Bond	Bond
Excise Tax	Excise

Owner Markups

Escalation	Category
Contingency	Escalation
SIOH	Contingency
	SIOH

Method

Productivity	
Overtime	
1st Shift	8.00
2nd Shift	0.00
3rd Shift	0.00
	0.00

OT Percent	0.00
FCCM Percent	0.00

Running % on Selected Costs

Running % on Selected Costs

Method

Running %	
Running %	
% of Labor	
JOCH (Calculated)	
Running %	
Running %	
Running %	
Running %	
Running %	
Running %	

Method

Running %	
Running %	
Running %	

Project Name:

St. Lucie County Coastal Storm Risk Management (CSRМ) Draft Feasibility Study and Integrated Environmental Assessment (EA) Tentatively Selection Plan (TSP)/Locally Preferred Plan (LPP) and National Economic Development (NED) Plan

Acquisition Plan:

Unconfirmed, but intent is RFP

Sub-contracting Plan:

Currently assuming subcontracting for all monitoring efforts (turbidity, vibration, environmental), surveying, sea turtle trawling, site work, vegetation, and diving

Scope of Work:

Excerpts from St Lucie-EngApp-Draft-11Feb16.pdf and NED 20ft Berm Beach Design.pdf:

Background

St. Lucie County is located on the south-central east coast of Florida (Figure 1-1). The county is bounded to the north by Indian River County and to the south by Martin County. St. Lucie County has approximately 22 miles of sandy shoreline located on a coastal barrier island that varies in width from approximately 400 feet to 1.5 miles. The St. Lucie County shoreline is subject to erosion caused by both tropical and extra-tropical storms as well as other natural shoreline processes. The purpose of this study is to assess the feasibility of providing Federal Coastal Flood Risk Management (CFRM) measures to the southern portion of the St. Lucie County shoreline.

Problem Identification

In the past, beaches of St. Lucie County have generally experienced substantial erosion due to the combined effects of winds, waves, and tides. The objectives of this appendix include quantification of existing beach erosion problems in the southern portion of St. Lucie County and the design of corrective measures specific to that environment. Quantification efforts involve analysis of historical shoreline positions, estimation of longshore transport rates, and prediction of cross-shore losses of beach material due to storms. The results of those efforts serve as the basis for the design and analysis of various measures, which could be employed to reduce storm damage in the project area.

Plans

Based on Beach-fx model results and economic evaluation, project alternative ABerm20DuneEx (a 20 foot berm template designed to maintain the existing (2008) dune between renourishments) was identified as the National Economic Development (NED) Plan for nourishment of St. Lucie County. However, the local Sponsor has identified ABerm30DuneEx (a 30 foot berm template designed to maintain the existing dune) as the Locally Preferred Plan (LPP). The LPP is economically justified and is therefore considered to be the Tentatively Selected Plan (TSP). The model base year (start for estimate) is 2020. There is a 50-year project life.

Project Length

The selected alternative, ABerm30DuneEx, covers approximately 3.4 miles of the study area. The beach fill will be placed from R-98 to the Martin County line with tapers extending approximately 1,000 feet to the north of R-98 and approximately 1,000 feet to the south. As Martin County, south of St. Lucie is part of an authorized Federal project, future nourishment events may be timed to tie into the southern project, negating the need for a taper.

Project Summary

The project consists of beach nourishment/renourishment along approximately 3.4 miles of shoreline between FDEP monuments R-98 and the Martin County line.

TSP/NED: The design beach fill template is characterized by a 20 foot berm extension (+7 ft-NAVD88 to Depth of Closure) from the existing dune. Beach fill material required under the Base SLR case includes an average of 422,000 cubic yards for initial construction of the design beach profile and two to three renourishment events averaging 380,000 cubic yards each. Periodic nourishment, after initial construction, is expected at approximately 18 year intervals.

Post-Construction Monitoring: Physical monitoring of the project is necessary to assess project performance and to ensure that project functionality is maintained throughout the 50-year project life. Post construction monitoring activities include topographic and bathymetric surveys of the placement area on an annual basis for 3 years following construction and then biannually until the next construction event. The cost for this post construction monitoring is included in the cost shared total project cost.

Other monitoring efforts include bathymetric mapping of the borrow site, which will be done as part of the pre-construction engineering and design (PED) phase prior to each nourishment.

Documents Used as the Basis for this Estimate:

- StLucieCoSPP Initial Alternatives Screening Estimates, dated 10 SEP 2015
- StLucieCoSPP Final Array Screening Estimates, dated 29 JAN 2016
- St Lucie-EngApp-Draft-11Feb16.pdf
- NED 20ft Berm Beach Design.pdf
- StLucie_ReportSynopsis_06_15_2015.docx
- St Lucie Feas NonConstruction Budget Info (002).xlsx
- Permit documents for St. Luce County - South Beach Restoration and South County
- Beach & Dune Restoration Project
- Google Earth images

Narrative and Analytical Description on Rate/Price/Cost Development:

Dredging Costs were developed using Ho21-SAJ A 021816 and Pi021b_012516_SAJ_Booster CEDEP (Cost Engineering Dredge Estimate Program). (See ETL 1110-2-573, Appendix D-4d.)

Historical Information - (See ETL 1110-2-573, Appendix D-5 (Historical Pricing Analysis, Past Contracts, etc.)

There is no historical information. CEDEP inputs are based upon Dade Co SPP, which uses a hopper. While Ft. Pierce is a closer beach project, and uses a hopper, the process that will have to be followed for beach pumpout at St. Lucie is more similar to Dade County than Ft. Pierce. At Ft Pierce, beach work is a simple matter of dredging sand into the hopper, attaching to a moor set up near the jetty, and pumping from there. The South Hutchinson Island reach has no such offerings and will have to mimic Dade County instead. Dade County, unfortunately, has a lower production than Ft. Pierce, and yields a much higher unit cost.

Selection of Equipment - (See ETL 1110-2-573, Appendix D-7)

There is no dredging data for this project. The only Corps MII (2008) was for a truck haul from Stewart Mine. It does not appear to be an IGE. The estimate assumes a hopper due to use of Dade County SPP history as a reference, defining of the pipeline corridors, hardbottoms, and permit language. The Local Sponsor's permit for St. Lucie does not bar use of the hopper and Environmental team members didn't indicate that this would be a problematic assumption.

Production - (See ETL 1110-2-573, Appendix D-8)

CEDEP inputs are based upon Dade Co SPP. See above 'Historical Information' section.

Mobilization and Demobilization - (See ETL 1110-2-573, Appendix D-11)

Standard assumptions apply.

Associated Work Items - (See ETL 1110-2-573, Appendix D-2)

Due to hopper assumptions, considerations for non-capture sea turtle trawling will be considered in addition to the other associated work items such as turbidity monitoring and endangered species monitoring. Beach placement necessitates associated work such as turtle nest monitoring (not the same as endangered species monitoring), construction/vibration monitoring, and beach tilling.

Quantity Calculations/Sources: Based upon extensive modeling efforts and calculations from PDT. See St Lucie-EngApp-Draft-11Feb16.pdf.

Effective Dates for Labor, Equipment and Material Pricing:
FY16

Supporting Databases:

MII Labor (2015), Equipment (2014), and Cost Book (2012)

Major Project Features:

Beach placement

Federal and non-Federal Cost Sharing Requirements:

See Project Partnership Agreement (PPA) or Total Project Cost Summary (TPCS) document

Construction Schedule (including date of mid-point of construction):

See schedule in Backup

Known Construction Windows:

From Permit Number: 0154626-001-JC, Expiration Date: June 6, 2017

Sand placement shall be started after October 31 and be completed before May 1. From May 1 through October 31, no construction equipment or pipes shall be stored on the beach.

During the early (March 1 through April 30) and late (November 1 through November 30) sea turtle nesting season, the Contractor shall not extend the beach fill more than 500 feet along the shoreline between dusk and sunrise of the following day until the daily nesting survey has been completed and the beach cleared for fill advancement. An exception to this may occur if there is permitted sea turtle surveyor present on-site to ensure no nesting and hatching sea turtles are present within the extended work area. If the 500 feet is not feasible for the project, an agreed upon distance will be decided on during the preconstruction meeting. Once the beach has been cleared and the necessary nest relocations have been completed, the Contractor will be allowed to proceed with the placement of fill during daylight hours until dusk at which time the 500-foot length limitation shall apply.

Escalation:

Applied in TPCS

General Assumptions:

1. Taxes: 6.5%
2. FOOH: 8%/4%
3. HOOH: 8%/4%
4. Profit 10%/8%
5. Bond: 1.5%
6. Price Level: FY16
7. Productivity/Overtime Usage: --
8. Contingency: Based upon CSRA, will be applied in Total Project Cost Summary (TPCS)
9. PED costs: Based upon PM/PDT input; see Backup
10. S&A costs: Based upon PM/PDT input; see Backup

Site Access:

Atlantic Ocean

Borrow Areas:

From Permit Number: 0154626-001-JC, Expiration Date: June 6, 2017

The offshore borrow area is located on the southern portion of St. Lucie Shoal, 3 to 4 miles offshore of R-98 through R-115, and the mitigation reef is approximately 400-550 feet offshore between R-90 and R-91, in the Atlantic Ocean off of St. Lucie County.

Site Conditions:

Estimator is not aware of any unusual or unique conditions at this time

Unusual Conditions (Soil, Water, Weather):

South Florida gets unpredictably high amounts of rainfall during certain seasons.

Weather Days:

Incorporated through CEDEP

Unique Construction Techniques:

See MII folder notes.

Equipment and Labor Availability and Distance Traveled:

Standard assumptions apply.

Environmental Concerns During Construction:

From StLucie_ReportSynopsis_06_15_2015.docx:

Existing

- Effects from storms including erosion, storm surge (flooding), and wave attack are threatening coastal infrastructure including residential and commercial property in St. Lucie County.
- Natural beach habitat of nesting sea turtles, benthic invertebrates, and shore birds is being lost to coastal erosion.
- Decreasing beach width due to shoreline erosion threatens recreation and tourism.

Other Constraints

The universal constraints are to avoid conflict with state and Federal regulations, as stated in Federal law, USACE regulations and Executive Orders, specifically the:

- Coastal Barrier Resource Act (CBRA)
- Clean Water Act
- Coastal Zone Management Act

The planning constraints for this study are to:

- Avoid conflict with state and Federal regulations, as stated in Federal law, USACE regulations and Executive Orders, specifically the Coastal Barrier Resource Act (CBRA), Clean Water Act and Coastal Zone Management Act.
- Avoid and / or minimize impacts to offshore hard bottom resources over a 50-year planning horizon (2020-2070).
- Avoid impacts to sea turtle nesting habitat including the placement of fill during construction and / or nourishment during nesting season over a 50-year planning horizon (2020-2070).
- Maintain the Hutchinson Island emergency evacuation routes over a 50-year planning horizon (2020 - 2070).
- Consider impacts of Federal participation in designated Coastal Barrier Resource Units within the study area (2020 - 2070).

Volatile Cost Items:

Fuel

Risk Analysis:

See CSRA, contingency will be applied in Total Project Cost Summary (TPCS)

Cost/Schedule Impacts (Modifications):

N/A

Miscellaneous comments:

Marine insurance has been applied to all marine equipment (7.32% total). CEDEP for hoppers already applies 3%. In order to avoid double-counting, a special mark-up has been applied to CEDEP equipment (dredge, equipment part of excavation cost) to make up the difference (4.32%). For marine equipment accounted for in MII directly (mooring rig efforts, hardbottom monitoring efforts, turbidity), the full 7.32% was applied to the equipment portion of those tasks only.

Project Cost Summary Report		Description	Quantity	UOM	ContractCost	Escalation	Contingency	ProjectCost
FINAL RECOMMENDED PLAN (R09 - R115)								
2019 - P&S, PED Mapping	Non-Construction	USR - Physical Monitoring	1,000	LS	40,708,906	0	0	40,708,906
			1,000	LS	460,000	0	0	460,000
			1,000	LS	30,000	0	0	30,000
2020 - Initial Construction	Non-Construction		1,000	LS	13,005,643	0	0	13,005,643
			1,000	LS	10,558,221	0	0	10,558,221
					60.59	0.00%	0	60.59
		USR - Turtle Nest Monitor/Relocations	86.70	HR	5,253	0	0	5,253
	Non-Construction	USR - Construction Management	1,000	LS	2,447,421	0	0	2,447,421
			1,000	LS	1,517,421	0	0	1,517,421
2021 - 1st Year Monitoring	Non-Construction		1,000	LS	625,000	0	0	625,000
		USR - Economic Update	1,000	LS	625,000	0	0	625,000
			1,000	LS	30,000	0	0	30,000
2022 - 2nd Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
2023 - 3rd Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2024	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2025 - 4th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2026	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2027 - 5th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2028	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2029 - 6th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2030	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2031 - 7th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2032 - 8th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2033 - 9th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2034 - 10th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2035 - 11th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2036 - 12th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2037 - 13th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2038 - 14th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2039 - 15th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2040 - 16th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2041 - 17th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2042 - 18th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2043 - 19th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2044 - 20th Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2045 - 21st Year Monitoring	Non-Construction		1,000	LS	140,000	0	0	140,000
		USR - Biological Monitoring/Surveillance	1,000	LS	140,000	0	0	140,000
			1,000	LS	50,000	0	0	50,000
			1,000	LS	40,000	0	0	40,000
	Non-Construction		1,000	LS	40,000	0	0	40,000
		USR - Economic Update	1,000	LS	40,000	0	0	40,000
			1,000	LS	30,000	0	0	30,000
2046 - 22nd Year Monitoring	Non-Construction		1,000	LS	140,000			

Description		Quantity	UOM	ContractCost	Escalation	Contingency	ProjectCost
USR Biological Monitoring/Surveillance		1.00	LS	50,000	0	0	50,000
2032							
Non-Construction		1.00	EA	40,000	0	0	40,000
USR Economic Update		1.00	LS	40,000	0	0	40,000
2033 - 8th Year Monitoring		1.00	LS	30,000	0	0	30,000
Non-Construction		1.00	LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
2034							
Non-Construction		1.00	LS	50,000	0	0	50,000
USR Economic Update		1.00	LS	40,000	0	0	40,000
2035 - 9th Year Monitoring		1.00	LS	40,000	0	0	40,000
Non-Construction		1.00	LS	30,000	0	0	30,000
2035 - 9th Year Monitoring		1.00	EA	140,000	0	0	140,000
Non-Construction		1.00	LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance		1.00	LS	50,000	0	0	50,000
2036							
Non-Construction		1.00	EA	40,000	0	0	40,000
USR Economic Update		1.00	LS	40,000	0	0	40,000
2037 - P&S, FED Mapping		1.00	LS	30,000	0	0	30,000
Non-Construction		1.00	EA	460,000	0	0	460,000
Non-Construction		1.00	LS	460,000	0	0	460,000
USR Physical Monitoring		1.00	LS	30,000	0	0	30,000
2038 - 1st Renourishment		1.00	LS	10,699,132	0	0	10,699,132
Construction		1.00	LS	9,379,014	0	0	9,379,014
USR Turtle Nest Monitor/Relocations		79.40	HR	60.50	0.00%	0.00%	60.50
Non-Construction		1.00	LS	4,811	0	0	4,811
USR Construction Management		1.00	LS	1,320,118	0	0	1,320,118
2039 - 1st Year Monitoring		1.00	LS	1,105,118	0	0	1,105,118
Non-Construction		1.00	LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
2040 - 2nd Year Monitoring		1.00	LS	50,000	0	0	50,000
Non-Construction		1.00	LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
2041 - 3rd Year Monitoring		1.00	LS	50,000	0	0	50,000
Non-Construction		1.00	LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
2042							
Non-Construction		1.00	EA	40,000	0	0	40,000
USR Economic Update		1.00	LS	40,000	0	0	40,000
2043 - 4th Year Monitoring		1.00	LS	30,000	0	0	30,000

Currency in US dollars

Labor ID: LFL2015 EQ ID: EP14R03

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Description		Quantity	UOM	ContractCost	Escalation	Contingency	ProjectCost
				140,000.00			140,000.00
2043 - 4th Year Monitoring			1.00 EA	140,000	0	0	140,000
Non-Construction			1.00 LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance			1.00 LS	50,000	0	0	50,000
				40,000.00			40,000.00
2044			1.00 EA	40,000	0	0	40,000
Non-Construction			1.00 LS	40,000	0	0	40,000
USR Economic Update			1.00 LS	30,000	0	0	30,000
				140,000.00			140,000.00
2045 - 5th Year Monitoring			1.00 EA	140,000	0	0	140,000
Non-Construction			1.00 LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance			1.00 LS	50,000	0	0	50,000
				40,000.00			40,000.00
2046			1.00 EA	40,000	0	0	40,000
Non-Construction			1.00 LS	40,000	0	0	40,000
USR Economic Update			1.00 LS	30,000	0	0	30,000
2047 - 6th Year Monitoring			1.00 LS	140,000	0	0	140,000
Non-Construction			1.00 LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance			1.00 LS	50,000	0	0	50,000
				40,000.00			40,000.00
2048			1.00 EA	40,000	0	0	40,000
Non-Construction			1.00 LS	40,000	0	0	40,000
USR Economic Update			1.00 LS	30,000	0	0	30,000
				140,000.00			140,000.00
2049 - 7th Year Monitoring			1.00 EA	140,000	0	0	140,000
Non-Construction			1.00 LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance			1.00 LS	50,000	0	0	50,000
				40,000.00			40,000.00
2050			1.00 EA	40,000	0	0	40,000
Non-Construction			1.00 LS	40,000	0	0	40,000
USR Economic Update			1.00 LS	30,000	0	0	30,000
				140,000.00			140,000.00
2051 - 8th Year Monitoring			1.00 EA	140,000	0	0	140,000
Non-Construction			1.00 LS	140,000	0	0	140,000
USR Biological Monitoring/Surveillance			1.00 LS	50,000	0	0	50,000
				40,000.00			40,000.00
2052			1.00 EA	40,000	0	0	40,000
Non-Construction			1.00 LS	40,000	0	0	40,000
USR Economic Update			1.00 LS	30,000	0	0	30,000
				140,000.00			140,000.00
2053 - 9th Year Monitoring			1.00 EA	140,000	0	0	140,000

Description		Quantity	UOM	ContractCost	Escalation	Contingency	ProjectCost
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
		1.00	LS	40,000	0	0	40,000
Non-Construction USR Economic Update		1.00	LS	40,000	0	0	40,000
		1.00	LS	30,000	0	0	30,000
		1.00	LS	0	0	0	0
2055 - P&S, PED Mapping Non-Construction	USR Physical Monitoring	1.00	LS	460,000	0	0	460,000
		1.00	LS	460,000	0	0	460,000
		1.00	LS	30,000	0	0	30,000
2056 - 2nd Renourishment Construction		1.00	LS	10,699,132	0	0	10,699,132
		1.00	LS	9,379,014	0	0	9,379,014
		1.00	LS	60.59	0.00%	0.00%	60.59
Non-Construction USR Turtle Nest Monitor/Relocations		79.40	HR	4,811	0	0	4,811
		1.00	LS	1,320,118	0	0	1,320,118
		1.00	LS	1,105,118	0	0	1,105,118
2057 - 1st Year Monitoring Non-Construction	USR Construction Management	1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
2058 - 2nd Year Monitoring Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
2059 - 3rd Year Monitoring Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
2060 Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	40,000	0	0	40,000
		1.00	LS	40,000	0	0	40,000
		1.00	LS	30,000	0	0	30,000
2061 - 4th Year Monitoring Non-Construction	USR Economic Update	1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
2062 Non-Construction	USR Biological Monitoring/Surveillance	1.00	EA	40,000	0	0	40,000
		1.00	LS	40,000	0	0	40,000
		1.00	LS	30,000	0	0	30,000
2063 - 5th Year Monitoring Non-Construction	USR Economic Update	1.00	EA	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
2064 Non-Construction	USR Biological Monitoring/Surveillance	1.00	EA	40,000	0	0	40,000
		1.00	LS	40,000	0	0	40,000
		1.00	LS	30,000	0	0	30,000
		1.00	LS	140,000	0	0	140,000

Description		Quantity	UOM	ContractCost	Escalation	Contingency	ProjectCost
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
		1.00	LS	50,000	0	0	50,000
Non-Construction USR Economic Update		1.00	LS	40,000	0	0	40,000
		1.00	LS	40,000	0	0	40,000
2066 2067 ~ 7th Year Monitoring		1.00	LS	30,000	0	0	30,000
		1.00	LS	30,000	0	0	30,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
Non-Construction USR Economic Update		1.00	LS	50,000	0	0	50,000
		1.00	LS	40,000	0	0	40,000
2068 2069 ~ 8th Year Monitoring		1.00	LS	40,000	0	0	40,000
		1.00	LS	30,000	0	0	30,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	140,000	0	0	140,000
		1.00	LS	140,000	0	0	140,000
Non-Construction USR PM		1.00	LS	50,000	0	0	50,000
		1.00	LS	40,000	0	0	40,000
2070 2071 ~ 9th Year Monitoring		1.00	LS	40,000	0	0	40,000
		1.00	LS	10,000	0	0	10,000
		1.00	LS	10,000	0	0	10,000
		1.00	LS	30,000	0	0	30,000

Description		Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Contract Cost Summary Report									
FINAL RECOMMENDED PLAN (R99 - R115)									
2019 - P&S, PED Mapping									
Non-Construction		1,00	LS	Government	34,009,384	329,600	33,598,282	6,369,922	40,708,906
		1,00	LS		460,000	0	460,000	0	460,000
		1,00	LS		460,000	0	460,000	0	460,000
2020 - Initial Construction									
Non-Construction		1,00	LS	Government	10,579,238	163,094	10,495,431	2,263,311	13,005,643
		1,00	LS		8,131,816	163,094	8,048,009	2,263,311	10,558,221
		1,00	LS		2,447,421	0	2,447,421	0	2,447,421
2021 - 1st Year Monitoring									
Non-Construction		1,00	LS	Government	625,000	0	625,000	0	625,000
		1,00	LS		625,000	0	625,000	0	625,000
		1,00	LS		140,000	0	140,000	0	140,000
2022 - 2nd Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
2023 - 3rd Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2024									
Non-Construction		1,00	LS	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	LS		140,000	0	140,000	0	140,000
2025 - 4th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2026									
Non-Construction		1,00	LS	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	LS		140,000	0	140,000	0	140,000
2027 - 5th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2028									
Non-Construction		1,00	LS	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	LS		140,000	0	140,000	0	140,000
2029 - 6th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2030									
Non-Construction		1,00	LS	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	LS		140,000	0	140,000	0	140,000
2031 - 7th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2032									
Non-Construction		1,00	EA	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	LS		140,000	0	140,000	0	140,000
2033 - 8th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	LS		40,000	0	40,000	0	40,000
2034									
Non-Construction		1,00	LS	Government	40,000	0	40,000	0	40,000
		1,00	LS		40,000	0	40,000	0	40,000
		1,00	EA		140,000	0	140,000	0	140,000
2035 - 9th Year Monitoring									
Non-Construction		1,00	LS	Government	140,000	0	140,000	0	140,000
		1,00	LS		140,000	0	140,000	0	140,000
		1,00	EA		40,000	0	40,000	0	40,000
2036									
Non-Construction		1,00	EA	Government	40,000	0	40,000	0	40,000
		1,00	EA		40,000	0	40,000	0	40,000
		1,00	EA		40,000	0	40,000	0	40,000
		1,00	EA		40,000	0	40,000	0	40,000

Description		Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2037 - P&S, PED Mapping		1.00	EA		460,000	0	460,000	0	460,000
Non-Construction		1.00	LS	Government	460,000	0	460,000	0	460,000
2038 - 1st Renourishment		1.00	LS		8,562,573	83,253	8,398,925	2,053,306	10,699,132
Non-Construction		1.00	LS	Government	7,242,455	83,253	7,078,807	2,053,306	9,379,014
2039 - 1st Year Monitoring		1.00	LS		1,320,118	0	1,320,118	0	1,320,118
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2040 - 2nd Year Monitoring		1.00	LS	Government	140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2041 - 3rd Year Monitoring		1.00	LS	Government	140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2042		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2043 - 4th Year Monitoring		1.00	EA		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2044		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2045 - 5th Year Monitoring		1.00	EA		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2046		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2047 - 6th Year Monitoring		1.00	LS		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2048		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2049 - 7th Year Monitoring		1.00	EA		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2050		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2051 - 8th Year Monitoring		1.00	EA		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2052		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
2053 - 9th Year Monitoring		1.00	EA		140,000	0	140,000	0	140,000
Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
2054		1.00	EA		40,000	0	40,000	0	40,000
Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000

Description		Quantity	UOM	Contractor	DirectCost	SubCMU	CostToPrime	PrimeCMU	ContractCost
2055 - P&S, PED Mapping Non-Construction		1.00	LS	Government	460,000	0	460,000	0	460,000
		1.00	LS		460,000	0	460,000	0	460,000
2056 - 2nd Renourishment Construction		1.00	LS	Government	8,562,573	83,253	8,398,925	2,053,306	10,699,132
		1.00	LS		7,242,455	83,253	7,078,807	2,053,306	9,379,014
2057 - 1st Year Monitoring Non-Construction		1.00	LS	Government	1,320,118	0	1,320,118	0	1,320,118
		1.00	LS		140,000	0	140,000	0	140,000
2058 - 2nd Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2059 - 3rd Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2060 - Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000
2061 - 4th Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2062 - Non-Construction		1.00	EA	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000
2063 - 5th Year Monitoring Non-Construction		1.00	EA	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2064 - Non-Construction		1.00	EA	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000
2065 - 6th Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2066 - Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000
2067 - 7th Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2068 - Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000
2069 - 8th Year Monitoring Non-Construction		1.00	LS	Government	140,000	0	140,000	0	140,000
		1.00	LS		140,000	0	140,000	0	140,000
2070 - Non-Construction		1.00	LS	Government	40,000	0	40,000	0	40,000
		1.00	LS		40,000	0	40,000	0	40,000

Description	Quantity	UOM	Contractor	Direct Labor	Direct EQ	Direct Matl	Direct SubBid	Direct UserCost	Direct Cost
Project Direct Costs Report				1,281,615	4,364,153	410,271	362,856	27,590,488	34,009,384
FINAL RECOMMENDED PLAN (R99 - R115)				1,281,615	4,364,153	410,271	362,856	27,590,488	34,009,384
2019 - P&S, PED Mapping				0	0	0	0	460,000	460,000
Non-Construction	1.00	LS	Government	0	0	0	0	460,000	460,000
USR Physical Monitoring	1.00	LS	Government	0	0	0	0	30,000	30,000
2020 - Initial Construction				608,151	1,618,509	156,832	127,568	8,068,177	10,579,238
Construction	1.00	LS		608,151	1,618,509	156,832	127,568	5,620,756	8,131,816
USR Turtle Nest Monitor/Relocations	86.70	HR	Environmental Sub - AlBerm260DuneEx	45,000 3,901	0,000 0	0,000 0	0,000 0	0	45,000 3,901
Non-Construction	1.00	LS	Government	0	0	0	0	2,447,421	2,447,421
USR Construction Management	1.00	LS	Government	0	0	0	0	1,517,421	1,517,421
2021 - 1st Year Monitoring				0	0	0	0	625,000	625,000
Non-Construction	1.00	LS	Government	0	0	0	0	625,000	625,000
USR Economic Update	1.00	LS	Government	0	0	0	0	30,000	30,000
2022 - 2nd Year Monitoring				0	0	0	0	140,000	140,000
Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	50,000	50,000
2023 - 3rd Year Monitoring				0	0	0	0	140,000	140,000
Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	50,000	50,000
2024				0	0	0	0	40,000	40,000
Non-Construction	1.00	LS	Government	0	0	0	0	40,000	40,000
USR Economic Update	1.00	LS	Government	0	0	0	0	30,000	30,000
2025 - 4th Year Monitoring				0	0	0	0	140,000	140,000
Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	50,000	50,000
2026				0	0	0	0	40,000	40,000
Non-Construction	1.00	LS	Government	0	0	0	0	40,000	40,000
USR Economic Update	1.00	LS	Government	0	0	0	0	30,000	30,000
2027 - 5th Year Monitoring				0	0	0	0	140,000	140,000
Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	50,000	50,000
2028				0	0	0	0	40,000	40,000
Non-Construction	1.00	LS	Government	0	0	0	0	40,000	40,000
USR Economic Update	1.00	LS	Government	0	0	0	0	30,000	30,000
2029 - 6th Year Monitoring				0	0	0	0	140,000	140,000
Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	50,000	50,000
2030				0	0	0	0	40,000	40,000
Non-Construction	1.00	LS	Government	0	0	0	0	40,000	40,000

Description		Quantity	UOM	Contractor	Direct Labor	DirectEQ	DirectMatl	DirectSub	DirectUserCost	DirectCost
Non-Construction	USR Economic Update	1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
2031 - 7th Year Monitoring	Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00	40,000.00	
2032	Non-Construction	1.00	EA	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
2033 - 8th Year Monitoring	Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00	140,000.00	
2035 - 9th Year Monitoring	Non-Construction	1.00	EA	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00	40,000.00	
2036	Non-Construction	1.00	EA	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00	460,000.00	
2037 - P&S, PED Mapping	Non-Construction	1.00	EA	Government	0	0	0	0	460,000	460,000
		1.00	LS	Government	0	0	0	0	460,000	460,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
		1.00	LS	Government	336,732	1,372,822	126,719	117,644	6,608,655	8,562,573
2038 - 1st Renourishment	Construction	1.00	LS	Government	336,732	1,372,822	126,719	117,644	5,288,537	7,242,455
					45.00	0.00	0.00	0.00	45.00	
USR Turtle Nest Monitor/Relocations	Non-Construction	79.40	HR	Environmental Sub - ABerm20/DundEx	3,573	0	0	0	0	3,573
		1.00	LS	Government	0	0	0	0	1,320,118	1,320,118
		1.00	LS	Government	0	0	0	0	1,105,118	1,105,118
		1.00	LS	Government	0	0	0	0	140,000	140,000
2039 - 1st Year Monitoring	Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
2040 - 2nd Year Monitoring	Non-Construction	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000

Description		Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
2041 - 3rd Year Monitoring		1.00	LS		0	0	0	0	140,000	140,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2042		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction USR Economic Update		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00		140,000.00
2043 - 4th Year Monitoring		1.00	EA		0	0	0	0	140,000	140,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2044		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction USR Economic Update		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00		140,000.00
2045 - 5th Year Monitoring		1.00	EA		0	0	0	0	140,000	140,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2046		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction USR Economic Update		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0	0	0	0	140,000	140,000
2047 - 6th Year Monitoring		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2048		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction USR Economic Update		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00		140,000.00
2049 - 7th Year Monitoring		1.00	EA		0	0	0	0	140,000	140,000
Non-Construction USR Biological Monitoring/Surveillance		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2050		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction USR Economic Update		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00		140,000.00

Description		Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMat	DirectSubBid	DirectUserCost	DirectCost
2051 - 8th Year Monitoring		1.00	EA		0	0	0	0	140,000	140,000
Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00		40,000.00
2052		1.00	EA		0	0	0	0	40,000	40,000
Non-Construction	USR Economic Update	1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00		140,000.00
2053 - 9th Year Monitoring		1.00	EA		0	0	0	0	140,000	140,000
Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	40,000	40,000
2054		1.00	LS		0	0	0	0	40,000	40,000
Non-Construction	USR Economic Update	1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0	0	0	0	460,000	460,000
2055 - P&S, PED Mapping	Non-Construction	1.00	LS	Government	0	0	0	0	460,000	460,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0	0	0	0	30,000	30,000
2056 - 2nd Renourishment		1.00	LS		336,732	1,372,822	126,719	117,644	6,608,655	8,562,573
Construction	USR Turtle Nest Monitor/Relocations	1.00	LS		336,732	1,372,822	126,719	117,644	5,288,537	7,242,455
				Environmental Sub - ALBerm201DuneEx	45.00	0.00	0.00	0.00	0	45.00
		79.40	HR		3,573	0	0	0	0	3,573
2057 - 1st Year Monitoring		1.00	LS		0	0	0	0	1,320,118	1,320,118
Non-Construction	USR Construction Management	1.00	LS	Government	0	0	0	0	1,105,118	1,105,118
					0	0	0	0	140,000	140,000
2058 - 2nd Year Monitoring		1.00	LS		0	0	0	0	140,000	140,000
Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	140,000	140,000
2059 - 3rd Year Monitoring		1.00	LS		0	0	0	0	140,000	140,000
Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	40,000	40,000
2060		1.00	LS		0	0	0	0	40,000	40,000
Non-Construction	USR Economic Update	1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0	0	0	0	140,000	140,000
2061 - 4th Year Monitoring		1.00	LS		0	0	0	0	140,000	140,000
Non-Construction	USR Biological Monitoring/Surveillance	1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00	40,000.00	40,000.00

Description		Quantity	UOM	Contractor	DirectLabor	DirectEQ	DirectMatl	DirectSubBid	DirectUserCost	DirectCost
2062 Non-Construction USR Economic Update		1.00	EA		0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
					0.00	0.00	0.00	0.00	140,000.00	140,000.00
2063 - 5th Year Monitoring Non-Construction USR Biological Monitoring/Surveillance		1.00	EA		0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0.00	0.00	0.00	0.00	40,000.00	40,000.00
2064 Non-Construction USR Economic Update		1.00	EA		0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
2065 - 6th Year Monitoring Non-Construction USR Biological Monitoring/Surveillance		1.00	LS		0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	40,000	40,000
2066 Non-Construction USR Economic Update		1.00	LS		0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
2067 - 7th Year Monitoring Non-Construction USR Biological Monitoring/Surveillance		1.00	LS		0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	40,000	40,000
2068 Non-Construction USR Economic Update		1.00	LS		0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	30,000	30,000
2069 - 8th Year Monitoring Non-Construction USR Biological Monitoring/Surveillance		1.00	LS		0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	140,000	140,000
		1.00	LS	Government	0	0	0	0	50,000	50,000
					0	0	0	0	40,000	40,000
2070 Non-Construction USR PM USR Economic Update		1.00	LS		0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	40,000	40,000
		1.00	LS	Government	0	0	0	0	10,000	10,000
					0	0	0	0	30,000	30,000

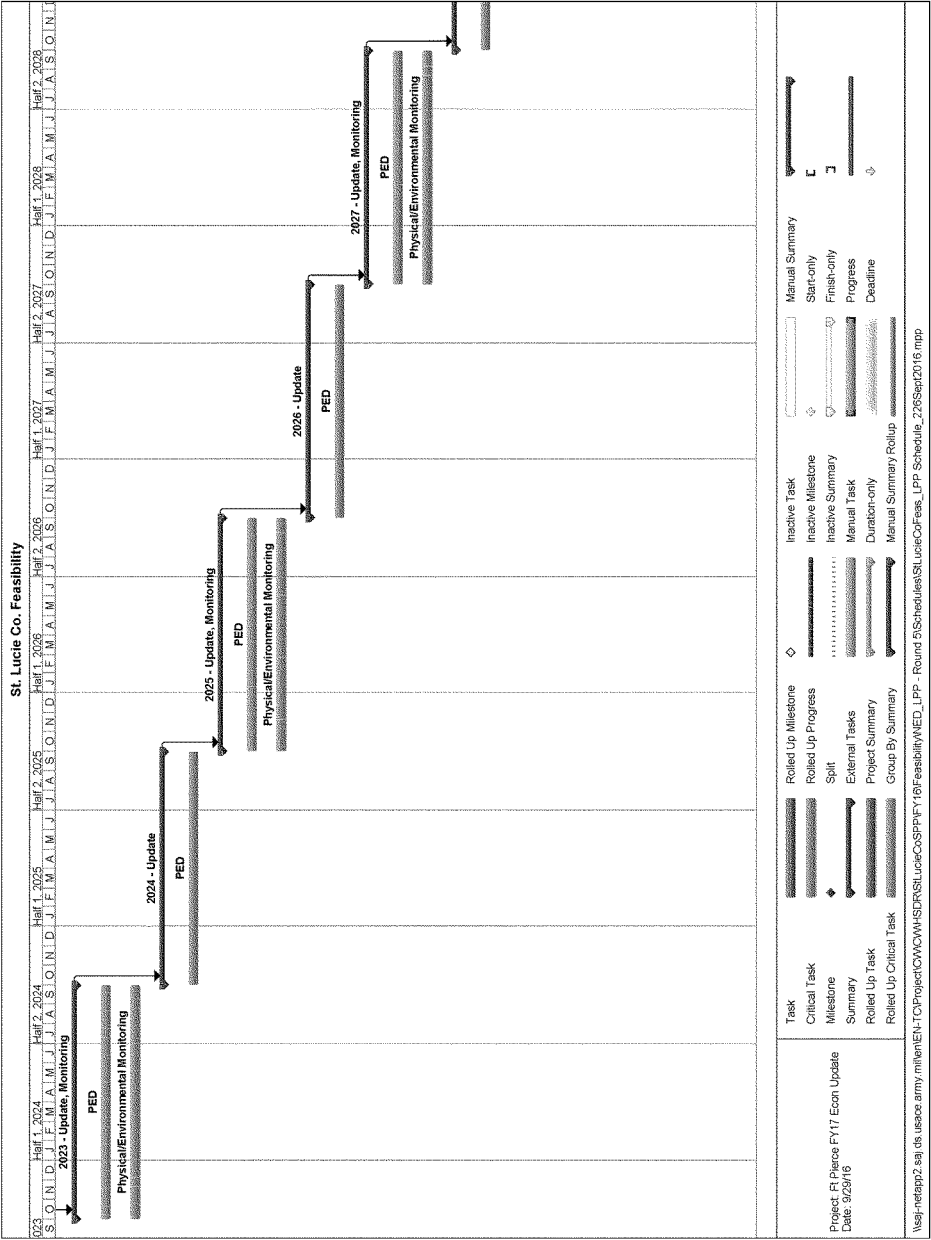
ADDENDUM B: Schedule

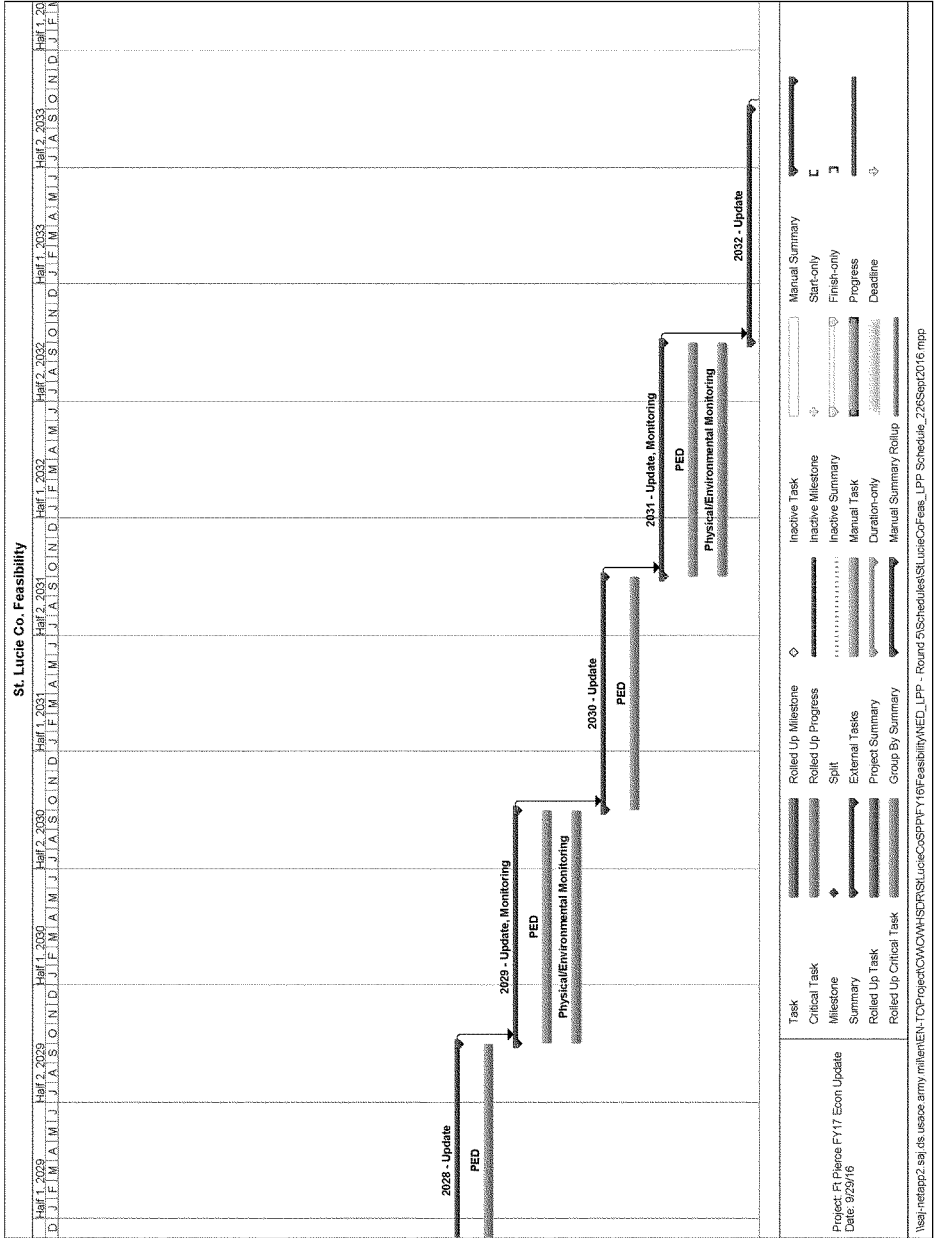
B-1

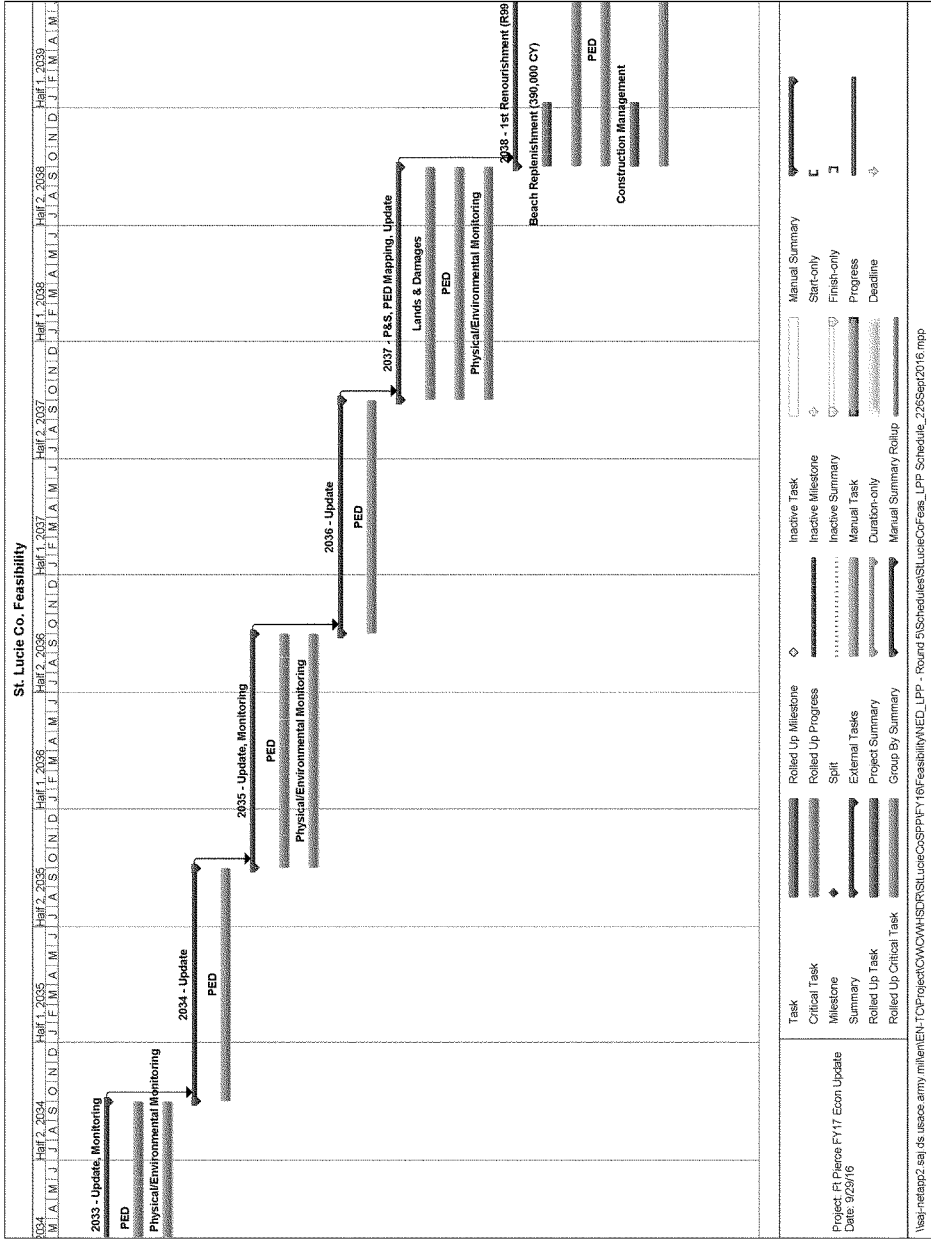
St. Lucie Co. Feasibility									
ID	Task Name	Duration	Start	Finish	Predecessors	Half 2, 2016 A M J J A S O N D J F M A M J J A S O N D J F M A M Half 1, 2017 J F M A M J J A S O N D J F M A M J J A S O N D J F M A M Half 1, 2018 J F M A M J J A S O N D J F M A M J J A S O N D J F M A M			
1	St. Lucie Co SPP Feasibility - LPP (R99 to R115)(MCL)	1237 days	4/21/16	10/22/19					
2	Report Milestones	533 days	4/21/16	10/16/17					
3	Tentatively Selected Plan (TSP) Milestone	0 days	4/21/16	4/21/16					
4	Agency Decision Milestone (ADM)	0 days	8/11/16	8/11/16					
5	Civil Works Review Board (CWRB) Milestone	0 days	4/18/17	4/18/17					
6	Chief of Engineer's Report Milestone	0 days	7/25/17	7/25/17					
7	Final Approval through ASA	0 days	10/6/17	10/6/17					
8	2019 - PAS, PED Mapping, Update	365 days	10/1/19	9/30/20		◆ 421 ◆ 811 ◆ 418 ◆ 725 ◆ 106			
9	Lands & Damages	365 days	10/1/19	9/30/20					
10	PED	365 days	10/1/19	9/30/20					
11	Physical/Environmental Monitoring	365 days	10/1/19	9/30/20					
12	2020 - Initial Construction (R99 - R115)	364 days	10/1/20	9/30/21 8FS+1 day					
13	Beach Replenishment (422,000 CY)	100 days	10/1/20	1/9/21					
14	Lands & Damages	364 days	10/1/20	9/30/21					
15	PED	364 days	10/1/20	9/30/21					
16	Construction Management	100 days	10/1/20	1/9/21					
17	Physical/Environmental Monitoring	364 days	10/1/20	9/30/21					
18	2021 - Update, Monitoring	364 days	10/1/21	9/30/22 12FS+1 day					
19	Lands & Damages	364 days	10/1/21	9/30/22					
20	PED	364 days	10/1/21	9/30/22					
21	Physical/Environmental Monitoring	364 days	10/1/21	9/30/22					
22	2022 - Update, Monitoring	364 days	10/1/22	9/30/23 18FS+1 day					
23	PED	364 days	10/1/22	9/30/23					
24	Physical/Environmental Monitoring	364 days	10/1/22	9/30/23					
Task Task Critical Task Milestone Summary Roll Up Task Roll Up Critical Task Roll Up Milestone Roll Up Progress Split External Task Project Summary Group By Summary Inactive Task Inactive Milestone Inactive Summary Manual Task Duration-only Manual Summary Rollup Manual Summary Start-only Finish-only Progress Deadline									
Project: Ft Pierce FY17 Econ Update Date: 9/29/16									
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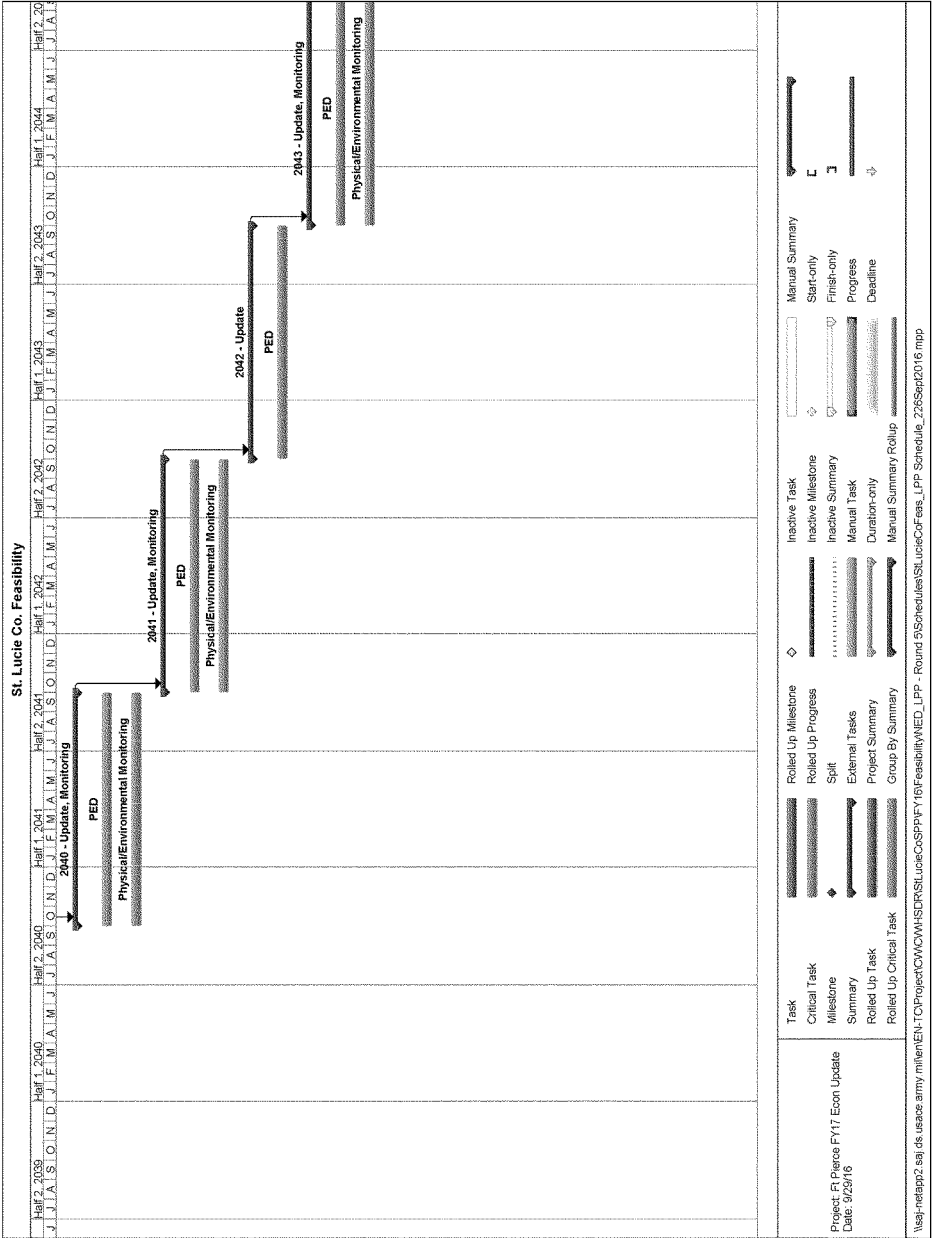
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Date: 9/29/16

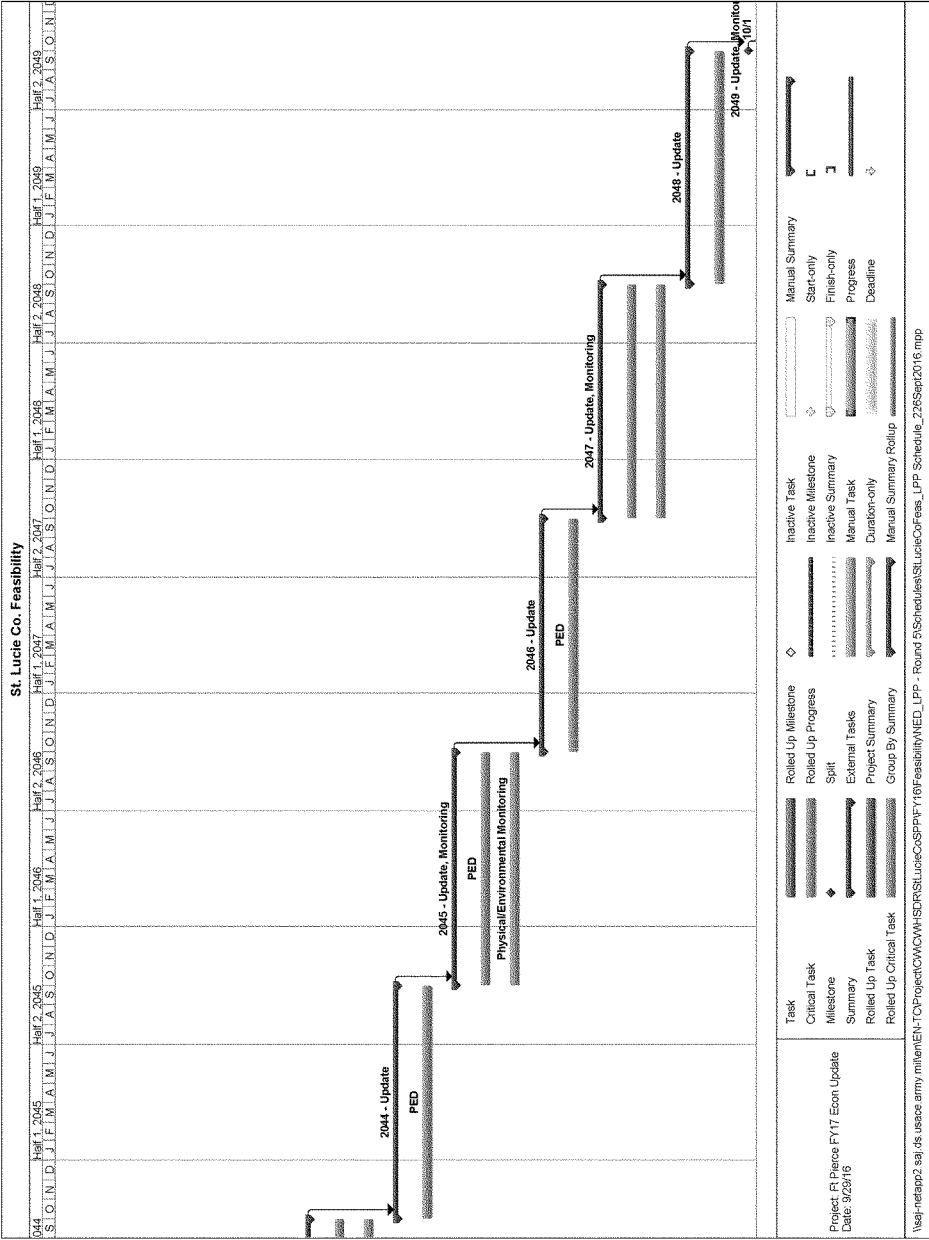
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ADDENDUM C: Risk Report



**US Army Corps
of Engineers®**

**St. Lucie County Coastal Storm Risk Management (CSRM)
St. Lucie County, Florida
Draft Feasibility Study and Integrated Environmental
Assessment (EA)
Project Cost and Schedule Risk Analysis (CSRA) Report**

Prepared by:

U.S. Army Corps of Engineers
Jacksonville District
Cost Engineering Section

October 2016

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EXECUTIVE SUMMARY

The CSRA was developed with support by the Cost Engineering Mandatory Center of Expertise (MCX) for Civil Works. The CSRA will be reviewed by the MCX during Agency Technical Review (ATR) and during subsequent coordination between the MCX and Jacksonville District Cost Engineering. This report presents a recommendation for the total project cost and schedule contingencies for the St. Lucie County CSRM's Draft Feasibility Study and Integrated Environmental Assessment. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated 15 September 2008, a formal risk analysis study was conducted for the development of contingency on the total project cost. The purpose of this risk analysis study was to establish project contingencies by identifying and measuring the cost and schedule impact of project uncertainties with respect to the estimated total project cost.

Specific to the St. Lucie County CSRM project, the project base cost for the remaining work is approximately \$39.1 Million. Based on the results of the analysis, the Jacksonville District recommends a contingency value of \$10.9 Million, or 28%. This contingency includes \$10.4 Million (27.5%) for risks related to cost and \$0.5 Million (0.5%) for the effect of schedule delay on overall project costs.

The Jacksonville District performed the risk analysis using the *Monte Carlo* technique, producing the aforementioned contingencies and identifying key risk drivers. This has been reviewed, as required, by the MCX, Walla Walla District.

The following table portrays the development of contingencies (28% overall). The contingency is based on an 80% confidence level, as per USACE Civil Works guidance.

Table ES-1. Contingency Analysis Table

Base Cost Estimate	\$39,119,000	
Confidence Level	Value (\$)	Contingency (%)
5%	\$41,857,330	7%
50%	\$46,942,800	20%
80%	\$50,072,320	28%
95%	\$53,593,030	37%

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

The key cost risk drivers identified through sensitivity analysis are PR-1 (Fuel Prices), TL1 (Volume Variations), ET3 (Quantity Estimates), and REG2 (Environmental Monitoring & Mitigation) which together contribute over 86 percent of the statistical cost variance.

- Fuel Prices refers to the potential impacts to the cost due to fluctuations in fuel costs during various phases of the project, both in and out of construction.
- Volume Variations captures the risk to the cost caused by fluctuations in erosion rates between modeling and, later, dredging surveys.
- Quantity Estimates captures the risk that projected bid volumes increase or decrease between design and pre-construction surveys.
- Environmental Monitoring & Mitigation addresses the risk of triggering mitigation of some kind, or new and/or more stringent environmental requirements being developed.

An additional moderate cost risk that should be closely monitored is TL2 (Periodic Nourishment Interval).

- Periodic nourishment intervals captures the risk to the cost due to the events not occurring at the projected intervals.

The key schedule risk drivers identified through sensitivity analysis are REG5 (Permit Delays), PR1 (Bidding Climate and Competition), and LD3 (Easements), which together contribute over 81 percent of the statistical schedule variance.

- Permit Delays captures the risk to the schedule due to complications that may arise during permit coordination.
- Bidding Climate and Competition captures the risk that the bidding pool is impacted by such things as economic swings and scheduling.
- Easements captures the risk to schedule that unexpected problems/delays occur during the process of obtaining easements/land certifications.

An additional moderate schedule risk that should be closely monitored is PM4 (Review & Authorization Delays).

- Review and Authorization Delays captures the impacts to the schedule due to delayed authorization and/or reviews.

Recommendations, as detailed within the main report, include the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life-cycle, potential mitigation throughout the PED phase, and proactive monitoring and control of risk identified in this study.

MAIN REPORT

1.0 PURPOSE

This report presents a recommendation for the total project cost and schedule contingencies for the St. Lucie County CSRMs Draft Feasibility Study and Integrated Environmental Assessment.

2.0 BACKGROUND

St. Lucie County is located on the south-central east coast of Florida (Figure 1-1). The county is bounded to the north by Indian River County and to the south by Martin County. St. Lucie County has approximately 22 miles of sandy shoreline located on a coastal barrier island that varies in width from approximately 400 feet to 1.5 miles. The St. Lucie County shoreline is subject to erosion caused by both tropical and extra-tropical storms as well as other natural shoreline processes. The purpose of this study is to assess the feasibility of providing Federal Coastal Flood Risk Management (CFRM) measures to the southern portion of the St. Lucie County shoreline.

Based on Beach-fx model results and economic evaluation, project alternative ABerm20DuneEx (a 20-foot berm template designed to maintain the existing (2008) dune between periodic nourishments) was identified as the National Economic Development (NED) Plan for nourishment of St. Lucie County. However, the local Sponsor has identified ABerm30DuneEx (a 30-foot berm template designed to maintain the existing dune) as the Locally Preferred Plan (LPP). The LPP is not economically justified. Therefore, the NED is considered to be the Tentatively Selected Plan (TSP).

The full study area (7.4 miles), extending from FDEP monument R-99 to R-115/Martin County line, was initially considered during project evaluation using Beach-fx. The TSP, ABerm20DuneEx, covers approximately 3.4 miles of the study area. The beach fill will be placed from R-99 to the Martin County line with tapers extending approximately 1,000 feet to the north of R-99 and approximately 1,000 feet to the south. As Martin County, south of St. Lucie is part of an authorized Federal project, future nourishment events may be timed to tie into the southern project, negating the need for a taper.

The design beach fill template is characterized by a 20-foot berm extension (+7 ft-NAVD88 to Depth of Closure) from the existing dune. Beach fill material required under the Base SLR case includes an average of 422,000 cubic yards for initial construction of the design beach profile and two to three periodic nourishment events averaging 390,000 cubic yards each. Dune planting is expected for initial construction only, with responsibility falling to the Local Sponsor during periodic nourishments. Periodic nourishment, after initial construction, is expected at approximately 18 year intervals.

It is likely that the contracts will be acquired using a Request for Proposal (RFP). The expected construction schedule is about 4 months for initial construction in 2020, and approximately 3 months for the subsequent periodic nourishments in 2038 and 2056.

As a part of this effort, Jacksonville District will request that the USACE Cost Engineering MCX provide an ATR of the CSRA.

3.0 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 cost risks for all project features. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the baseline Micro Computer Aided Cost Estimating System (MCACES) cost estimate, schedule, and funding profiles using Crystal Ball software to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

The project technical scope, estimates and schedules were developed and presented by the Jacksonville District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of problems, needs, opportunities and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2 USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. 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.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to 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 analysis 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, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated 30 June 2016.
- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated 30 September 2008.

4.0 METHODOLOGY / PROCESS

As part of the Draft Feasibility Study and Integrated EA, the Jacksonville District performed the Cost and Schedule Risk Analysis, conducting a risk identification meeting on 19 November 2015 with the Project Delivery Team (PDT) to produce a risk register that served as the framework for the risk analysis. The cost engineer solicited updates from the PDT on 24 February 2016, as part of the previous CSRA. An updated CSRA was developed as a result of the ATR requirement to reformulate the final plan economic analysis, which included an updated cost estimate. The updated cost estimate included new additional dredge production information including a past contract on the same project administered by NFS (St. Lucie County). Another PDT risk register review was held on 14 September to reevaluate the previous risk ratings with special attention given to risk that could have increased impacts due to the use of the updated dredge production data, specifically the NFS contract information. Participants in the risk identification process included the following:

Initial Risk Register Development Meeting - Initial TSP**Date:** Thursday, 19 November 2015

Attendance	Name	Office	Representing
In-Person	Shelley Trulock	PM-WN	Project Manager
In-Person	Stacey Roth	PD-PN	Planning Technical Lead
In-Person	Erik Adamiec	PD-D	Economics
In-Person	Emmanuel Freeman	RE-A	Real Estate
In-Person	Lori Hadley	EN-WC	Water Resources
In-Person	Troy Mayhew	EN-GG	Geotech
Call-In	Meredith Moreno	PD-ES	Archaeology/Cultural Resources
In-Person	Brittany Berger	OC	Legal
In-Person	Sophia Bryant	EN-TC	Cost Estimating

Follow-Up Discussions - Individual or group discussions - Initial TSP**Date:** Friday, 20 November 2015**through**

Tuesday, 22 March 2016

Attendance	Name	Office	Representing
In-Person, E-mail	Jim LaGrone	EN-DW	Engineering Technical Lead (Former)
In-Person	Shelley Trulock	PM-WN	Project Manager
In-Person	Stacey Roth	PD-PN	Planning Technical Lead
In-Person	Erik Adamiec	PD-D	Economics
In-Person	Emmanuel Freeman	RE-A	Real Estate
In-Person	Lori Hadley	EN-WC	Water Resources
In-Person	Troy Mayhew	EN-GG	Geotech
In-Person	Meredith Moreno	PD-ES	Archaeology/Cultural Resources
Call-In	Brittany Berger	OC	Legal
In-Person	Sophia Bryant	EN-TC	Cost Estimating
In-Person	Mike Neves	EN-DW	Engineering Technical Lead (Current)
E-mail	Katrina Denson	CT	Contracting

Follow-Up Meeting Notes

Updates/corrections from team members as work on the feasibility report continues.

Follow-ups also include input from team members who weren't able to attend the initial meeting.

An update session was held 2/24/2016.

Follow-Up Discussions - Individual or group discussions - NED/LPP (ADM)

Date: Wednesday, 14 September 2016

through

Friday, 23 September 2016

Attendance	Name	Office	Representing
E-mail	Jim LaGrone	EN-DW	Engineering Technical Lead (Former)
In-Person	Shelley Trulock	PM-WN	Project Manager
In-Person	Stacey Roth	PD-PN	Planning Technical Lead
In-Person	Erik Adamiec/Colin Rawls	PD-D	Economics
In-Person	Emmanuel Freeman	RE-A	Real Estate
In-Person	Lori Hadley	EN-WC	Water Resources
In-Person	Troy Mayhew	EN-GG	Geotech
Call-In	Robin Moore	PD-ES	Archaeology/Cultural Resources
Call-In	Brittany Berger	OC	Legal
In-Person	Brian Blake	EN-TC	Cost Estimating
In-Person	Mike Neves	EN-DW	Engineering Technical Lead (Current)
E-mail	Griselle Gonzalez	CT	Contracting

Follow-Up Meeting Notes

Updates/corrections from team members as work on the feasibility report continues.

Follow-ups also include input from team members who weren't able to attend the initial meeting.

An update session was held 9/14/2016.

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 the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80% confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

In simple terms, contingency is an amount added to an estimate 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 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 averse 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 selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

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. 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 are provided in Section 6.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative 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.

A formal PDT meeting and follow up discussions were held for the purposes of identifying and assessing risk factors. The meeting included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, geology, and coastal engineering.

The initial formal meetings 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. Subsequent meetings focused primarily on risk factor assessment and quantification and appropriate updates to the risk register.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were 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 involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following 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

The resulting product from the PDT discussions is captured within a risk register as presented in Section 6 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 support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 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 baseline 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.

5.0 PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the St. Lucie County CSRM.

- a. The Jacksonville District completed the MII MCACES (Micro-Computer Aided Cost Estimating Software), serving as the basis for the cost and schedule risk analyses, on 31 March 2016.
- b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at the feasibility level for the remaining work.
- c. Schedules are analyzed for impact to the project cost in terms of both uncaptured escalation (variance from OMB factors and the local market) and unavoidable fixed contract costs and/or languishing Federal administration costs incurred throughout delay. Specific to the St. Lucie County CSRM, the schedule was analyzed only for impacts due to residual fixed costs.
- d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factor for the State of Florida is 0.92, meaning that the average inflation for the project area is assumed to be 8% lower than the national average for inflation. Therefore, it is assumed that the project inflations experienced are similar to OMB inflation factors for future construction. Based on this information, the risk analysis accounted for a slight escalation adjustment over and above the national average.
- e. The assumed residual fixed cost rate for this project is 7.6%. This rate has been used to calculate impacts to the P80 schedule and cost contingencies within the risk model. This is based upon the standard Planning, Engineering, and Design (PED) and Supervision & Administration (S&A) percentage for the Jacksonville District CSRM projects. The majority of schedule risk is assumed to occur during the early stages of PED.
- f. The Cost MCX guidance generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the eighty-percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.
- g. Only high and moderate risk level impacts, as identified in the risk register, were considered for the purposes of calculating cost contingency. Low level risk impacts should be maintained in project management documentation, and reviewed at each project milestone to determine if they should be placed on the risk "watch list".

6.0 RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing 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 feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

6.2 Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 1 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes only.

Contingency was quantified as approximately \$10.9 Million at the P80 confidence level (28% of the baseline cost estimate). For comparison, the cost contingencies at the P50 and P100 confidence levels were quantified as 20% and 68% of the baseline cost estimate, respectively.

Table 1. Project Cost Contingency Summary

Risk Analysis Forecast	Baseline Estimate	Total Contingency^{1,2} (\$)	Total Contingency (%)
50% Confidence Level			
Project Cost	\$39,119,000	\$7,823,800	20%
80% Confidence Level			
Project Cost	\$39,119,000	\$10,953,320	28%
100% Confidence Level			
Project Cost	\$39,119,000	\$26,600,920	68%

Notes:

1) These figures combine uncertainty in the baseline cost estimates and schedule.

2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of "unknown unknowns") makes 100% confidence a theoretical impossibility.

6.2.1 Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

6.2.2 Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 1 presents a sensitivity analysis for cost growth risk from the high level cost risks identified in the risk register. Likewise, Figure 2 presents a sensitivity analysis for schedule growth risk from the high level schedule risks identified in the risk register.

6.3 Schedule and Contingency Risk Analysis

Table 2 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P100 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 31.0 months based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 1 presentation of total cost contingency. The schedule contingencies were calculated by applying the high level schedule risks identified in the risk register for each option to the durations of critical path and near critical path tasks.

The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs.

Table 2. Schedule Duration Contingency Summary

Risk Analysis Forecast	Baseline Schedule Duration (months)	Contingency ¹ (months)
50% Confidence Level		
Project Duration	620.0	24.8
80% Confidence Level		
Project Duration	620.0	31.0
100% Confidence Level		
Project Duration	620.0	49.6

Notes:
1) The schedule was not resource loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented in Table 2.
2) A P100 confidence level is an abstract concept for illustration only, as the nature of risk and uncertainty (specifically the presence of “unknown unknowns”) makes 100% confidence a theoretical impossibility.

Figure 1. Cost Sensitivity Analysis

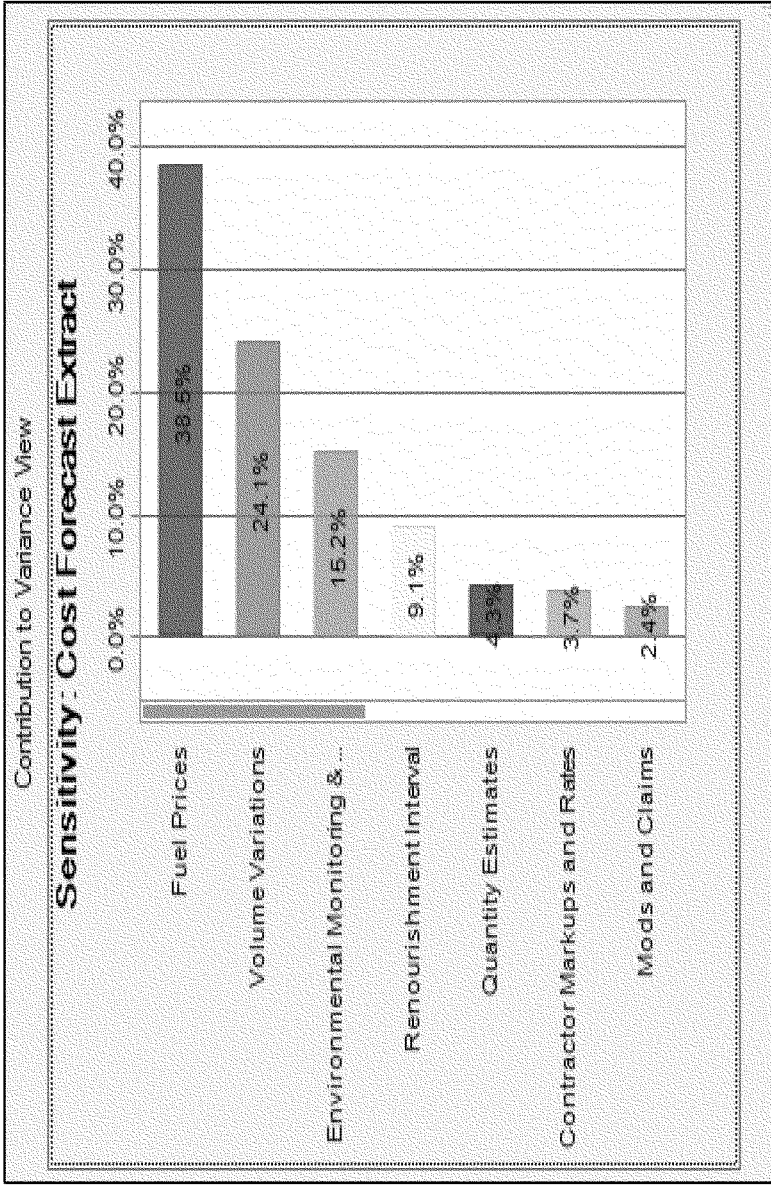
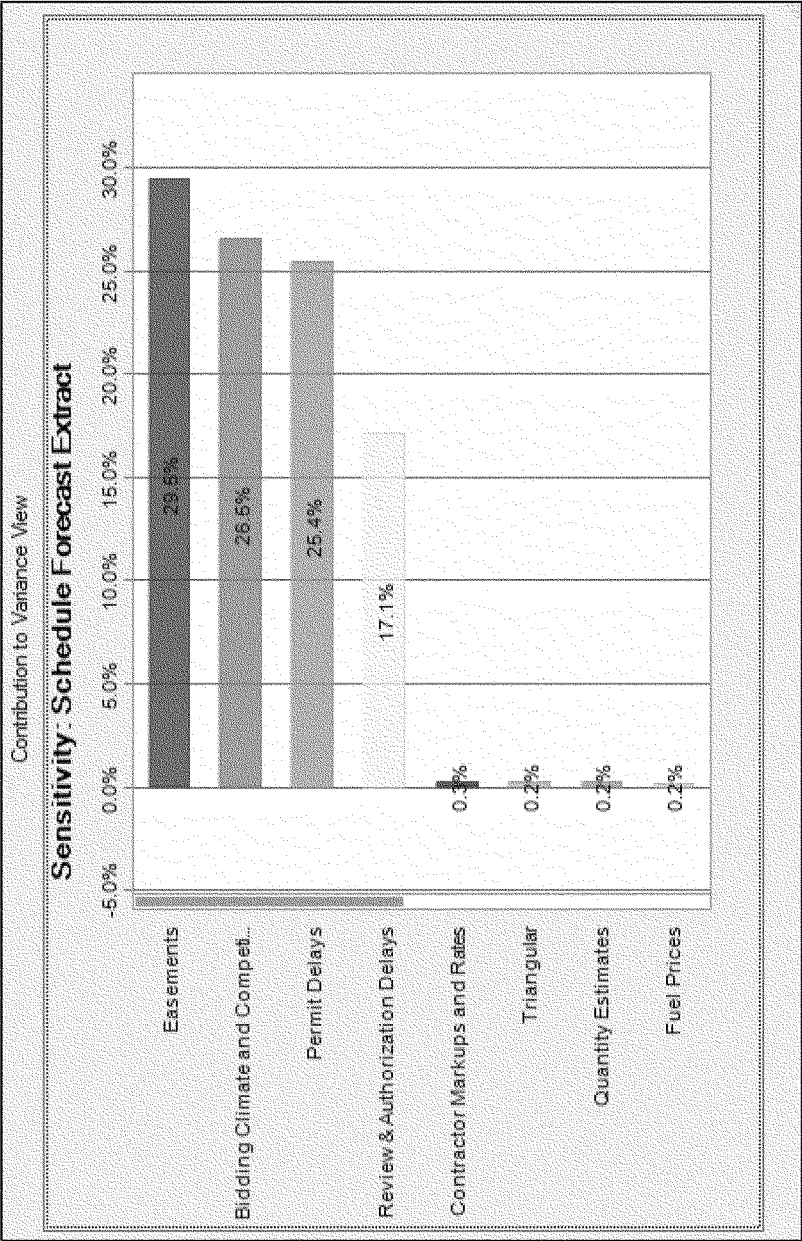


Figure 2. Schedule Sensitivity Analysis



7.0 MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1 Major Findings/Observations

Project cost comparison summaries are provided in Table 3 and Figure 3. Additional major findings and observations of the risk analysis are listed below.

1. The key cost risk drivers identified through sensitivity analysis are PR-1 (Fuel Prices), TL1 (Volume Variations), and REG2 (Environmental Monitoring & Mitigation) which together contribute over 86 percent of the statistical cost variance.
2. An additional moderate cost risk that should be closely monitored is TL2 (Periodic Nourishment Interval).
3. The key schedule risk drivers identified through sensitivity analysis are LD3 (Easements) PR1 (Bidding Climate and Competition) and REG5 (Permit Delays), which together contribute over 81 percent of the statistical schedule variance.
4. An additional moderate schedule risk that should be closely monitored is PM4 (Review & Authorization Delays).

Table 3. Project Cost Comparison Summary (Uncertainty Analysis)

Confidence Level	Project Cost (\$)	Contingency (\$)	Contingency (%)
0%	\$36,380,670	-\$2,738,330	-7%
5%	\$41,857,330	\$2,738,330	7%
10%	\$43,030,900	\$3,911,900	10%
15%	\$43,422,090	\$4,303,090	11%
20%	\$44,204,470	\$5,085,470	13%
25%	\$44,595,660	\$5,476,660	14%
30%	\$44,986,850	\$5,867,850	15%
35%	\$45,378,040	\$6,259,040	16%
40%	\$46,160,420	\$7,041,420	18%
45%	\$46,551,610	\$7,432,610	19%
50%	\$46,942,800	\$7,823,800	20%
55%	\$47,333,990	\$8,214,990	21%
60%	\$47,725,180	\$8,606,180	22%
65%	\$48,116,370	\$8,997,370	23%
70%	\$48,898,750	\$9,779,750	25%
75%	\$49,289,940	\$10,170,940	26%
80%	\$50,072,320	\$10,953,320	28%
85%	\$51,245,890	\$12,126,890	31%
90%	\$52,419,460	\$13,300,460	34%
95%	\$53,593,030	\$14,474,030	37%
100%	\$65,719,920	\$26,600,920	68%

Figure 3. Project Cost Summary (Uncertainty Analysis)

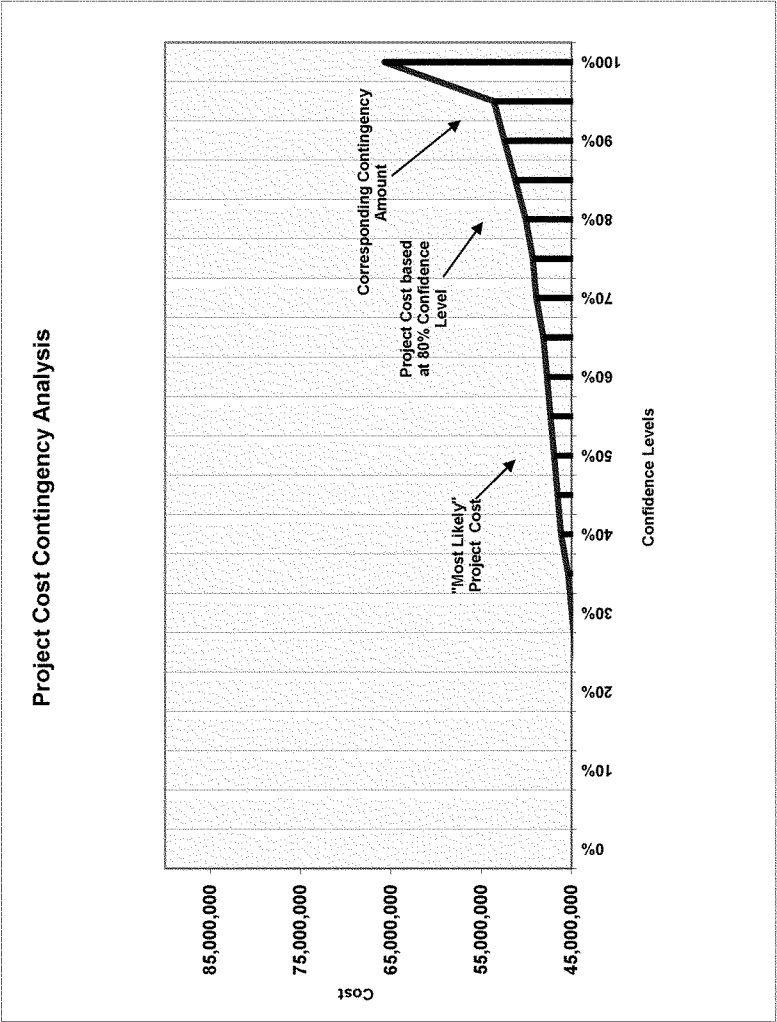
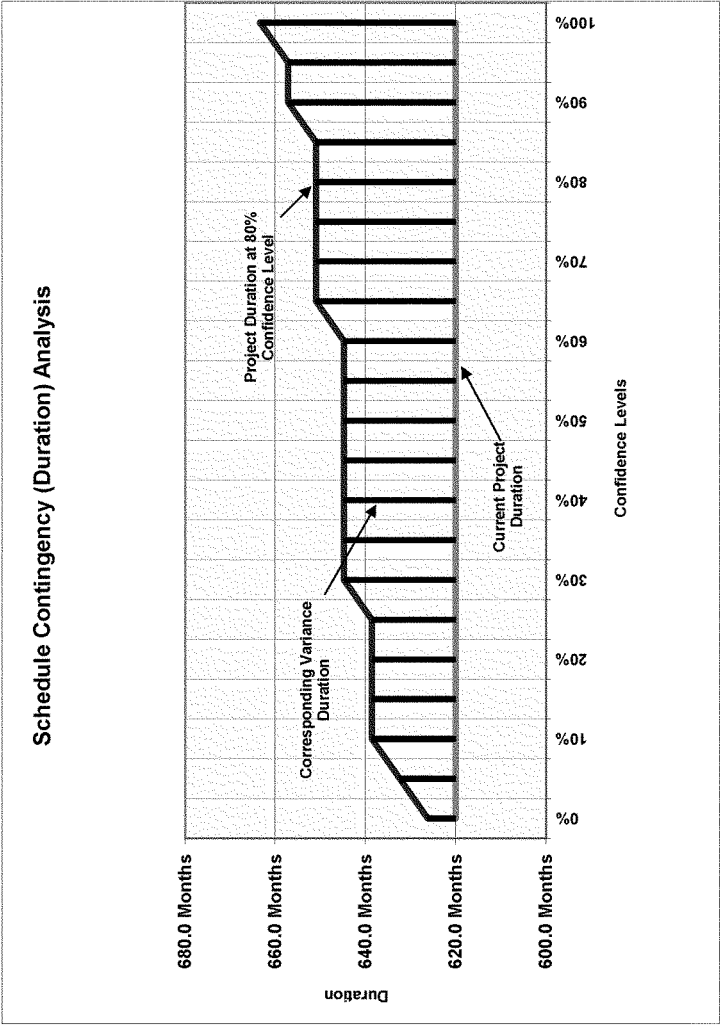


Figure 4. Project Duration Summary (Uncertainty Analysis)



7.2 Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, 4th edition, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Its outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The CSRA produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

1. Key Cost Risk Drivers: The key cost risk drivers identified through sensitivity analysis are PR-1 (Fuel Prices), TL1 (Volume Variations), ET3 (Quantity Estimates), and REG2 (Environmental Monitoring & Mitigation) which together contribute over 86 percent of the statistical cost variance.

- a) **Fuel Prices:** Naturally, fuel is an ever-fluctuating cost, and a big factor in dredging projects. While contract estimates for each nourishment would use the most-recent rates, the budget submission estimate attempts to mitigate risks by considering a 5-year average. Recently, fuel costs have been quite low, so the average does well to counter the risk of fuel rising beyond current rates between now and the end of the project life. There is not much that the team can do about fuel costs, other than keep an eye on the trends.
- b) **Volume Variations:** Erosion rates vary. The team accounts for this through historical data, averages, storm data, and modeling software like Beach-fx. Factors like heavy storms could cause variations beyond team control. The PDT will keep variation potential in mind as the project, post-authorization, progresses in order to maintain accurate volume calculations. This would be accomplished most readily via up-to-date surveys. The estimate uses the average volumes as presented in the draft Engineering Appendix.
- c) **Environmental Monitoring & Mitigation:** Monitoring and mitigation requirements as a result of hardbottom impacts could impact cost and schedule. The PDT is not expecting to trigger mitigation for this project; however, costs for mitigation

have already been explored in the alternative screenings for this project (mimicking Local Sponsor mitigation project). For monitoring, such requirements already well-known and would be incorporated into the contract. No surprises are either front are expected. Regardless, the impacts would be notable, if they occurred. The team can counter this by ensuring that mitigation is not triggered or, at least, ensure that the team is prepared to take appropriate measures are taken if mitigation is triggered.

- d) Periodic Nourishment Intervals: The Beach-fx predicted intervals could change based on future storm events which may reset the remaining project periodic nourishment requirements. Although major storm events may qualify the project for emergency FCCE funding, which would mitigate the financial impact of this risk. This is based on previous experience on other Federal Shore Protection projects along the East Coast of Florida. Weather impacts are covered under PR8 Weather in the risk register.

2. Key Schedule Risk Drivers: The key schedule risk drivers identified through sensitivity analysis are LD3 (Easements), PR1 (Bidding Climate and Competition), and REG5 (Permit Delays) which together contribute over 63 percent of the statistical schedule variance.

- a) Easements: The project does require easements/land certifications. Eminent domain, condemnation, unwillingness of property owners, etc. could cause delays for easements west of the erosion control line. However, the county has already paved a path for this project by completing their own in the recent past (2012/2013), so problems following in the established trail are not expected.
- b) Bidding Climate and Competition: Bidder interest is fairly consistent for these types of projects, especially in this area (vicinity of Ft. Pierce and Martin Co, which are well-established SAJ projects). Bidder availability is always considered in advance. The PDT will try to time construction as favorably as possible. Historically, there hasn't been a problem with projects in this area. The small size of the project may impact bidder interest, but that is something the team can better predict with pre-proposal meetings. Poor turnout could cause bidders to artificially drive up costs. Receiving no bids, though extremely unlikely, would delay the project. Competition requirements only call for two (2) bidders in order to make award and the PDT is confident that this is something that can be accomplished. Bidder availability as impacted by weather is captured under PR8 Weather.
- c) Permit Delays: Predictably, delays in permitting actions can lead to delays in the advertisement process. It is possible that a lengthy delay on future permit mods/extensions could push the construction into the following environmental window. Permitting conditions have been fairly consistent, as this is a routine project, and the team usually has advance notice of new requirements that may impact the project. As long as the team keeps abreast of requirements and

3. Risk Management: Project leadership should use the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

4. Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life-cycle. Risks should be reviewed for status and reevaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk's likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

ADDENDUM D: Total Project Cost Summary with Cost Risk Analysis, Contingency and Schedule Analysis Escalation

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: St. Lucie County CSRM
PROJECT NO P2 112359
LOCATION: St. Lucie County, FL
DISTRICT: St. Lucie County CSRM
POC: CHIEF, COST ENGINEERING, MATTHEW CUNNINGHAM
PREPARED: 10/18/2016

St. Lucie County CSRM Draft Feasibility Study and Integrated EA Report													
This Estimate reflects the scope and schedule in the report.													
Civil Works Work Breakdown Structure				ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)	
WBS NUMBER				Estimate Prepared: Effective Price Level:				Program Year (Budget CC): Effective Price Level Date:				2018 Spent Thru:	
A				11-Oct-16 1-Oct-16				1 OCT 17					
B				1-Oct-16									
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**** TOTAL PROJECT COST SUMMARY ****

PROJECT: St. Lucie County CSRM
PROJECT NO: P2 112339
LOCATION: St. Lucie County, FL

DISTRICT: SAJ District
POC: CHIEF, COST ENGINEERING, MATTHEW CUNNINGHAM

PREPARED: 10/18/2016

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)		TOTAL PROJECT COST (FULLY FUNDED)			
WBS NUMBER	Feature & Sub-Feature Description	Schedule Prepared: Effective Price Level:				Program Year (Budget Basis) Effective Price Level Date:		Spent Thru: Effective Price Level Date:			
		COST \$BOL \$	QNTG \$BOL \$	QNTG \$BOL \$	TOTAL \$BOL \$	COST \$BOL \$	QNTG \$BOL \$	TOTAL \$BOL \$	QNTG \$BOL \$	COST \$BOL \$	FULL \$BOL \$
17	Replenishment BEACH REPLENISHMENT	\$16,758	\$5,252	28.0%	\$24,010	\$19,105	\$5,349	\$24,454	\$0	\$35,130	\$44,968
01	Replenishment LANDS AND DAMAGES	\$60	\$17	28.0%	\$77	\$19,105	\$5,349	\$24,454	\$0	\$35,130	\$44,968
30	Replenishment PLANNING, ENGINEERING & DESIGN	\$4,190	\$1,173	28.0%	\$5,363	\$961	\$17	\$78	\$0	\$111	\$142
31	Replenishment CONSTRUCTION MANAGEMENT	\$2,210	\$919	28.0%	\$2,629	\$4,341	\$1,216	\$5,557	\$0	\$28,467	\$33,004
PROJECT COST TOTALS:		\$25,218	\$7,061	28.0%	\$32,279	\$25,797	\$7,223	\$33,020	\$0	\$10,069	\$12,888

FOR: CHIEF, COST ENGINEERING, MATTHEW CUNNINGHAM
ACTING CHIEF, REAL ESTATE, TORI WHITE
CHIEF, PLANNING, ERIC SUMMA
CHIEF, ENGINEERING, LAUREN BOROCHANER
CHIEF, OPERATIONS, CAROL BERNSTEIN
CHIEF, CONSTRUCTION, STEPHEN DUBA
CHIEF, CONTRACTING, TIMOTHY BLACK
CHIEF, PM-PB, GERALD GRUBB
CHIEF, DPM, TIM MURPHY

TOTAL PROJECT COST RENOURISHMENTS: \$91,900
ESTIMATED TOTAL PROJECT COST: \$91,900

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX C **Economics**



**US Army Corps
of Engineers**
Jacksonville District

1. **EXECUTIVE SUMMARY**

St. Lucie County is located on the central-east coast of Florida to the immediate south of Indian River County, and the immediate north of Martin County. Portions of St. Lucie County’s 22 mile shoreline are subject to erosion caused by both storms and natural shoreline processes. A study was undertaken to assess the feasibility of providing Federal Coastal Storm Risk Management measures to portions of the county’s shoreline. The local sponsor for this project, St. Lucie County, has indicated strong support for feasibility phase studies to address CSRM. They have also declared willingness and the capability to share applicable costs in the current study. In accordance with appropriate federal guidance, an investigation was performed to estimate the economic benefits of alleviating erosion, inundation, and wave-attack damage to coastal infrastructure.

Alternative Evaluation

Upon initiation of a preliminary screening, followed by a detailed evaluation of a final array of alternatives, the project delivery team (PDT) has determined a National Economic-Development Plan (NED) (i.e. a plan that maximizes net-benefits), and a recommended plan for reducing risks associated with coastal storm and erosion damage to infrastructure. These plans were evaluated using FY2017 price levels and the FY2017 federal water resources discount rate of 2.875%. The evaluation covered the span of a 50-year period of analysis with a base year of 2020. Alternatives were measured against the criteria of efficiency, effectiveness, and acceptability as well as being compared to the No Action Plan. Refer to **Table 1-1** for more detail on the evaluation of the final array of alternatives en route to discovering the NED. Benefit values in this table include those derived from land loss estimations and incidental recreation benefits. In order for a consistent and more accurate comparison to be made, costs for the final array of alternatives were more refined than the costs used during initial screening. Initial screening relied solely on Beach-Fx output costs (i.e. mobilization/demobilization and placement cost only, averaged over 100 iterations). The refined cost for the final array comparison, which are displayed in Table 1-1 below, took into account the defined nourishment interval, the placement cost for the estimated cubic yards to be placed for initial construction and future periodic nourishments, as well as costs incurred in non-nourishment years (e.g. monitoring).

Table 1-1: Alternative Net-Benefits & BCR’s

Alternative Name	Brief Description	Total Costs ¹ (AAEQ)	Net Benefits (AAEQ)	BCR
ABerm20DuneEx	Existing Dune and 20' sacrificial berm	\$ 1,314,927	\$ 1,650,356	2.26
ABerm30DuneEx	Existing Dune and 30' sacrificial berm	\$ 1,462,493	\$ 1,503,541	2.03
ABerm40DuneEx	Existing Dune and 40' sacrificial berm	\$ 1,627,343	\$ 1,335,742	1.82
ABERM10DuneEx	Existing Dune and 10' sacrificial berm	\$ 1,411,990	\$ 1,545,923	2.09
Dune10	10' Dune Extension	\$ 1,485,348	\$ 1,441,501	1.97
No Action	No Action	\$ 0	\$ 0	N/A

¹ ABerm20DuneEx costs in this table are certified costs. For each of the other alternatives costs were estimated based on certified cost information and information obtained from Beach-fx output files. A 28% cost contingency is included. At this point in the process OMRR&R and IDC were not included.

The plan with the highest net-benefits (NED), and the recommended plan, is the project that maintains the current dune and berm template while adding 20' of sacrificial fill (**ABerm20DuneEx**). **Table 1-2** provides a summary of the recommended plan with and without land loss and incidental recreation benefits² and the total cost includes interest during construction (IDC) as well as operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs.

Table 1-2: Economic Summary of the Recommended Plan (\$AAEQ)

ECONOMIC SUMMARY	STORM RISK MANAGEMENT BENEFITS ONLY	STORM RISK MANAGEMENT + LAND-LOSS BENEFITS (PRIMARY)	STORM RISK MANAGEMENT + LAND-LOSS + RECREATION
Price Level	FY17	FY17	FY17
FY17 Water Resources Discount Rate	2.875%	2.875%	2.875%
Storm Risk Management Benefits	\$2,165,474	\$2,165,474	\$2,165,474
Land Loss Benefits	\$0	\$234,138	\$234,138
Recreation Benefits	\$0	\$0	\$565,671
Total Benefits	\$2,165,474	\$2,399,612	\$2,965,283
Total Cost ³	\$1,348,623	\$1,348,623	\$1,348,623
Net-Benefits	\$816,851	\$1,050,989	\$1,616,660
Benefit Cost Ratio	1.61	1.78	2.20

² Unlike incidental recreation benefits, land loss benefits are considered primary benefits in CSRM studies. Both benefit categories are discussed in detail in sections 4.1 and 4.2.

³ This cost includes IDC and OMRR&R

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1. **INTRODUCTION**

The purpose of this appendix is to tell the story of the economics investigation and resulting analysis. A detailed explanation of the qualitative rigor and the precise modeling efforts, from inputs to outputs, which gave rise to the recommended plan will be provided. The subsequent sections will cover the following topics:

- ✦ **Existing Conditions:** Items discussed include an assessment of socio-economic conditions, spatial organization of the study area, and an inventory of the coastal infrastructure within the study area.
- ✦ **Future Without-project Condition (FWOP):** The FWOP is a forecast of the economic conditions and structure values located within the project area that are subject to the risks associated with coastal processes and coastal storms. The FWOP is the basis for alternative comparison in order to obtain the benefits from any potential federal project.
- ✦ **Coastal Storm Risk Management (CSRM) Benefits:** This section will cover the methods and assumptions used to estimate the future without-project and future with-project condition using Beach-fx, while also accounting for risk and uncertainty. The FWOP will cover the distribution of the damages in the following dimensions:
 - ✦ Spatial (Where)
 - ✦ Categorization of structures (What)
 - ✦ Damage driving parameter (How)
 - ✦ Temporal (When)

Discussion of the future-with project condition (FWP) will address the management measures and alternative plans evaluated. In addition, a sensitivity analysis of how the alternatives perform under varying sea-level rise scenarios is provided.

- ✦ **NED & Recommended Plan Selection and Performance:** This section addresses the quantitative analysis executed to determine which alternative maximizes NED and which alternative will be the recommended plan. A detailed description of the performance of the NED plan, including certified cost estimates, is provided with the same four dimensions described above in the CSRM section. The methodology underpinning the calculation of additional benefits provided by the project (i.e. land loss benefits, incidental recreation benefits) will be summarized as well.

2. **EXISTING CONDITIONS**

A key step in the planning process is to establish the existing (i.e. current) condition by developing an inventory and characterizing the critical resources within the project area. The existing condition is also a key component for forecasting the FWOP, which is described in detail in **Section 3.3**.

2.1 **Socio-Economic Conditions**

St. Lucie County is located in the central-east region of Florida and has approximately twenty-two miles of coastline along the Atlantic Ocean. The cities comprising the county are Ft. Pierce, Port St. Lucie and the communities of Hutchinson Island and St. Lucie Village. It is also one of four counties included in the Research Coast Economic Development Coalition⁴.

2.1.1 **Demographic Characteristics**⁵

According to the US Census Bureau, the 2010 population of St. Lucie County was 277,789 with a land area of 571.93 square miles. Over the past several years, the county has seen rapid population growth. Between 2000 and 2010 the county grew by approximately 44%. Since then, the population has grown by 4.8% to reach an estimated 291,028 in July of 2014.

The ethnic makeup of St. Lucie County is relatively homogeneous. Caucasians make up approximately 71.8% of the population. The largest minority group is African American, which make up approximately 19.1%. All other racial groups comprise less than 10% of the total population. The median age for residents is 43.3 and those aged 60 years and over represent 27.4% of the population. Overall, St. Lucie County is largely an adult population with those aged 18 years and older at 77.7%.

2.1.2 **Economic Characteristics**

With several notable attractions located within its borders tourism is a critical component of the economy. St. Lucie County is a premier recreational fishing destination with a variety of species available for catch. Notably, the International Game Fish Association (IGFA) reports the record-setting spotted sea trout catch occurred within county waters (17 lbs. 7 oz., Ft. Pierce). In addition to the miles of pristine beaches and nature reserves, the county's Tradition Field is also host to the New York Mets Major League Baseball team for the entirety of spring training. As a result of this influx of tourists St. Lucie County has over 6,000 jobs in the service industry⁶.

Additionally, agriculture, manufacturing and health care are all important drivers of economic activity in St. Lucie. According to the United States Department of Agriculture, the county has more than 75,000

⁴ For more information see *Research Coast Representatives Promote Region for Business*. Vero News. December 7, 2015

⁵ All figures from this section are from source: United States Census Bureau, American Fact Finder. Unless otherwise specified, data references 2010 Census.

⁶ Source: St. Lucie Economic Development Council

acres of crop land between grapes, citrus, and oranges alone⁷. Manufacturing accounts for 1,870 jobs and health care an additional 2,890⁶.

The income trends within St. Lucie County are very similar to that of the state of Florida overall. The following is a summary of those trends from the most recent year available (2014)⁸:

- ✦ Median Household Income: \$42,665
- ✦ Per Capita Income: \$23,422
- ✦ Individuals Below Poverty Line: 14.2%
- ✦ Unemployment Rate: 7.5%
- ✦ Individuals Receiving Social Security Income: 42.2%
- ✦ Individuals with Retirement Income: 22.8%

2.2 Study Area

The initial study area ranged from the Florida Department of Environmental Protection (FDEP) range monument (R) R-077 to the Martin County Line (R-001). Four study reaches were established within the 7.2 mile span of coastline: The Power Plant, North Hutchinson Island, Narrows of Hutchinson Island, and South Hutchinson Island. Preliminary modeling indicated that the federal project should focus exclusively on the South Hutchinson Island reach due to its erosive nature and dense development. Though the power plant represented a potential risk for damages, heavy existing fortification suggested further measures would prove redundant. As a result, the project area was refined to begin at R-98.5 and end at the Martin County line (R001) as displayed in **Figure 2-1**. All benefit and cost analysis performed and described in this appendix refer specifically to this project area⁹.

⁷ Source: CropScape – USDA National Agricultural Statistics Service

⁸ Source: Us Census Fact Finder 2014

⁹ The model reaches used to encompass this area are R-099 to R-115 which is explained more in Section 2.3.

foundation type, construction type, width, length, number of floors, depreciated replacement value, and year built.

The St. Lucie County study area consists of seven profiles, 15 model reaches, and 59 lots for economic modeling and reporting purposes. This hierarchical structure is depicted as follows:

- ✦ **Profiles:** Coastal surveys of the shoreline modified by USACE SAI Coastal Engineering personnel to apply coastal morphology changes to the model reach level. Profiles are strictly used for modeling purposes and only referred to in this section for informational purposes. Specific information regarding the makeup of the profiles can be found in the Engineering Appendix of this report.
- ✦ **Beach-Fx Model Reaches:** Quadrilaterals parallel with the shoreline used to incorporate coastal morphology changes for transfer to the lot level. In this study the model reaches use Florida Department of Environmental Protection (FDEP) range monuments. As mentioned above, the true length of the project is from R-98.5 to R-001 and is approximately 3.25 miles long. The Beach-fx model reaches incorporate that same 3.25 mile span but are labeled as R-99 to R-115 and will be referred to simply as “reaches” throughout this appendix. Each model reach is approximately 1,000’ in length with the exception of R-115, which includes an additional 1,000’ to the Martin County line. **Figure 2-1** above displays these reaches in the project area.
- ✦ **Lots:** Quadrilaterals encapsulated within reaches used to transfer the effect of coastal morphology changes to the damage element. Lots also ensure that the model does not overstate damages by placing value parameters around rebuilding (this is discussed further in section 3.2.2).
- ✦ **Damage Elements:** Represent a unit of coastal inventory in the existing condition and a store of economic value subject to losses from wave-attack, inundation, and erosion damages. Damage elements are a primary model input and the topic of focus in the following section.

2.4 Existing Condition Coastal Structure Inventory

Information on the existing economic conditions along the St. Lucie County coastline was collected for economic modeling purposes. The information on the coastal assets detailed in this section was collected from St. Lucie County mapping resources, site visits, and contractors. Each parcel along the beach was identified as developed or undeveloped, with streets and parks noted. USACE real estate specialists provided depreciated replacement value of existing structures within the study area.

2.4.1 Structure & Contents Value

The economic value of the existing St. Lucie County structure inventory represents the depreciated replacement costs of damageable structures (i.e. damage elements) and their associated contents along the coastline. Real Estate professionals from the USACE SAI district worked together with economists and planners to provide economic valuations for all of the 236 damageable structures and their contents. These damage elements have an overall estimated value of \$669.3M, with structure and content valuations of \$579M and \$91M respectively. Content values were established as a ratio to overall structure value. When applicable, content-to-structure ratios were based off the USACE final report “Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVR) in Support of the Donaldsonville to the Gulf, Louisiana, Feasibility Study”. For example, the ratios for one- and two-story residences from the study were used for St. Lucie properties (i.e. 70% and 67% respectively). However, the study did not contain any high-rise structures and therefore those ratios

were determined by SAI economists based on available information from St. Lucie County and best professional judgment. Since high-rise buildings would receive minimal damage above the second floor the CSVr was conservatively estimated at 14%. Many items in the structure inventory had a CSVr of 0% (e.g. roads, dunewalks, parking lots). As a result, the average CSVr across the entire study area is roughly 16%. The overall distribution of value by reach is summarized in **Table 2-1**.

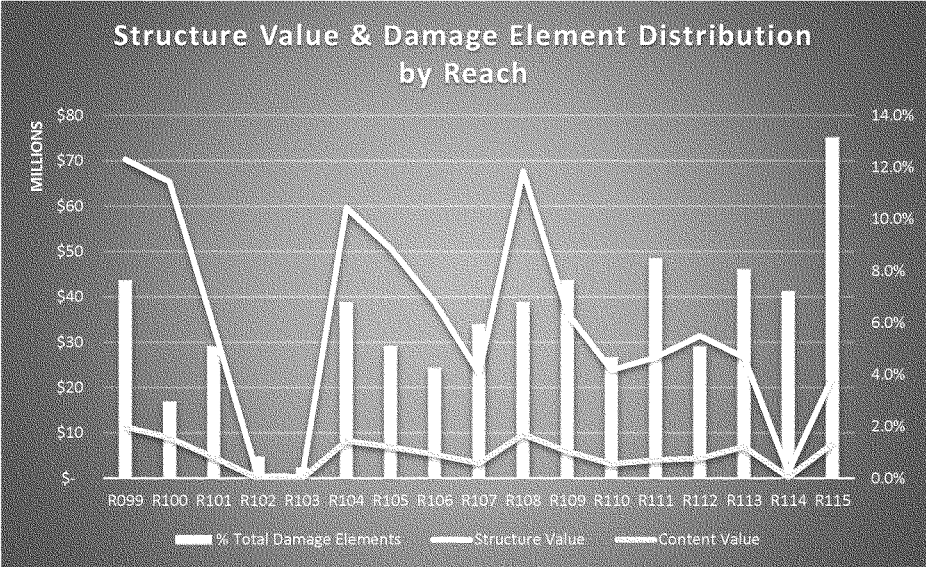
Table 2-1: Distribution of Structures & Structure Value by Study Reach

Reach	Structure Value	Content Value	% Total Value	# Damage Elements	% Total Damage Elements
Reach	Structure Value	Content Value	% Total Value	# Damage Elements	% Total Damage Elements
R099	\$ 70,328,170	\$ 11,335,909	12.2%	18	7.6%
R100	\$ 65,393,015	\$ 8,938,156	11.1%	7	3.0%
R101	\$ 33,292,909	\$ 4,583,021	5.7%	12	5.1%
R102	\$ 510,685	\$ 0	0.1%	2	0.8%
R103	\$ 382,169	\$ 0	0.1%	1	0.4%
R104	\$ 59,638,936	\$ 8,233,070	10.1%	16	6.8%
R105	\$ 50,671,441	\$ 6,935,733	8.6%	12	5.1%
R106	\$ 38,827,604	\$ 5,262,028	6.6%	10	4.2%
R107	\$ 23,131,259	\$ 3,342,885	4.0%	14	5.9%
R108	\$ 67,674,190	\$ 9,683,231	11.6%	16	6.8%
R109	\$ 36,383,413	\$ 5,941,502	6.3%	18	7.6%
R110	\$ 23,862,725	\$ 3,165,472	4.0%	11	4.7%
R111	\$ 26,672,082	\$ 4,018,670	4.6%	20	8.5%
R112	\$ 31,434,922	\$ 4,406,246	5.4%	12	5.1%
R113	\$ 26,669,670	\$ 6,969,432	5.0%	19	8.1%
R114	\$ 1,393,215	\$ 217,112	0.2%	17	7.2%
R115	\$ 22,365,140	\$ 7,626,235	4.5%	31	13.1%

Despite the relatively uniform distribution of damage element count, the values aggregated by reach show significant variation, with four of the reaches (R099, R100, R104, R108) accounting for approximately 45% of total value. The variation is due mainly to differentiation between the types of development within the reach. Specifically, reaches with large commercial structures, such as R113 and R115 with Turtle Reef and Villa Del Sol condominium complexes, tend to contain greater value than neighboring reaches, such as R102-R103 which is a public conservation area. For modeling and reporting

purposes the structure inventory was separated into four different structure types. Table 2-2 provides a summary of these structure types and the associated inventory values¹¹.

Figure 2-2: Structure Value & Damage Element Distribution by Reach¹²



¹¹ Some of the high-rise structures and other condominiums in the project area are used for commercial activity and many are residential. For economic modeling purposes the delineation between commercial and residential may differ from that of SAJ real estate appendices. However, the total values of the structures do not vary and thus represent the same inventory. Most condos and high-rises were deemed commercial for damage aggregation.

¹² The percent score on the right axis corresponds with the damage element count, not the damage element dollar value.

Table 2-2: Economic Value of Structure Inventory by Structure Type

Structure Type	Structure Value	Contents Value	Total	% of Total	Structure Count
Commercial	\$ 557,424,139.88	\$ 90,315,788.35	\$ 647,739,928.23	96.78%	59
Other	\$ 10,995,345.80	\$ 52,780.90	\$ 11,048,126.70	1.65%	115
Public	\$ 9,806,054.90	\$ 18,109.24	\$ 9,824,164.14	1.47%	61
Residential	\$ 406,004.17	\$ 272,022.79	\$ 678,026.96	0.10%	1
Grand Total	\$ 578,631,544.75	\$ 90,658,701.28	\$ 669,290,246.03	100%	236

2.4.2 Evacuation Route

The residents of South Hutchinson Island rely heavily on Florida State Road A1A as a means to evacuate during extreme hurricane events. Additionally, A1A provides residents with access to, and from, critical infrastructure and services located on the mainland such as fire departments, police departments, and hospitals. The project area impacts 3.25 miles of A1A since it parallels the coastline throughout South Hutchinson Island. A1A connects residents to the mainland via Northeast Causeway Boulevard to the south and Seaway Drive to the north. Any obstruction to A1A in the southern reaches that blocks access to Northeast Causeway Boulevard would result in traffic needing to be rerouted approximately 16 miles north to Seaway Drive. All of the nearest hospital services, which are located on the mainland, require clear access to A1A. An analysis of flood concerns impacting A1A and how a project ameliorates these effects will be discussed in subsequent sections.

3. COASTAL STORM RISK MANAGEMENT BENEFITS

This section of the appendix covers the approach used to estimate the economic benefits of reducing hurricane and storm related damages in St. Lucie County using Beach-fx. The topics covered include:

- ✦ Benefit Estimation Approach Using Beach-fx
- ✦ FWOP Condition
- ✦ The Future-With Project Condition (FWP)

3.1 Benefit Estimation Approach Using Beach-fx

Beach-fx was developed by the USACE Engineering Research and Development Center in Vicksburg, Mississippi. On April 1, 2009 the Model Certification Headquarters Panel certified the Beach-fx CSRM model based on recommendations from the Planning Center of Expertise (PCX) and in accordance with EC 1105-2-412 (Assuring Quality of Planning Models). The model was reviewed by the PCX for Coastal and Storm Damage and found to be appropriate for use in CSRM studies and is therefore the optimum model for use in the St. Lucie CSRM Study. The model links the predictive capability of coastal evolution modeling with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the costs and total damages under various shore protection alternatives. The output generated from the model is then used to determine the benefits of each alternative. As an event-based Monte Carlo life-cycle simulation, Beach-fx fully incorporates risk and

uncertainty. It is used to simulate future hurricane and storm damages at existing and future years and to compute accumulated present-worth damages and costs. Storm damage is defined as the ongoing monetary loss to contents and structures incurred as a direct result of waves, erosion, and inundation caused by a storm of a given magnitude and probability. The model also computes permanent shoreline reductions so that land-loss benefits can be derived exogenously. These damages and associated costs are calculated over a 50-year period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Beach-fx also provides the capability to estimate the costs of certain future measures undertaken by state and local organizations to protect coastal assets. Based on these attributes, Beach-fx is an ideal modeling tool for use in the St. Lucie CSRSM study.

Of course, the abovementioned computations require inputs from USACE personnel in order to function accurately. Data on historic storms, beach survey profiles, and private, commercial and public structures within the project area are used as these inputs. Refer to sections 2.2 and 2.4 for detailed information on key input data specific to St. Lucie County.

The future structure inventory and values are the same as the existing condition. This conservative approach neglects any increase in value accrued from future development. Though Florida has historically experienced increases in density and value in real-dollar terms, using the existing inventory is considered preferable due to the uncertainty involved in projections of future development.

The FWOP damages are used as the base condition and potential project alternatives are measured against this base. The difference between FWOP and FWP damages will be used to determine primary CSRSM benefits.

Once benefits for each of the project alternatives are calculated, they will be compared to the costs of implementing the alternative. Dividing the total benefits by the total costs of the alternative yields a benefit-to-cost ratio (BCR). This ratio must be greater than 1.0 (i.e. the benefits must be greater than the costs) in order for the alternative to be justified and implementable. The federally preferred plan, or NED, is the plan that maximizes net benefits. Net benefits are determined by simply subtracting the cost of any given alternative from the benefits of that alternative (*Benefits – Costs = Net Benefits*).

3.2 Assumptions

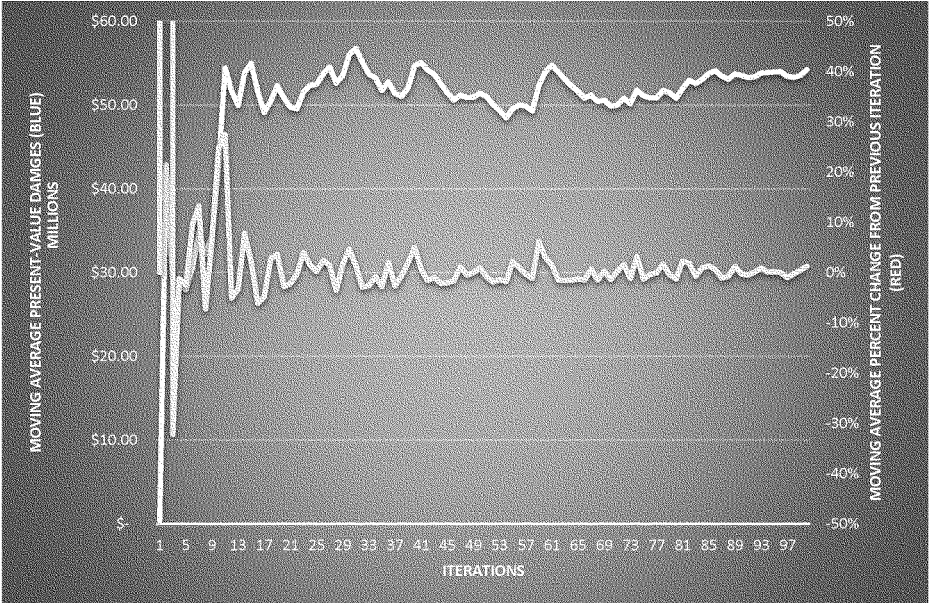
Beach-fx accuracy is not only dependent upon inputs but also requires a meticulous level of thought be given to the parameters (i.e. assumptions) under which the model is bound. This section describes some key assumptions specific to the St. Lucie County CSRSM study and the resulting consequences.

3.2.1 Timeframe and Discount Rate

- ✦ **Start Year:** The year in which the simulation begins is 2019. This year determines the starting shoreline position which will be impacted by standard erosion and storm forces throughout the period of analysis. It is also the starting point for the sea-level rise projections.
- ✦ **Base Year:** The year in which the benefits of a constructed federal project would be expected to begin accruing is 2020.
- ✦ **Period of Analysis:** 50 years, from 2020 to 2069.
- ✦ **Discount Rate:** 2.875% FY2017 Federal Water Resources Discount Rate
- ✦ **Iterations:** Beach-fx was run using 100 iterations. The moving average of FWOP damages stabilized by this point and was thus determined an adequate number of iterations. **Figure 3-1** demonstrates the model stabilizing since the moving average does not vary by more than three percent after the

61 iteration. A sensitivity was conducted using the base FWOP condition and a 100 iteration run was compared to a 300 iteration run. Again, the moving average stabilizes around the 61 iteration but the standard error of the mean is reduced from \$191,000 (AAEQ) to \$110,000 (AAEQ) in the 300 iteration run without significant variation in the moving average of damages (\$2,197,692 in the 100 iteration run VS \$2,121,637 AAEQ in the 300 iteration run, a decrease of 3.5%). Given the numerous alternatives to be run and the time necessary for each model run, it was determined that 100 iterations was a sufficient balance of stabilization of the model and time required for all runs to be completed.

Figure 3-1: Model Stabilization



3.2.2 Rebuilding

The rebuilding parameter within Beach-fx allows the economic modelers to restrict the amount of monetary investment allocated to structural repair for any specific building type in order to most accurately reflect real-world behavior. Rebuilding does not refer to a total rebuild event (i.e. 100% of structure value), but rather a repair event (i.e. some non-zero percent of value intended to restore the structure). Allowing for an unlimited amount of rebuilding in the period of analysis may be unrealistic for a CSRM study and can potentially overstate damages in the FWOP. However, issuing emergency permits for rebuilding on lots meeting a minimal setback restriction is generally the rule, not the exception in Florida. Common practice and historical evidence also show that rebuilding lost structures, provided

setback restrictions are met, occurs frequently¹³. Additionally, county records dating back to 1994 demonstrate that there have been no known rejections to rebuilding requests. As a result, the number of rebuilds within the model has been limited to reflect this behavior as follows:

✦ Number of Times Rebuilding Allowed Assumptions

- ✦ Public Access Structures¹⁴: 124X
- ✦ Commercial Recreation Facilities¹⁵: 62X
- ✦ Remaining: 31X

Additionally, after long-term erosion has claimed more distance on the oceanfront lot than the building requires, the model ceases to reinstate the same property. The model also considers a lot “condemned” once 50%¹⁶ of the total value of that lot is damaged. There is also a control feature that allows an individual damage element to become condemned once 50% of the original structure value has been damaged at which point the damage element undergoes a “time to rebuild” period where no additional damages can accrue. These assumptions will continue to prevent overestimation of the FWOP damages while allowing for realistic rebuilding to occur.

One concern for having a high number of rebuilds is that there may be many high-value repair events (i.e. rebuilds that cause more than 50% of the structure’s value to be accrued as damage in a single event) that occur throughout the period of analysis which may overstate damages. On the opposite end, restricting rebuilds too low may exclude many of the lower-value repair events (i.e. rebuilds that cause less than 50% of the structure’s value to be accrued as damage in a single event) that occur throughout the period of analysis which may not adequately capture expected damages. A sensitivity analysis was conducted during the modeling efforts for the St. Lucie CSRM in order to gauge the impact of this rebuilding assumption. The damage element type that was the greatest driver of damages, “BUILDING-1¹⁷”, was used to test the sensitivity. Using rebuilding assumptions of 10, 15, 25, 31, and unlimited (999), a frequency distribution was obtained to gauge how a change in rebuilding shifts the proportion of rebuilds from high-value rebuilds to low-value rebuilds. The result of the sensitivity demonstrates that a change in the number of rebuilds for “Building-1” has a negligible effect on the proportion of high-value to low-value rebuilds. The only noticeable effect is a slight increase in the proportion of low-value repair events and a decrease in the proportion of high-value repair events (see **Table 3-1** and **Figure 3-2**).

¹³ Reference Florida Office of General Counsel order 12-1453 and 12-1264 as examples.

¹⁴ Examples of public access structures include dune walks, shelters, guard shacks and roads.

¹⁵ Examples of commercial recreation facilities include pools, parking areas, and tennis courts.

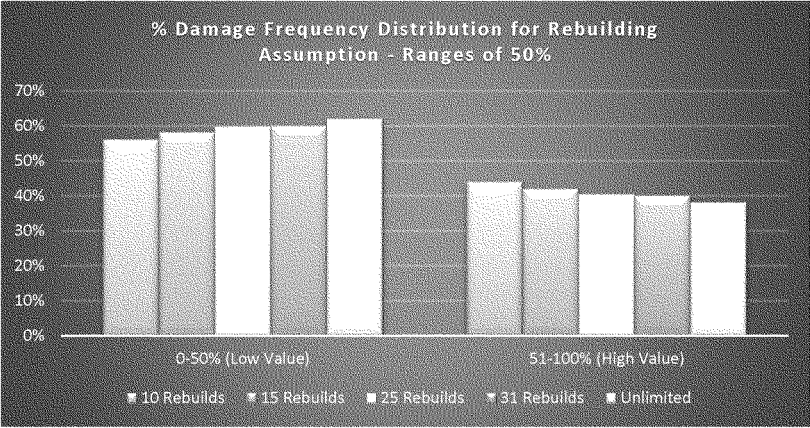
¹⁶ This amount, the lot condemnation ratio, can be manipulated within the model as needed but is set to 50% for this study

¹⁷ These damage elements are composed of various structures with slab-on-grade foundations. For the frequency distribution only the damage elements that had at least, on average, one rebuild across all iterations were included.

Table 3-1: Proportion of Damages Based on Rebuild Assumption

Damage Range (% of Initial Structure Value)	10 Rebuilds	15 Rebuilds	25 Rebuilds	31 Rebuilds	Unlimited
0-50% (Low Value)	56%	58%	60%	60%	62%
51-100% (High Value)	44%	42%	40%	40%	38%

Figure 3-2: Damage Frequency for Rebuilding Assumption – Ranges of 50%



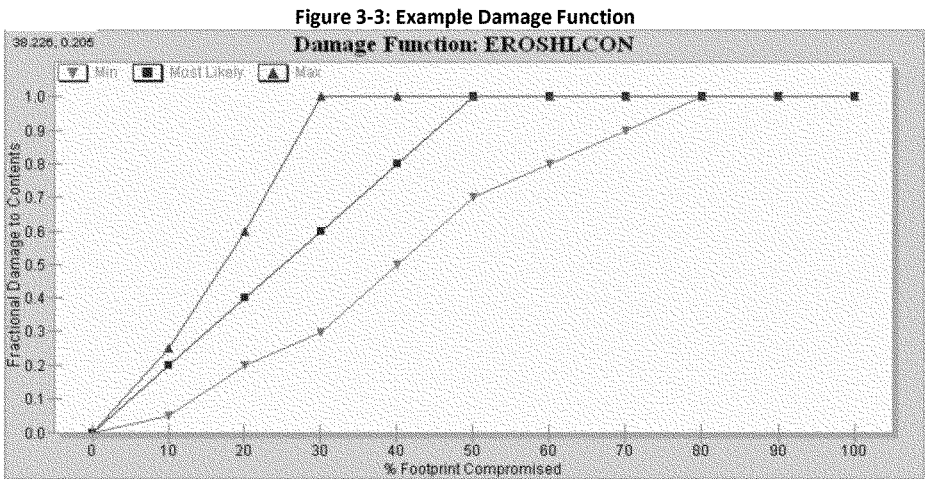
The proportion of damages doesn't tell the whole story, though, so the sensitivity analysis was also used to review the absolute rebuild count across all of the iterations and across the 50-year period of analysis. When reviewing the rebuild assumption in this manner, there is a more noticeable impact as the number of rebuilds increases. From the 15 rebuild assumption to the 25 rebuild assumption the average number of rebuilds per year nearly doubles from .86 to 1.67. See **Table 3-2** for complete results. It is important to note, though, that this is the average rebuilds per year for all "BUILDING-1" damage elements which includes 21 different structures across the St. Lucie shoreline. So, given the current model assumption of 31 rebuilds, all "BUILDING-1" structures have an 8.7% chance of incurring a repair event in any given year and a 3.5% chance that the repair event will be greater than 50% of initial structure value.

Table 3-2: Average Rebuilds Per Year Given Different Rebuilding Assumptions

	10 Rebuilds	15 Rebuilds	25 Rebuilds	31 Rebuilds	Unlimited Rebuilds
Total Average Rebuilds Per Year	0.95	0.86	1.67	1.84	3.69
0-50% (Low Value)	0.53	0.50	1.00	1.10	2.29
51-100% (High Value)	0.42	0.36	0.67	0.74	1.40

3.2.3 Damage Functions

Damage functions are used within the model to determine the extent of storm-induced damages attributable to any specific combination of damage element type, foundation type, and construction type. There are a total of six types of damage function which include erosion damages, inundation damages, and wave damages for both contents and structure. The functions are completely user-definable within the model and transfer damages to the individual damage elements. Damage is determined as a percentage of overall structure or content value using a triangular distribution (minimum, most likely, maximum). The range of percentage points used for the damage is determined by parameters dependent upon which function is being triggered. For erosion it is dependent upon the extent to which the structure's footprint has been compromised and inundation and wave-attack are dependent upon storm-surge heights in excess of first-floor elevation. An example diagram of how these damage functions operate is provided by **Figure 3-3**.



For the vast majority of aforementioned combinations within this study the damage functions used were those developed by the Institute for Water Resources (IWR), within the Coastal Storm Damage Workshop (CSDW), Coastal Storm Damage Relationships Based on Expert Opinion Elicitation in 2002. However, the various high-rise buildings located within the project area proved to be the exception since the IWR wave-damage function did not adequately address these structures¹⁸. Research to review damages associated with wave-attack to high-rise buildings was conducted and two sources were the focus for basing a new damage function. The first source considered was the Federal Emergency Management Agency's (FEMA) Mitigation Assessment Team Report (MAT) on Hurricane Sandy. Section

¹⁸ Preliminary model runs were demonstrating massive damages (i.e. 100% of structure value) to high-rise buildings despite evidence of performance to the contrary.

4.2 of the FEMA Sandy MAT focused specifically on the structural performance of high-rise buildings and indicated that “Most of the high-rise buildings visited by the MAT had no structural damage...[and] physical damage observed was limited to the collapse of nonstructural concrete block partition walls in basements.” These partition walls experienced damage due to inundation loads and not wave attack. Additionally, a look into FEMA’s MAT on Hurricane Katrina documents similar structural soundness in the presence of wave attack. Section 4.1.5 similarly focuses on high-rise building performance and indicates that, due to the lack of erosion experienced, “the foundation stability of the large buildings was not affected...[and] although sited near the shoreline and experiencing the worst flood conditions, the high-rises were some of the better examples of successes”. Based on these observations it was conservatively assumed that wave-attack damages would likely only affect the lower floors. As a result, the high-rise structures were separated into three categories:

- ✦ HIGHRISE1: Maximum of 6-10 floors
- ✦ HIGHRISE2: Maximum of 11-14 floors
- ✦ HIGHRISE3: Maximum of 16-20 floors

Once separated, a relationship between the structure value and maximum number of floors was established to create the triangular distribution of values for the model to more accurately calculate wave-attack damages.

3.2.4 Coastal Armoring

Beach-fx allows for assumptions surrounding coastal armoring (e.g. sandbags, breakwaters, seawalls) as well. A user can define the different types of armoring applied to individual damage elements as well as a distance trigger, applied at the lot level, which will prompt construction of said armor. However, in St. Lucie County the use of armoring is prohibited and is therefore omitted from the model.

3.3 **Future without Project Condition (FWOP)**

Descriptive statistics on the damages per the FWOP model results are as follows:

- ✦ Mean: \$2,197,692 (AAEQ)
- ✦ Standard deviation: \$1,909,139 (AAEQ)
- ✦ Coefficient of Variance: .869
- ✦ Median: \$1,846,128 (AAEQ)

The nearness in value between the mean and standard deviation indicates some volatility of the FWOP damage incurred in the project area throughout the 100 iterations. This volatility is due to the fact that damages are primarily driven by storm occurrence and severity rather than annual erosion rates. In short, St. Lucie County’s shoreline structures are highly susceptible to storm damage in the FWOP. Pursuant to estimating FWOP damages and associated costs for the study area in St. Lucie County, Beach-fx was used to estimate damages and costs in the following categories:

- ✦ Damages:

- ❏ **Structure Damage:** Economic losses resulting from the structures situated along the coastline being exposed to wave attack, inundation, and erosion damages. Structure damages account for 71% of the damages for the FWOP.
- ❏ **Contents Damage:** The material items housed within the structures (usually air-conditioned and enclosed) that are potentially subject to damage. Content damages are 29% of the total damages.

3.3.1 Damage Distribution by Structure Category and Type

This section addresses what is being damaged in the FWOP by structure category and type. The coastal inventory was categorized as 'Commercial', 'Public Access & Recreation', and 'Residential'. **Table 3-3** provides greater detail on the type of structures within each category as well as the composition of the FWOP damages within those categories. The distribution of the damages by category is as follows:

- ❏ Commercial: 88%
- ❏ Public Access & Recreation Structures: 12%
- ❏ Residential: >1%

Table 3-3: Distribution of Damages by Damage Category

Category	Type	Structure	Contents	Total	% of Total
Commercial	BUILDING-1	\$ 1,250,403	\$ 638,991	\$ 1,889,395	85.97%
	COMM-1	\$ 342	\$ 127	\$ 469	0.02%
	HIGHRISE-1	\$ 9,828	\$ 1,425	\$ 11,253	0.51%
	HIGHRISE-2	\$ 17,080	\$ 2,447	\$ 19,527	0.89%
	HIGHRISE-3	\$ 19,390	\$ 2,423	\$ 21,813	0.99%
Commercial Subtotal		\$ 1,297,044	\$ 645,413	\$ 1,942,457	88.39%
Public Access & Recreation Structures	DECK	\$ 9,700	\$ -	\$ 9,700	0.44%
	DUNEWALK	\$ 173,882	\$ -	\$ 173,882	7.91%
	GARAGE	\$ 503	\$ 378	\$ 882	0.04%
	GARAGE-U	\$ 639	\$ 320	\$ 959	0.04%
	GUARDSHACK	\$ 192	\$ 27	\$ 219	0.01%
	PARKING	\$ 16,019	\$ -	\$ 16,019	0.73%
	PATIO	\$ 19	\$ -	\$ 19	0.00%
	POOL	\$ 38,979	\$ -	\$ 38,979	1.77%
	POOLHEATER	\$ 19	\$ -	\$ 19	0.00%
	PUBLIC-1	\$ 21	\$ 3	\$ 24	0.00%
	SHELTER	\$ 13,716	\$ -	\$ 13,716	0.62%
	STORAGE	\$ 30	\$ 19	\$ 49	0.00%
	ROAD-1	\$ -	\$ -	\$ -	0.00%

	TENNIS	\$ 7	\$ -	\$ 7	0.00%
PA & Rec Subtotal		\$ 253,728	\$ 747	\$ 254,475	11.58%
Residential	SFR-3	\$ 455	\$ 305	\$ 760	0.03%
Residential Subtotal		\$ 455	\$ 305	\$ 760	0.03%
GRAND TOTAL		\$ 1,551,227	\$ 646,465	\$ 2,197,692	100%

3.3.1.1 Commercial

The St. Lucie shoreline is dotted with various commercial real estate subject to damage. The structures are primarily condominium complexes or large hotels and represent almost 90% of all the damages in the FWOP. Again, some of these condominiums may be used primarily as permanent residences and thus deemed residential in real estate appendices. However, for purposes of economic damage aggregation the delineation between condominiums was not made and they are deemed commercial.

3.3.1.2 Residential

The only type of residential structure in the project area is the three-story single-family residence (SFR-3 in **Table 3-3**). The damage incurred to these structures is minimal and makes up less than one-percent of overall damages.

3.3.1.3 Public Access and Recreation Structures

A public access structure refers to those that provide the general public with safe access to beaches and shorelines throughout St. Lucie County which include, but are not limited to, roads, dune walks, public shower and bathroom facilities, and life-guard stations. A recreation structure refers to items such as pools, patios and tennis courts.

3.3.2 Spatial Distribution of Without Project Damages

FWOP damages really spike in the southern portion of St. Lucie's shoreline. Reaches R-113 and R-115 make up around 83% of the damages, while the remainder are relatively evenly distributed; R-098 and R-100 to R-103 are the only reaches that account for less than one-percent of damages each. R-115 accounts for the lion's share of total damage at 65% due in large part to several groups of valuable condominium complexes situated very near the dune that are on slab foundations instead of deep-pile. Structures on slab foundation are far more susceptible to damages from erosion than those with a deep-pile foundation and their location in the nearshore further compounds the damage risk. The spatial damage results are summarized in **Figure 3-4**. The concentration of damages in the southern section was a focal point for the PDT and resulted in an incremental analysis which will be discussed in **Section 4.3.3**.

Figure 3-4: FWOP Damages by Reach (AAEQ \$ and %)

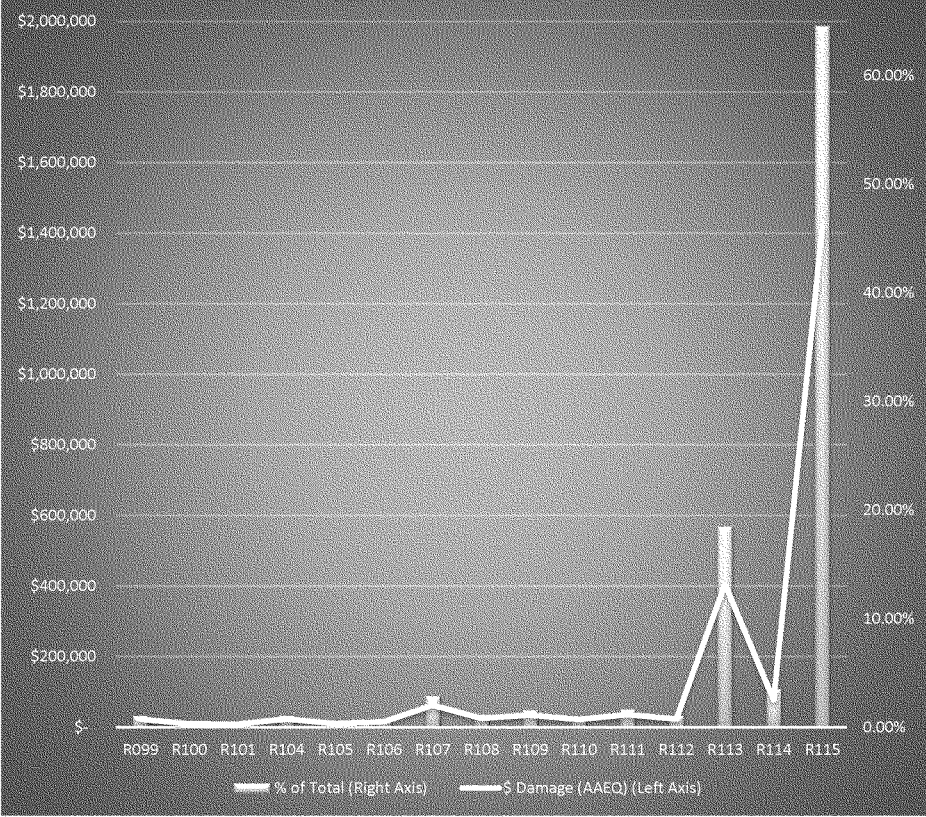


Figure 3-5 illustrates the spatial distribution of damages and erosion rates¹⁹ by reach. Similar to Figure 3-4 above,

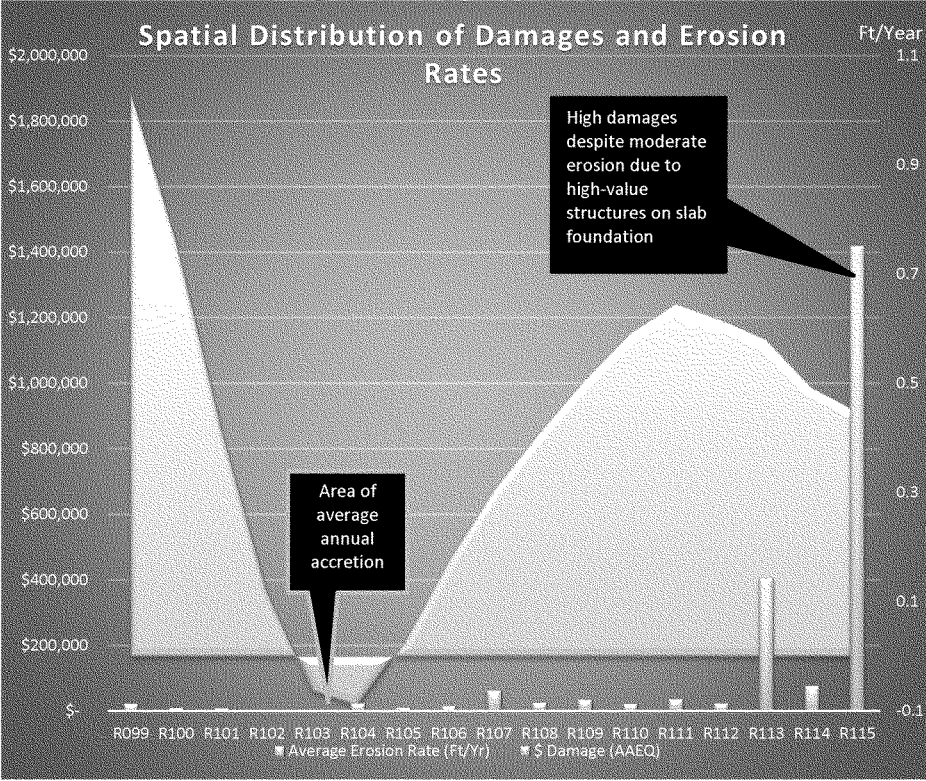
Figure 3-5 displays minor damages until R107 and then the spikes at R113 and R115. The spatial distribution of erosion and damage shows the following pattern:

¹⁹ Negative erosion rates indicate areas of annual accretion

- ❏ **R-099 to R-101:** This stretch has the highest erosion rates averaging 0.74 ft/year but relatively low damages at around 2% of the total. R-099 is the main driver of damages in this range due to the presence of condominium complexes in the nearshore environment.
- ❏ **R-102 to R-103:** There are no damages occurring in these two reaches²⁰. This is primarily due to the fact that there are only two damageable elements in these reaches and they are set back far enough from the shoreline to avoid all damages. Also, erosion rates are minimal and R103 sees annual accretion versus erosion.
- ❏ **R-104:** Despite having the highest level of accretion in the project area this reach still incurs a fair amount of damage. The average annual accretion is offset by the value and high density of structures susceptible to storm-based damages within the reach (roughly seven-percent of total damage elements, refer to previous Figure 2-2).
- ❏ **R-105 to R-112:** Erosion rates begin to rise throughout these southern reaches and culminate in a secondary peak of 0.65 ft/year at R-111. Despite the increasing erosion rates, the damages are fairly smooth in this area and hover around the average for all reaches excluding outliers (R-113 and R-115).
- ❏ **R-113 to R-115:** In these final reaches the erosion rate is stable and very near the mean. Again, the spike in damages is driven almost entirely by the many structures on slab foundations in the nearshore.

²⁰ Damages accrue only in the highest sea-level rise scenario, which will be discussed in greater detail below

Figure 3-5: Spatial Distribution of Damages and Erosion Rates by Model Reach



3.3.3 Damage Distribution by Damage Driving Parameter

It is very typical for Florida CSRM studies to find that most damages are due to erosion. St. Lucie is no exception as virtually all of the FWOP damages are attributable to erosion. The distribution of damage is as follows:

- ✦ Erosion: 97.29%
- ✦ Inundation: 2.55%
- ✦ Wave Attack: .16%

3.3.4 Temporal Distribution of Damages

Damages begin to rise steadily from the base year until 2042, beyond which they remain relatively constant on a yearly basis. The pattern is somewhat intuitive as one would expect the cumulative impact of erosion to take a toll on nearshore structures.

Figure 3-6 illustrates the damages over time by condensed reaches²¹ in non-present value. In years 2036-2046 there are a series of small spikes in damages and that pattern continues throughout the remaining years culminating in a final peak in 2069. The pattern of damage spikes brings to light the frequent vulnerability of the St. Lucie shoreline to the powerful effects of storms and hurricanes. **Figure 3-7** displays similar information but converts the damages into present-value (PV). As would be expected due to the effects of discounting, the damages peak in the relative near-term (2042). However, it is important to note that despite discounting effects, damages remain relatively high in the final half of the period of analysis.

²¹ For graphical display purposes the reaches were grouped as R-099 to R-107, R-108 to R-114, and R-115. R-102 and R-103 were not displayed as damages remain at zero throughout the period of analysis.

Figure 3-6: Non-PV Damages Over Time by Combined Reaches

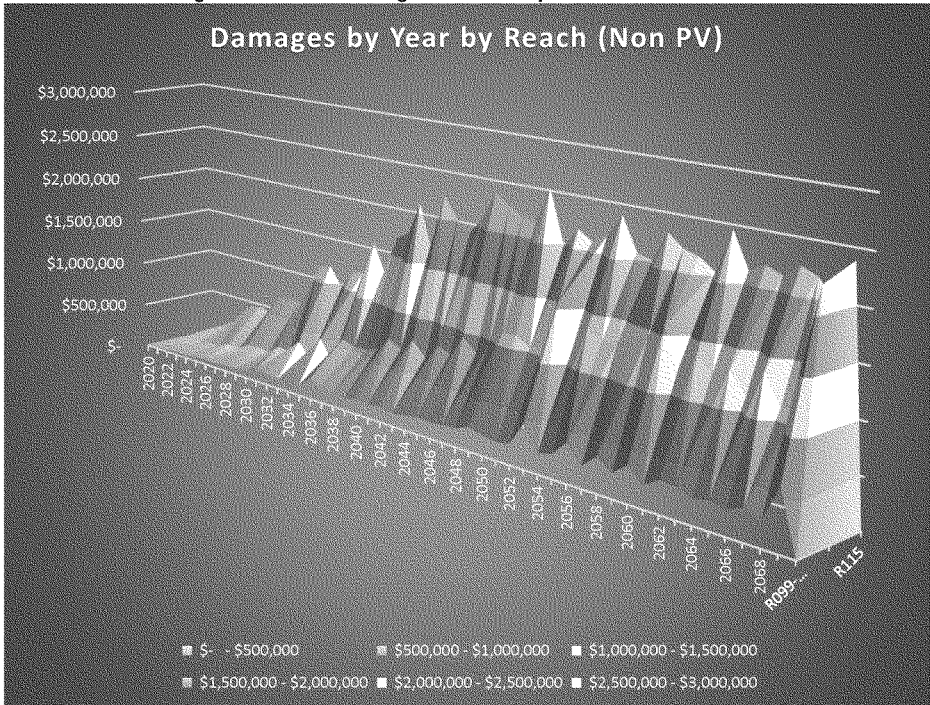
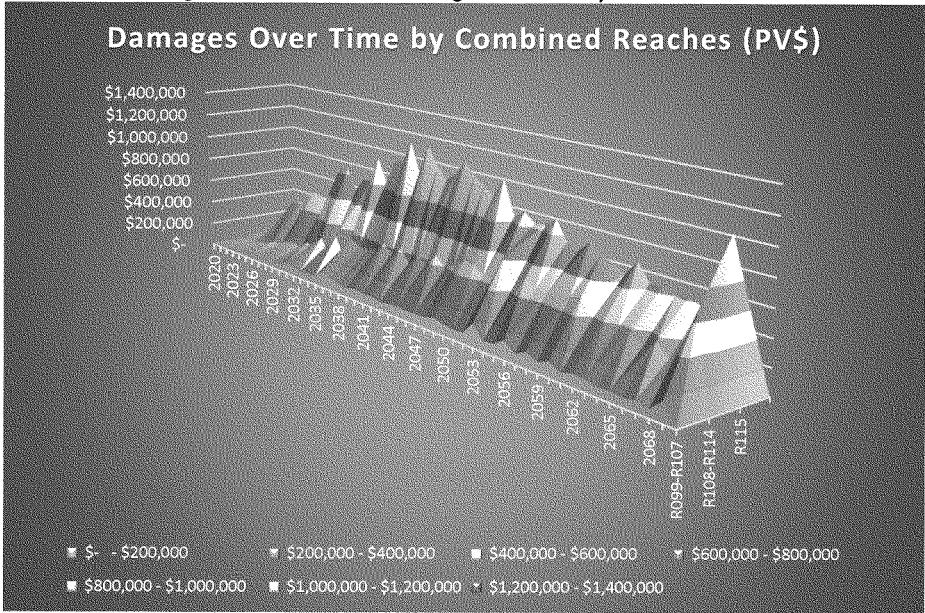


Figure 3-7: Present-Value Damages Over Time by Combined Reach



3.3.5 Evacuation Route Flooding

As described in section 2.4.2 Florida State Road A1A is South Hutchinson Island’s hurricane evacuation route and provides vital access to critical infrastructure and services. Of additional importance, the Centers for Disease Control report that each year more deaths occur due to flooding than from any other thunderstorm related hazard and half of those fatalities occur when a vehicle is driven into hazardous flood water. The National Weather Service (NWS) reports that just 12 inches of rushing water can carry away a small car and two-feet can sweep away most vehicles.

In order to gauge the potential impact of flooding on Florida State Route A1A Beach-fx was adjusted to model two different scenarios with the statistics from the NWS used as a framework. In the first scenario, all damage element types were assigned a null damage function except inundation damages to A1A. In order to gauge the depth of flooding all damages were set to zero until inundation reached one-foot. In this model scenario, 38% of iterations experienced one foot or more of flooding at some point in the 50-year period of analysis. One of the southern reaches, R112, is flooded in 34% of the iterations. The importance of the southern reaches is as mentioned above in section 2.4.2; an impassable A1A to the south could result in traffic needing to be rerouted approximately 16 miles during evacuations.

The second scenario followed the exact same methodology but damages were set to zero until inundation on A1A reached two feet. In this scenario 31% of iterations experienced two or more feet of flooding. Again, R112 was consistently inundated, having two or more feet in 27% of iterations.

This flooding represents a potential hazard to all residents of Hutchinson Island both within and outside of the project area boundaries. There are no alternative roads that run north to south and attempting to navigate flood waters in depths of one foot or more can prove to be fatal.

3.3.6 FWOP Damages in Alternative Sea-Level-Rise Scenarios

Evaluating sea-level rise (SLR) is a vital component in the planning process to ensure alternatives are selected based on risk-informed analysis. To incorporate risk into the analysis the FWOP must be run assuming three distinct future rates of SLR. EC 1165-2-211 provides both a methodology and a procedure for determining a range of SLR estimates based on the local historic rate, the construction (base) year of the project, and the design life of the project. In St. Lucie County the average baseline (SLR1), intermediate (SLR2) and high (SLR3) rates were found to be 0.0077 feet/year, 0.0163 feet/year, and 0.0439 feet/year, respectively. The Beach-fx results that were presented above refer strictly to SLR1, which is based on the historic rate. The results comparing the SLR scenarios are presented here. **Figure 3-8** provides an overall summary of damages in each SLR scenario and includes a trend line; Table 3-4 shows how those damages are distributed amongst the different structure types.

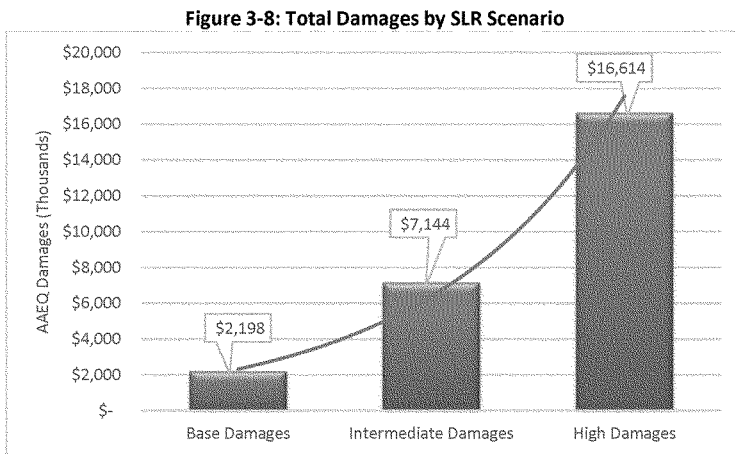


Table 3-4: Distribution of Damages by Category in the SLR scenarios

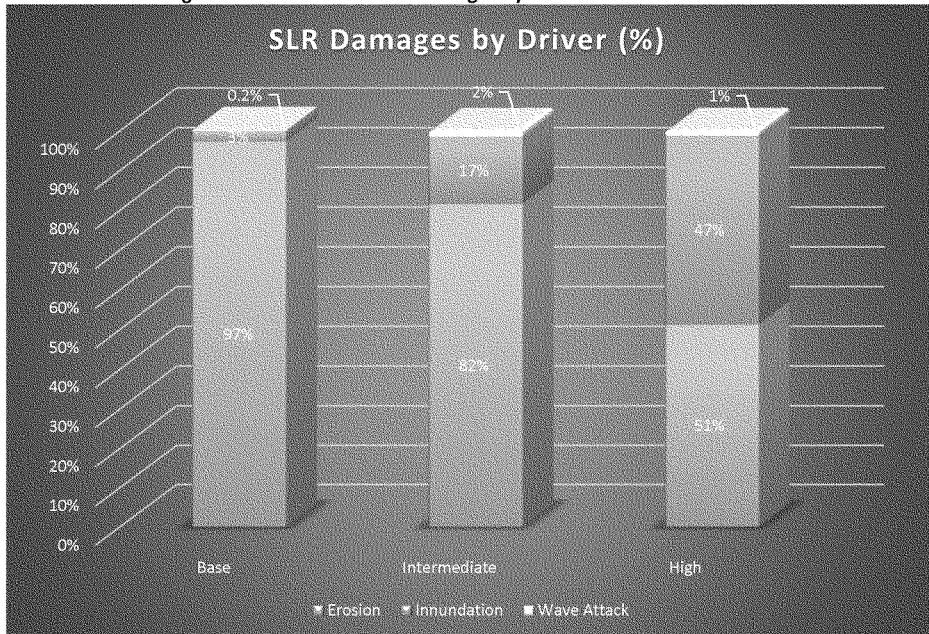
Category	Type	SLR1	SLR2	SLR3
Commercial	BUILDING-1	\$ 1,889,395	\$ 5,018,669	\$ 6,842,697
	COMM-1	\$ 469	\$ 199,140	\$ 464,632
	HIGHRISE-1	\$ 11,253	\$ 548,504	\$ 865,782
	HIGHRISE-2	\$ 19,527	\$ 228,131	\$ 2,231,231
	HIGHRISE-3	\$ 21,813	\$ 336,644	\$ 4,647,021
Commercial Subtotal		\$ 1,942,457	\$ 6,331,088	\$ 15,051,364
Public Access & Recreation Structures	DECK	\$ 9,700	\$ 24,989	\$ 24,699
	DUNEWALK	\$ 173,882	\$ 320,933	\$ 293,571
	GARAGE	\$ 882	\$ 23,629	\$ 176,278
	GARAGE-U	\$ 959	\$ 60,347	\$ 130,867
	GUARDSHACK	\$ 219	\$ 1,313	\$ 2,680
	PARKING	\$ 16,019	\$ 69,126	\$ 278,250
	PATIO	\$ 19	\$ 1,644	\$ 30,227
	PAVED	\$ -	\$ 112	\$ 1,044
	POOL	\$ 38,979	\$ 256,045	\$ 533,736
	POOLHEATER	\$ 19	\$ 674	\$ 2,405
	PUBLIC-1	\$ 24	\$ 2,288	\$ 4,609
	SHELTER	\$ 13,716	\$ 28,381	\$ 41,883
	STORAGE	\$ 49	\$ 1,467	\$ 2,938
	ROAD-1	\$ -	\$ 39	\$ 232
	ROAD-3	\$ -	\$ 88	\$ 536
	TENNIS	\$ 7	\$ 329	\$ 6,216
PA & Rec Subtotal		\$ 254,475	\$ 791,404	\$ 1,530,170
Residential	SFR-3	\$ 760	\$ 21,498	\$ 32,905
Residential Subtotal		\$ 760	\$ 21,498	\$ 32,905
GRAND TOTAL		\$ 2,197,692	\$ 7,143,991	\$ 16,614,439

The SLR results are intuitive in the sense that one would expect damages to be positively correlated with water levels (i.e. as water levels increase throughout the period of analysis so do damages). What is important to note, however, is the magnitude of the effect. From SLR1 to SLR2 the difference was a

mere .0086 ft./year in average SLR and resulted in an increase of roughly 225%, or roughly \$5M AAEQ, worth of damages. From SLR2 to SLR3 there was a .0276 ft./year average rise with a corresponding increase of 133%, or \$9.5M, in damages. From SLR1 to SLR3 damages increase over 655%.

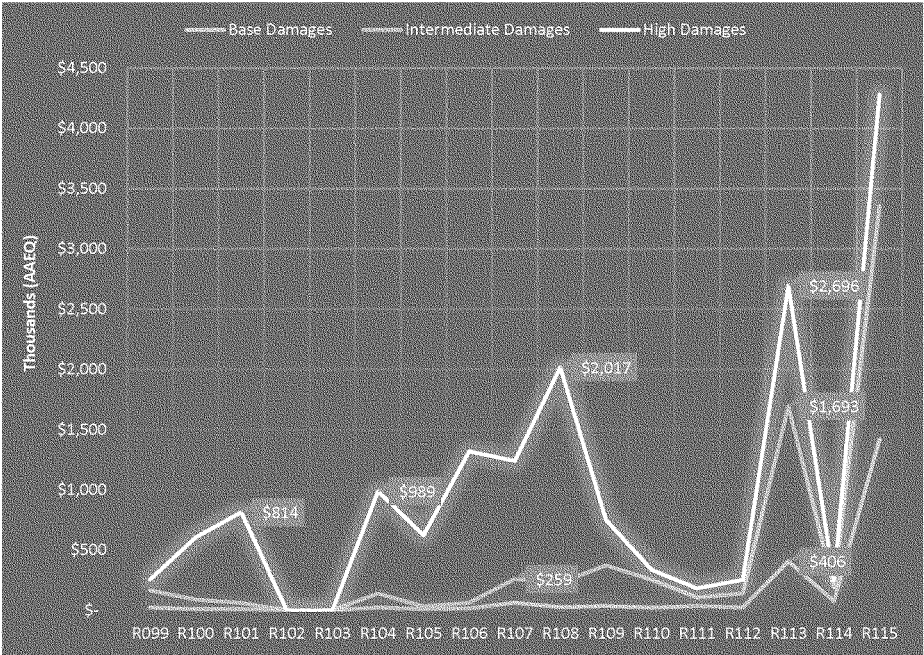
There is also an interesting shift in what drives the damages in each scenario. As mentioned in **section 3.3.3** above, it is very common for erosion to be the main cause of damages in Florida CSRM studies. However, as sea levels rise, inundation begins to take on more of the share of damages. By SLR3, damages caused by erosion have fallen from 97% to 51% with inundation accounting for most of the difference; coastal overstep is reducing the propensity for erosion. **Figure 3-9** displays the changing trend in how damages are occurring.

Figure 3-9: Percent of Total Damages by Driver in the SLR Scenarios



Coastal overstep is also causing an increasing number of lots to be determined condemned within the model and is shifting damage hot spots into areas that are more susceptible to flooding. Reaches 104-108 begin to see a larger increase in damages as high-value structures are increasingly inundated (**Figure 3-10**). Not only does this maintain the assertion that St. Lucie County is highly susceptible to storm damage but also demonstrates how critical a project would be in mitigating damages in the event sea levels continue to rise above and beyond baseline projections.

Figure 3-10: SLR Damages by Model Reach



3.4 FWOP Condition Conclusion

- ✦ Damages are largely driven by storm events instead of gradual erosion.
- ✦ The overwhelming majority of the damage is structural in nature. Commercial structures account for three-fifths of all damages.
- ✦ Proximity to the shoreline, vulnerability of structure type (i.e. slab foundation) and exposure to recurring damages are the most important factors for determining structure damage.
- ✦ Damages in the FWOP increase dramatically in the SLR scenarios.

3.5 Future with Project Condition

This section of the appendix tells the story behind the evaluation and comparison of the St. Lucie County CSRM study alternatives. A description of the alternatives, their performance in terms of benefits and costs, and the methods used for screening are provided in the sub-sections that follow.

3.5.1 Management Measures

Management measures were selected to accomplish at least one of the planning objectives for the St. Lucie County study. Both nonstructural and structural measures were identified. The following is a summary of the management measures considered:

✦ Structural Measures:

- ✦ Beach Nourishment
- ✦ Groins

- ❑ Submerged Artificial Reefs
- ❑ Dunes and Vegetation
- ❑ **Non-structural Measures:**
 - ❑ No Action
 - ❑ Condemnation and Land Acquisition

During the plan formulation process, management measures were screened against seven criteria. Benefits and costs were not calculated at this early stage of formulation, though a qualitative assessment of potential benefits was conducted. Ultimately, most of these measures were screened out. Two structural measures were carried forward to the modeling stage: Dunes and Vegetation and Beach Nourishment. The no-action plan was also weighed against the two structural measures. More information about each measure is provided below. More information about the management measure screening process is provided in the main report.

Dunes and Vegetation: This measure would include placement of beach compatible material, from either upland or offshore sources, into an extension of the existing dune feature. Vegetation would be planted after initial placement of the dune material. Preliminary engineering design work concluded that the most feasible plan for dunes and vegetation would be extending the existing dune by either 10 or 20 feet. These alternatives were named “Dune10” and “Dune20” respectively. Periodic nourishment triggers would occur once the extended dunes were fully eroded and construction would be completed using a hydraulic dredge or truck haul to transport material from an off-shore borrow source.

Beach Nourishment: This measure includes initial construction of a beach fill and future periodic nourishments at regular intervals. Periodic nourishment of the beach would be undertaken to maintain the erosion control features within design dimensions. There were several combinations of project dimensions initially considered for beach nourishment. Five different “design berm” templates were considered which included maintaining a zero-foot berm (A), 20-foot berm (B), 40-foot berm (C), 60-foot berm (D), and 80-foot berm (E). Using these design berm templates, a “sacrificial fill” amount was then considered in 20-foot increments. For example, one project option would be to maintain a 20-foot design berm with an additional 40-feet of sacrificial fill. Much like the dunes and vegetation measure, periodic nourishment triggers would occur once sacrificial berm lengths have been fully eroded. Using truck transportation of fill was considered as a possible option for beach nourishment as well as hydraulic dredging.

3.5.2 Alternative Development

An alternative plan is a set of one or more management measures functioning in tandem to address project-area objectives. Though the team only carried forward two management measures there were a total of 42 alternatives for initial modeling. The two dune extension options (10’ and 20’) were modeled individually and also in combination with the beach nourishment berm extensions. The alternative names were descriptive and followed a convention of design template (A-C as described above), berm width (20-100’), and the width of the dune extension (0-20’). So for example, a project that maintains a 0-foot design template, 40-foot berm extension, and maintains the existing dune would be labeled: ABerm40DuneEx. For a more detailed explanation of nourishment triggers and the various alternative specifications please refer to the **Engineering Appendix (APPENDIX A)** of this report.

After initial modeling it was apparent that the only economically justifiable design template was maintaining a zero-foot berm extension (A), and only sacrificial fill extensions up to 40-feet. The various alternatives provided nearly the same level of total benefits but the costs increased greatly with the size of the project. Dune extensions in combination with beach nourishments were also unjustifiable but a stand-alone project of Dune10 was carried forward to the final array. Upon realizing larger projects had no economic justification, the decision was made to add alternatives and model sacrificial-fill amounts in 10-foot increments. The alternatives carried into the final array for Beach-fx modeling (100 iterations) were as follows:

- ✦ ABerm10DuneEx²²
- ✦ ABerm20DuneEx
- ✦ ABerm30DuneEx
- ✦ ABerm40DuneEx
- ✦ Dune10²²

3.5.3 Alternative Comparison

All of the alternatives described above were modeled in Beach-fx using full (100 iteration) life-cycle simulations in order to calculate benefits and costs. Additionally, land-loss benefits of \$234,138 (AAEQ) were added to the total project benefits for each of the alternatives. For a full discussion on how land-loss benefits were calculated please refer below to section 4.1. The results of these simulations, which were used to discover the NED plan, are presented in **Table 3-5**, **Table 3-6**, and shown graphically in **Figure 3-11**. All values are in FY17 dollars (AAEQ). The alternative with the highest BCR and net-benefits is ABerm20DuneEx making it the NED Plan and the recommended plan. It is important to note that, during the evaluation of the final array, costs for OMRR&R and IDC had not yet been calculated and are therefore only added to the recommended plan during the cost certification process.

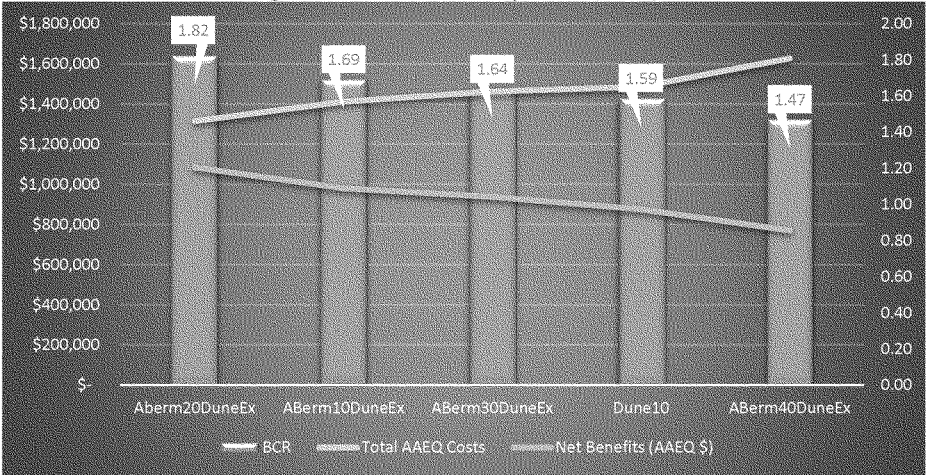
Table 3-5: AAEQ Damages for Final Array of Alternatives (AAEQ \$)

Alternative Name	FWOP Damages	FWP Damages	Land Loss Benefits	Total Primary Benefits
ABerm20DuneEx	\$ 2,197,692	\$ 32,218	\$ 234,138	\$ 2,399,612
ABerm40DuneEx	\$ 2,197,692	\$ 34,415	\$ 234,138	\$ 2,397,415
ABerm10DuneEx	\$ 2,197,692	\$ 39,587	\$ 234,138	\$ 2,392,243
ABerm30DuneEx	\$ 2,197,692	\$ 31,467	\$ 234,138	\$ 2,400,363
Dune10	\$ 2,197,692	\$ 70,651	\$ 234,138	\$ 2,361,179

²² These alternatives were determined too small for dredging so trucking costs were used in Beach-fx modeling and final cost estimation.

Table 3-6: Benefits and Costs for Final Array of Alternatives (AAEQ \$)

Alternative Name	Total Primary Benefits	Total Costs ²³	Primary Net-Benefits	BCR
Aberm20DuneEx	\$ 2,399,612	\$ 1,314,927	\$ 1,084,685	1.82
ABerm10DuneEx	\$ 2,392,243	\$ 1,411,990	\$ 980,253	1.69
ABerm30DuneEx	\$ 2,400,363	\$ 1,462,493	\$ 937,870	1.64
Dune10	\$ 2,361,179	\$ 1,485,348	\$ 875,831	1.59
ABerm40DuneEx	\$ 2,397,415	\$ 1,627,343	\$ 770,072	1.47

Figure 3-11: Alternative Comparisons (AAEQ)²³

3.5.4 Performance of NED/Recommended Plan in the SLR Scenarios²⁴

An important question when evaluating a final array of alternatives is performance under different SLR scenarios. Intuitively, given the protection a plan provides, total benefits will increase as sea-levels begin to rise and damages in the FWOP increase.

While this is true (see **Table 3-7**), costs also begin to increase since nourishment events are triggered more frequently. Also, a project must provide sufficient protection to establish enough benefits in each scenario. Each of the SLR scenarios are considered equally likely to occur so a project must perform satisfactorily across all three in order to be considered effective and robust.

²³ The total cost for the comparison of the final array of alternatives does not contain OMRR&R or IDC costs. As such, BCR totals for the Aberm20DuneEx plan (i.e. recommended plan) will differ from refined summary BCR tables that do include IDC and OMRR&R.

²⁴ Costs calculated for the SLR scenarios include certified costs for SLR1 (without OMRR&R or IDC) and model-projected costs for SLR2 and SLR3 with a 28% contingency added. Benefits do not include land loss or recreation.

The recommended plan performs satisfactorily in each SLR scenario and establishes itself as a robust option in the face of risk and uncertainty. Benefits increase at a much greater magnitude than costs and the BCR grows by 57% from SLR1 to SLR2. From SLR2 to SLR3 the magnitude of the increase is less but there is still a significant increase in BCR. The main reason for the diminishing returns is explained by the nourishment interval column in **Table 3-8**. The interval indicates that under the SLR3 scenario the recommended plan will have a number of nourishments such that the increase in costs grows faster than the increase in benefits compared to SLR2. That said, the recommended plan remains an efficient and effective plan for any of the three possible SLR scenarios. **Figure 3-12** demonstrates this completeness with a side-by-side comparison of the BCRs. Again, at this point in plan evaluation costs had not yet been determined for OMRR&R and IDC so they do not appear in the “Total Cost” column of the figures. The cost figures for IDC and OMRR&R will be introduced for the recommended plan in Section 4.

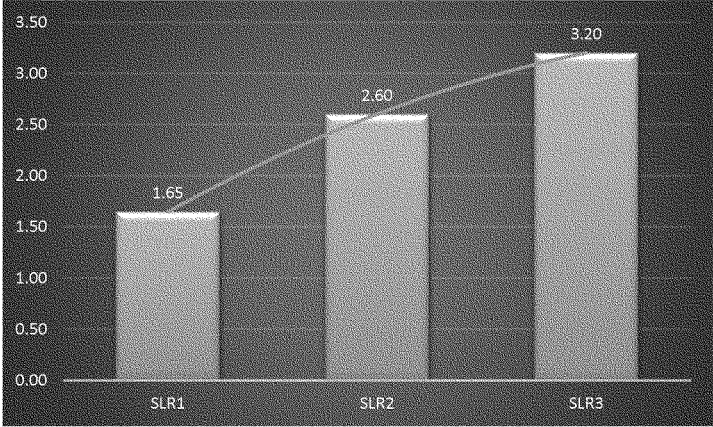
Table 3-7: FWOP and Recommended Plan Damages in SLR Scenarios

	FWOP Damages	FWP Damages	Total Benefits
SLR1	\$ 2,197,692	\$ 32,218	\$ 2,165,474
SLR2	\$ 7,143,991	\$ 45,522	\$ 7,098,469
SLR3	\$ 16,614,439	\$ 67,488	\$ 16,546,952

Table 3-8: AAEQ Benefits and Costs for Recommended Plan in SLR Scenarios

	Nourishment Interval (Years)	Total Cost	Total Benefits	Net Benefits	BCR
SLR1	19	\$ 1,314,927	\$ 2,165,474	\$ 850,547	1.65
SLR2	7	\$ 2,729,218	\$ 7,098,469	\$ 4,369,251	2.60
SLR3	4	\$ 5,169,728	\$ 16,546,952	\$ 11,377,224	3.20

Figure 3-12: Recommended Plan BCR Comparison in the SLR Scenarios



4. THE NED/RECOMMENDED PLAN COST DETAILS

Once all of the alternatives have been compared, a NED has been identified, and a plan recommended the costs that have been used in modeling require certification under ER 1110-1-1300. Costs are refined to a higher level of accuracy and include a contingency during this process. The costs previously mentioned in this document for the recommended plan are the total certified costs but this section aims to provide more detail on the composition of the total. **Table 4-1** provides a breakdown of the component parts making up the costs including OMRR&R and IDC. **Table 4-2** details the year the costs are estimated to occur and the type of cost but does not include OMRR&R nor IDC. It is important to note that the exact year in which periodic nourishment may occur will vary based on monitoring and project area needs.

The cost of OMRR&R for each year following initial construction was estimated at \$20,000 with an increase to \$100,000 every fifth year at FY17 price levels. The equivalent total present-value is \$833,033 annualized to \$31,612. Estimation of OMRR&R took into account tasks such as escarpment removal, vegetation maintenance, and beach tilling. The increase to \$100,000 accounts for any necessary major regrading and rebalancing of beach fill.

Table 4-1: NED Project Cost Refinements (AAEQ)

	Initial Construction ²⁵	IDC	First Periodic Nourishment	P&S, PED	Second Periodic Nourishment	Monitoring	OMRR&R	Total
Quantity (CY)	422,000	N/A	390,000	N/A	390,000	N/A	N/A	1,202,000
Cost	\$ 654,074	\$ 2,084	\$ 312,012	\$ 22,086	\$ 187,324	\$ 139,431	\$ 31,612	\$ 1,348,623

Table 4-2: NED Costs By Type and Year (PV \$)

Year	Cost	Cost Type
2020	\$ 17,236,023	Initial Construction
2021	\$ 777,643	Monitoring
2022	\$ 169,324	Monitoring
2023	\$ 164,592	Monitoring
2024	\$ 45,712	Monitoring
2025	\$ 155,521	Monitoring
2026	\$ 43,193	Monitoring
2027	\$ 146,950	Monitoring
2028	\$ 40,812	Monitoring
2029	\$ 138,851	Monitoring
2030	\$ 38,563	Monitoring

²⁵ Initial construction cost includes plans and specs and PED leading up to initial construction

2031	\$ 131,199	Monitoring
2032	\$ 36,438	Monitoring
2033	\$ 123,968	Monitoring
2034	\$ 34,430	Monitoring
2035	\$ 117,136	Monitoring
2036	\$ 32,532	Monitoring
2037	\$ 363,664	P&S PED
2038	\$ 8,222,071	1st Nourishment
2039	\$ 104,581	Monitoring
2040	\$ 101,658	Monitoring
2041	\$ 98,817	Monitoring
2042	\$ 27,444	Monitoring
2043	\$ 93,371	Monitoring
2044	\$ 25,932	Monitoring
2045	\$ 88,225	Monitoring
2046	\$ 24,503	Monitoring
2047	\$ 83,363	Monitoring
2048	\$ 23,152	Monitoring
2049	\$ 78,768	Monitoring
2050	\$ 21,876	Monitoring
2051	\$ 74,427	Monitoring
2052	\$ 20,671	Monitoring
2053	\$ 70,326	Monitoring
2054	\$ 19,531	Monitoring
2055	\$ 218,335	P&S PED
2056	\$ 4,936,327	2nd Nourishment
2057	\$ 62,788	Monitoring
2058	\$ 61,033	Monitoring
2059	\$ 59,327	Monitoring
2060	\$ 16,477	Monitoring
2061	\$ 56,058	Monitoring
2062	\$ 15,569	Monitoring
2063	\$ 52,968	Monitoring
2064	\$ 14,711	Monitoring
2065	\$ 50,049	Monitoring
2066	\$ 13,900	Monitoring
2067	\$ 47,291	Monitoring
2068	\$ 13,134	Monitoring
2069	\$ 57,451	Monitoring
TOTAL	\$ 34,650,683	

4.1 Land-Loss Benefits

In outlining the process and procedures to be used in the evaluation of CSRM projects, ER-1105-2-100 details the inclusion of land loss due to erosion, stating that such damages should be computed as the market value of the average annual area expected to be lost. Prevention of land loss is a component of primary benefits and is computed based on output data from Beach-fx. Land loss benefits must be added to the structure and content benefits as computed by Beach-fx to obtain the total CSRM benefits of the project.

Following the guidance provided, two key pieces of information are needed to calculate land loss benefits of a CSRM project: (1) the square-footage of the land lost each year and (2) the market value of land in the project footprint.

In the case of St. Lucie County, annual reduction in dune width and upland width across all Beach-fx study reaches was obtained from the Beach-fx *LandLoss.csv* FWOP and FWP output files based on modeled changes to the shoreline. ER 1165-2-130 does not allow land loss benefits be claimed for beach areas subject to temporary shoreline recessions. Thus, changes in dune and upland width, rather than changes in berm width, are used as the appropriate measure of land loss. Beach-fx measures dune width from the seaward toe of the dune to the landward toe of the dune.

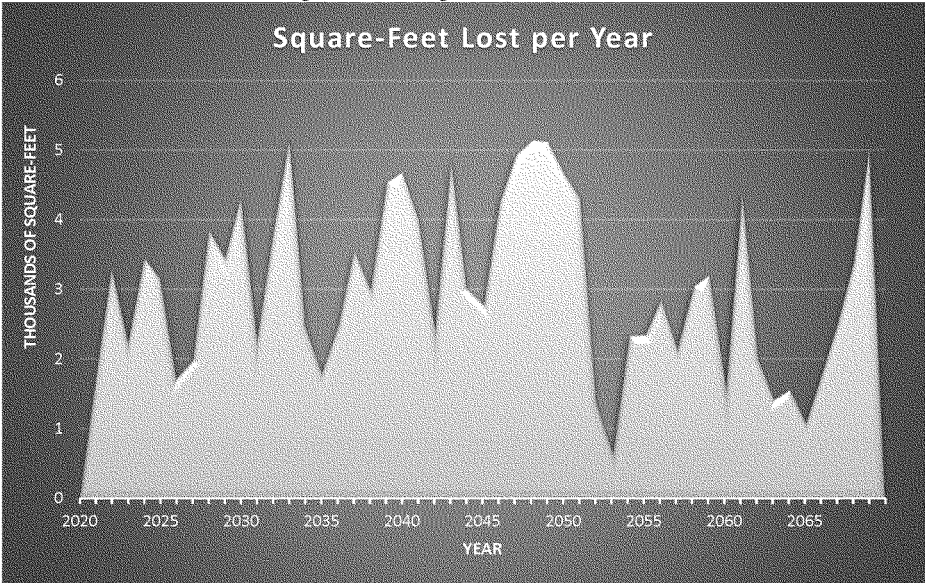
For Beach-fx reaches located within the project area (reaches R-099 to R-115), the basis of the annual changes in dune and upland width calculation is the width in each reach in the model start year (2019), which is the template assumed to be maintained throughout the period of analysis in the FWP. The difference between the constant with-project width and the without-project width in a given year results in the *cumulative* loss of dune and upland width given the profile of that specific reach. However, for the purpose of calculating land loss benefits, the *annual* loss of width is needed. This is obtained by taking the cumulative change in width in a given year and subtracting from it from the cumulative change in width from the previous year. This calculation results in the yearly incremental change in dune and upland width for a given reach.

Using the annual decrease in width for a specific reach and the corresponding length of shoreline eligible for land-loss benefits, the total annual square-footage of land lost is obtained on a reach-by-reach basis and then summed across all study reaches for a given project year. **Figure 4-1** graphically displays the square-feet lost in St. Lucie County each year.

As the second component of the land-loss benefits calculation, ER 1105-2-100 instructs that nearshore land values be used to estimate the value of land lost. In the *St. Lucie County Beach Restoration Estimated Depreciated Replacement Costs of Damage Elements* report, the SAJ Real Estate Department estimated a nearshore land value of \$14.00 per square foot for the St. Lucie study area.

Using the analysis technique described, the total present value of land-loss benefits over the 50 year period of analysis is estimated at \$6,169,968 (PV), or \$234,138 in average annual equivalent (AAEQ) terms.

Figure 4-1: Average Land Lost Each Year



4.2 Incidental Recreation Benefits

According to ER-1105-2-200, incidental recreation benefits that result from the construction of a project can be calculated and added to overall project benefits in CSRМ studies. Recreation benefits are not to be used in plan formulation, but they can be included in total project benefits so long as primary benefits (i.e. CSRМ and land loss benefits) constitute 51% of the benefits required for economic justification. Recreation benefits represent a vital component of a CSRМ project and access for the public to use and recreate on the beach is the foundation for federal interest in the project. Though recreation cannot be used for plan formulation, and though the recommended plan is economically justified on primary benefits alone, recreation benefits play a significant role in increasing net-benefits.

Typically in coastal studies, recreation benefits are calculated using the travel cost method (TCM). The basis for this method is that by increasing the carrying capacity of a particular recreation resource, a project may reduce the travel time and costs associated with recreation visits. In this case, preliminary investigations concluded that there is no excess demand for recreation in St. Lucie County. Therefore, TCM is not applicable.

However, even though a project in St. Lucie County would not increase the *availability* or *quantity* of recreation in the project area, there may be some benefits associated with increasing the *quality* of recreation that is already occurring. Thus, in the St. Lucie County Feasibility study, recreation benefits were calculated using the Unit Day Value method, as described in EGM 09-03 and in Appendix E of ER 1105-2-100. The Unit Day Value (UDV) method estimates a user's willingness to pay for a given

recreational opportunity (i.e. a dollar amount the recreational experience would be worth to them were they required to pay). This value is estimated via a series of criteria applied to the various recreation facilities and opportunities provided by the project; criteria gauging the overall quality of the experience, availability, carrying capacity, accessibility, and environmental factors. Each criterion can be assigned a score selected from one-of-five possible ranges which represents rating from low to high. These point values are summed together and applied a dollar value based on the current UDV guidance. The current unit-day values, provided by USACE Economic Guidance Memo #17-03, *Unit Day Values for Recreation*, FY 2017, are presented in **Table 4-3**. Linear interpolation was used to estimate the dollar value of point scores between ranges. So, for example, a point score of 2 in General Recreation corresponds with a dollar value of \$4.11. The recreation point values assigned to St. Lucie vary by year. They are summarized in **Table 4-4**.

Table 4-3: Current Unit Day Values for Recreation (FY17)

Point Values	General Recreation Values (1)	General Fishing and Hunting Values (1)	Specialized Fishing and Hunting Values (2)	Specialized Recreation Values other than Fishing and Hunting (2)
0	\$3.96	\$5.70	\$27.73	\$16.10
10	\$4.70	\$6.44	\$28.48	\$17.09
20	\$5.20	\$6.93	\$28.97	\$18.32
30	\$5.94	\$7.68	\$29.71	\$19.81
40	\$7.43	\$8.42	\$30.46	\$21.05
50	\$8.42	\$9.16	\$33.43	\$23.77
60	\$9.16	\$10.15	\$36.40	\$26.25
70	\$9.66	\$10.65	\$38.63	\$31.70
80	\$10.65	\$11.39	\$41.60	\$36.90
90	\$11.39	\$11.64	\$44.57	\$42.10
100	\$11.89	\$11.89	\$47.05	\$47.05

Table 4-4: Total Unit Day Point Scores applied to St. Lucie County

Year	Without Project	With Project
2020	45	53
2030	43	53
2040	41	53
2050	39	53
2060	38	53
2069	38	53

The point assignments are based on qualitative criteria; they depend on best professional judgment (i.e. “judgment criteria”). The differences in the assigned point scores vary for each category depending on the relevant recreation facilities. The following list briefly explains the logic behind the judgment criteria

applied to St. Lucie County and **Table 4-5** summarizes the point comparison halfway through the period of analysis (2045).

- ✦ **Recreation Experience:** St. Lucie County beaches were assigned a point score of 19 in the FWOP, which corresponds to “several general recreation activities; more than one high quality activity”. The beaches offer visitors the opportunity to experience several general activities, including swimming, surfing, fishing and hiking. As for high quality activities, the beaches of St. Lucie County are a premier destination for wildlife viewing (specifically turtle nesting) and regional triathlon competitions. The value in the FWP is assigned a 23 since the project will not create any additional recreation experiences but will improve upon the quality of those experiences. The value for the FWOP declines throughout the period of analysis as further degradation of quality is anticipated.
- ✦ **Availability of Opportunity:** The county beaches were assigned a point score of 1, which corresponds to “several opportunities within one hour of travel time and a few within 30 minutes”. All of the project area beaches are within easy driving distance of several other popular beaches, including Glascock and Pepper Park. This point score does not change between the FWOP and FWP because the proposed project would have no effect on the availability of other recreation opportunities.
- ✦ **Carrying Capacity:** In both the FWOP and FWP the carrying capacity was assigned a point score of 5, indicating basic facilities to conduct activities. This score remains throughout the lifecycle as the project is not anticipated to improve the basic facilities nor are damages anticipated to degrade the facilities such that they’d be determined as “minimum development”.
- ✦ **Accessibility:** Again, the FWOP and FWP do not change in this category. A point score of 14 for “good access, good roads to site; fair access, good roads within site” was assigned to both scenarios. Damages to roads in the FWOP are not enough to qualify a reduction in score throughout the period of analysis and the project is not expected to improve on the access quality.
- ✦ **Environmental Quality:** In the base year the FWOP was assigned a score of 6 as there exist some factors which lower quality to a minor degree (see **Figure 4-2** as an example). Over time, the aesthetic quality of the project area beaches are expected to deteriorate a significant degree as damages are inflicted on the dune and the dune walks. By 2069, the score assigned to St. Lucie County was reduced to 3. In the FWP, the point score was held constant at 10 as the project is expected to prevent most of the damage in the project area.

Table 4-5: Criteria Score Comparison in Year 2045

Judgment Criteria	FWOP Score (Year 2045)	FWP Score
Recreation Experience	17	23
Availability of Opportunity	1	1
Carrying Capacity	5	5
Accessibility	14	14
Environmental Quality	4	10

Figure 4-2: Indications of Lower Aesthetic Quality and Damaged Access in the Existing Condition



After assigning point scores and dollar values, these values must be assigned to expected recreation visits over the life of the project. In 2009, a study was published by Dr. William Stronge¹ on behalf of the county to gauge beach visitation estimates. The study was conducted across the entire county. For the purposes of this recreation analysis only the beaches that fall within the project area were extracted from Dr. Stronge's study and are summarized in detail in **Table 4-6**. The total number of visitors in that year was estimated at 186,268.

Table 4-6: Beach Visitations

Beach Name	Visits	Percent of Total
S. of Normandy-to Island Dunes	17,509	9%
Dollman Public	27,163	15%
Ocean Towers-Nettles Island	31,423	17%
Oceana-North of Waveland	19,297	10%
Waveland Public	46,822	25%
Island Crest S to County Line	44,054	24%
Total	186,268	100%

¹Visitation estimates based on 2009 study- *South St. Lucie County Beaches Recreational Use and Economic Impact 2007-08*

In order to project visitation over the life of the project we used a growth rate that was in step with that of overall visitation trends to the state of Florida. According to Visit Florida, visitation grew at an average of 2.99% from 2002-2014²⁶. Therefore, in an unconstrained environment visitation to all of the project-area beaches was expected to reach 1,088,619 by 2069.

However, it is reasonable to assume that there will be capacity constraints pertaining to each stretch of beach and visitation estimates should not exceed that ceiling. In order to estimate those constraints SAJ Economists used parking availability for the public beaches displayed in **Figure 4-3** (i.e. Waveland, Dollman) and for the remaining stretches the number of rental or privately-owned units located on the beach were used. For parking we assumed a maximum of four people per car with each available spot receiving up to two cars per day for the entire year. In the case of rental or privately-owned units, a conservative double-occupancy per unit for the entire year was assumed. The maximum visitation resulting from these constraints is summarized in **Table 4-7**. None of the beaches in the project area are estimated to reach their cap. As a result, total constrained visitation in the year 2069 was estimated at 1,088,619.

²⁶ In 2009, Visit Florida adjusted their visitation estimate methodology. As a result, only years using the same methodology were compared to establish the average growth rate.

Figure 4-3: Public Beach Access in Project Footprint

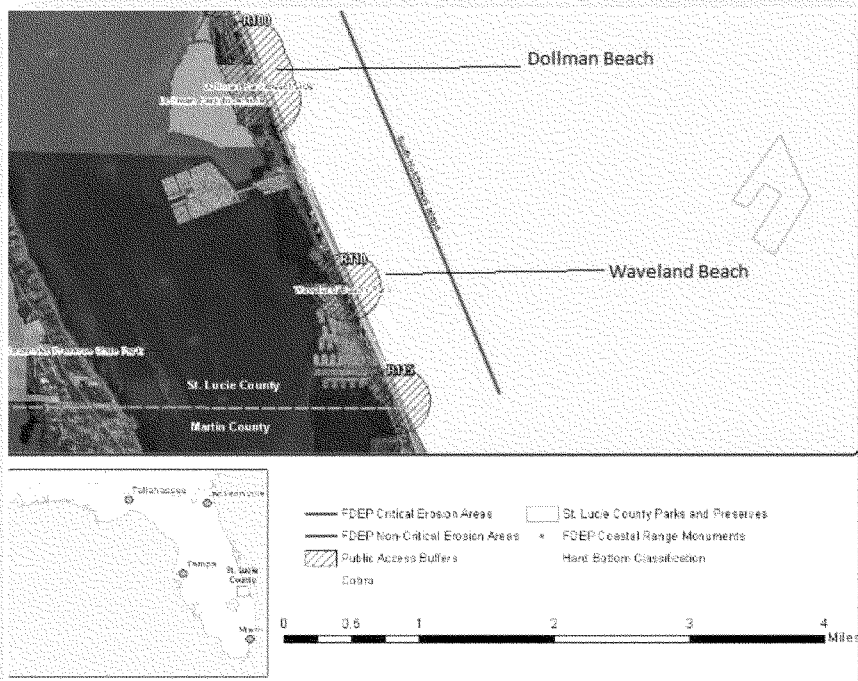


Table 4-7: Visitation Constraints

Beach Name	Parking	Rental Units	Max Visitation
S. of Normandy-to Island Dunes	N/A	274	200,020
Dollman Public	102	N/A	297,840
Ocean Towers-Nettles Island	N/A	540	394,200
Oceana-North of Waveland	N/A	757	552,610
Waveland Public	100	N/A	292,000
Island Crest S to County Line	N/A	950	693,500
Total	218	2521	2,476,890

The total annual visitation numbers combined with the relevant UDV in each year resulted in total recreation benefits for St. Lucie County to be calculated at **\$14,906,431 (PV)**, or **\$565,671** in AAEQ.

4.3 Benefits of the NED Plan

The CSRM primary economic benefits of the plan are generated by reductions in erosion, wave, and inundation damages. As described in **Table 4-8**, the model results suggest that the NED is highly effective at reducing nearly all damages. The FWP condition under the NED protects St. Lucie County from 98.5% of all damages in the period of analysis. In model reaches R-113 and R-115, where damages in the FWOP were the most dramatic due to high-value structures on slab foundation, 99.4% and 98.5% of damages are avoided respectively.

Table 4-8: Benefits (AAEQ) and % Damage Avoided by Reach

Model Reach	Model Reach CSRM ²⁷ Benefits	Percent Damages Avoided
R099	\$22,793	99.3%
R100	\$9,526	97.8%
R101	\$8,982	98.5%
R102	\$0	N/A
R103	\$0	N/A
R104	\$23,287	99.5%
R105	\$10,069	97.3%
R106	\$15,379	97.3%
R107	\$61,818	98.3%
R108	\$24,926	97.7%
R109	\$33,844	97.6%
R110	\$21,834	98.4%
R111	\$33,564	93.4%
R112	\$23,040	98.6%
R113	\$403,677	99.4%
R114	\$75,730	98.2%
R115	\$1,397,005	98.5%
TOTAL	\$2,165,474	98.5%

Additionally, the project is reducing the number of structure types that are receiving damage. In the FWOP, 20 different structure types were being damaged (**Table 3-3**) whereas under the NED only six different structure types receive damage (

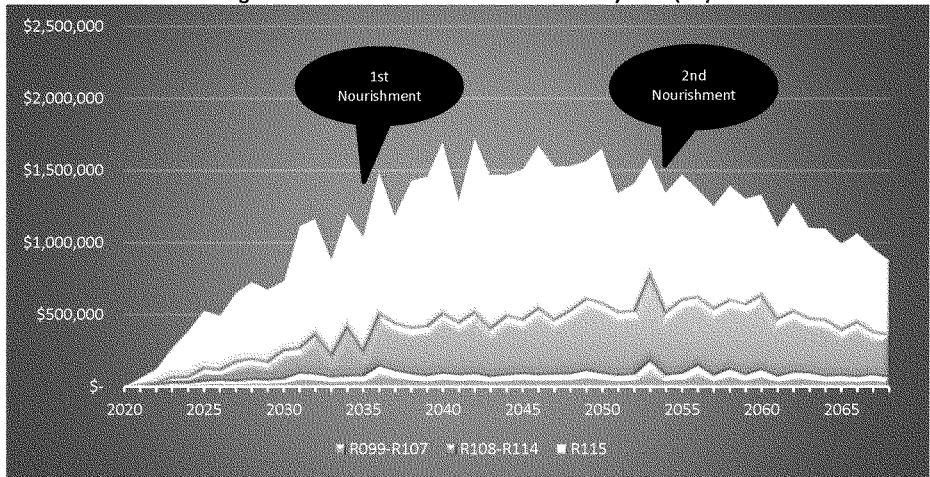
Table 4-9). Important to note is the complete absence of residential property, roads, and all high-rise structure damage.

²⁷ Land loss and recreation benefits are not included

Table 4-9: NED Damages by Category (AAEQ)

Type	Structure	Contents	Total	% of Total
BUILDING-1	\$ 16,104	\$ 8,262	\$ 24,366	76%
DECK	\$ 82	\$ -	\$ 82	0%
DUNEWALK	\$ 5,973	\$ -	\$ 5,973	19%
PARKING	\$ 172	\$ -	\$ 172	1%
POOL	\$ 200	\$ -	\$ 200	1%
SHELTER	\$ 1,425	\$ -	\$ 1,425	4%
Grand Total	\$ 23,956	\$ 8,262	\$ 32,218	100%

The NED is also effective over time and requires only two periodic nourishment events throughout the 50-year period of analysis. Benefits begin to accrue immediately after initial construction and spike initially in 2036 at \$1.5M (PV) before reaching a peak in 2042 when the project provides \$1.73M (PV) in benefits. Between 2036 and 2055 benefits remain steady and relatively high, hovering between \$1.2M (PV) and \$1.7M (PV). Benefits begin to gradually decline until reaching a relative low in 2068 of \$877K (PV). **Figure 4-4** summarizes these annual results.

Figure 4-4: Recommended Plan Benefits²⁸ by Year (PV)

²⁸ Without land loss and recreation benefits

Total CSRM benefits for the recommended plan amount to \$2,165,474 in AAEQ. Adding land loss benefits of \$234,138 AAEQ (**Section 4.1**) and recreation benefits of \$565,671 AAEQ (**Section 4.2**) brings the total project benefits to \$2,965,283 AAEQ. **Section 4.3.2** will summarize how these benefits compare to the refined costs to determine the final BCR.

4.3.1 Benefits of the Recommended Plan on Evacuation Route Inundation

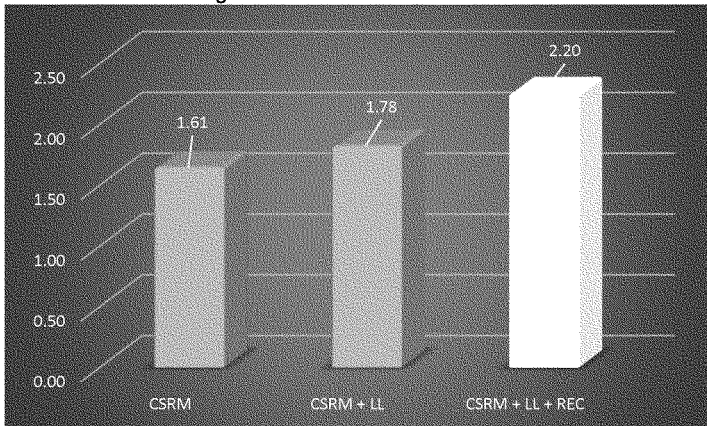
Following the same methodology used in section 3.3.5, the recommended plan was modeled to obtain how effective it would be at preventing flooding of both one foot or more and two feet or more to Florida State Route A1A. The plan was incredibly effective in achieving both of these goals since 0% of the iterations experienced flooding of either one or two feet. Thus, the recommended plan performs satisfactorily in keeping A1A accessible as an evacuation route.

4.3.2 Recommended Plan Benefit-Cost Ratio

Comparing the \$2,965,283 AAEQ in benefits with the \$1,348,623AAEQ in costs yields a BCR of 2.20.

Figure 4-5 summarizes the BCRs with a delineation between primary benefits and incidental benefits.

Figure 4-5: BCRs with Refined Costs



4.3.3 Incremental Analysis of the Recommended Plan

As previously mentioned, the concentration of damages in the southern section of the project area lead to an in-depth analysis of incremental economic justification for the recommended plan. SAJ Engineers and Economists collaborated to determine the proper number of increments to be analyzed. Ultimately, best professional judgement lead to the determination that no increment less than a mile long would be feasibly constructed as a standalone project and, thus, the 3.25-mile stretch of project area was separated into three different increments. Since, as mentioned in **Section 2.3**, each model reach is approximately 1,000' long except R-115 (2,000'), increments one and two are composed of six model reaches (R-99 to R-104, R-105 to R-110) and increment three is composed of five model reaches (R-111 to R-115).

Once the increments were established SAJ economists compared the marginal costs to the marginal benefits to determine justification. For a beach nourishment project such as the recommended plan, the marginal costs are the placement costs per cubic-yard for nourishing any particular increment. In order to determine the quantity of placement attributable to each increment, the Beach-Fx *reachstats.csv* output file was used. Using this output file SAJ Economists were able to determine the overall percentage of cubic-yards placed in each increment and then multiply that percentage by the total placement costs (AAEQ) derived from the certified cost schedule.

The marginal benefits are the sum of the storm damages prevented, land loss prevented, and recreation benefits for each individual increment. Proper guidance was followed with regard to recreation benefits in that recreation benefits were only applied to an increment if that increment required less than 49% of those recreation benefits to be economically justified (i.e. the primary BCR must be greater than .51).

The incremental analysis determined that all three increments were economically justifiable and would remain part of the recommended plan. Increments two and three had primary (i.e. without recreation benefits) BCR's greater than 1.0, whereas increment one had a primary BCR of .64. Since all increments had primary BCR's greater than .51 recreation benefits were added to determine final BCR's, all of which are greater than 1.0. See **Table 4-10** for a summary of the incremental analysis.

Table 4-10 Incremental Analysis of Recommended Plan

Increment	Model Reach	Marginal Cost	Primary Benefits	Rec Benefits	Incremental Primary Net-Benefits	Incremental Net-Benefits (With Rec)	Primary BCR	BCR With Rec
1	R-99	\$ 39,695	\$ 41,029	\$ 17,724	\$ 1,334	\$ 19,058	0.64	1.45
	R-100	\$ 41,340	\$ 24,789	\$ 17,724	\$ (16,551)	\$ 1,174		
	R-101	\$ 34,735	\$ 19,593	\$ 17,724	\$ (15,142)	\$ 2,582		
	R-102	\$ 28,390	\$ -	\$ 41,245	\$ (28,390)	\$ 12,855		
	R-103	\$ 22,939	\$ -	\$ 41,245	\$ (22,939)	\$ 18,306		
	R-104	\$ 30,719	\$ 41,477	\$ 23,857	\$ 10,758	\$ 34,615		
	Total1	\$ 197,818	\$ 126,888	\$ 159,520	\$ (70,930)	\$ 88,590		
2	R-105	\$ 26,373	\$ 22,292	\$ 23,857	\$ (4,082)	\$ 19,775	1.24	1.90
	R-106	\$ 29,544	\$ 29,084	\$ 23,857	\$ (460)	\$ 23,397		
	R-107	\$ 32,435	\$ 73,208	\$ 23,857	\$ 40,773	\$ 64,630		
	R-108	\$ 35,219	\$ 38,871	\$ 19,534	\$ 3,652	\$ 23,186		
	R-109	\$ 39,573	\$ 48,915	\$ 19,534	\$ 9,342	\$ 28,876		
	R-110	\$ 36,628	\$ 36,276	\$ 19,534	\$ (352)	\$ 19,182		
	Total2	\$ 199,771	\$ 248,645	\$ 130,173	\$ 48,873	\$ 179,046		
3	R-111	\$ 39,585	\$ 48,887	\$ 71,096	\$ 10,303	\$ 81,399	11.35	12.90
	R-112	\$ 44,032	\$ 53,202	\$ 71,096	\$ 9,171	\$ 80,267		
	R-113	\$ 34,892	\$ 416,623	\$ 44,595	\$ 381,731	\$ 426,326		
	R-114	\$ 31,440	\$ 87,652	\$ 44,595	\$ 56,212	\$ 100,808		
	R-115	\$ 28,324	\$ 1,416,715	\$ 44,595	\$ 1,388,391	\$ 1,432,986		
	Total3	\$ 178,272	\$ 2,024,080	\$ 275,978	\$ 1,845,808	\$ 2,121,786		
GRAND TOTAL		\$ 575,861	\$ 2,399,612	\$ 565,671	\$ 1,823,751	\$ 2,389,422		

4.4 Conclusion

St. Lucie County is highly susceptible to hurricane and storm damage. This is particularly true for the large and high-value commercial structures and more pronounced in the southern section of the project area. Beach-fx modeling has demonstrated that, in the absence of a federal project, significant economic damage from coastal forces can be expected to occur over the next 50-years. When factoring in the potential for sea levels to rise in excess of baseline projections those economic damages could average almost half of a billion dollars in present-value terms.

In an effort to reduce as much damage as possible this CSRM project team considered a multitude of management measures. Years of technical expertise, best professional judgment and rigorous modeling efforts were all leveraged to determine a plan that maximizes net-benefits and contributes to national economic development. This plan, ABerm20DuneEx, prevents an estimated 98% of economic damages across 50-years with only two periodic nourishments and nets \$1,616,660AAEQ worth of benefits. The project yields \$2.20 in benefits for every \$1.00 spent (i.e. BCR is 2.20). **Table 4-11** provides a summary of the recommended plan CSRM benefits with land loss and recreation added.

Table 4-11: Economic Summary of Recommended Plan (AAEQ)

ECONOMIC SUMMARY	STORM RISK MANAGEMENT BENEFITS ONLY	STORM RISK MANAGEMENT + LAND-LOSS BENEFITS (PRIMARY)	STORM RISK MANAGEMENT + LAND- LOSS + RECREATION
Price Level	FY17	FY17	FY17
FY17 Water Resources Discount Rate	2.875%	2.875%	2.875%
Storm Risk Management Benefits	\$2,165,474	\$2,165,474	\$2,165,474
Land Loss Benefits	\$0	\$234,138	\$234,138
Recreation Benefits	\$0	\$0	\$565,671
Total Benefits	\$2,165,474	\$2,399,612	\$2,965,283
Total Cost ²⁹	\$1,348,623	\$1,348,623	\$1,348,623
Net-Benefits	\$816,851	\$1,050,989	\$1,616,660
Benefit Cost Ratio	1.61	1.78	2.20

²⁹ This cost includes IDC and OMRR&R

The plan is efficient, acceptable and complete. It is also robust and increasingly efficient in the face of rising sea levels. Though the recommended plan is relatively small in scope and scale, it represents the most prudent investment of Federal and sponsor dollars.

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX D **Geotechnical**



**US Army Corps
of Engineers**
Jacksonville District

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1 BACKGROUND

This report includes a description of the regional and local geology of St. Lucie County, a sediment characterization of the native beach, and a preliminary sand source design. Vibracore boring logs and laboratory results are available upon request.

Sand source coordinates and quantities listed are based on “St. Lucie Sand Search – Geotechnical Investigations Reconnaissance Level Investigation” prepared by Coastal Technology Corporation (Coastal Tech), May 4, 2010 and “St. Lucie County Sand Search Plans & Specs-Level Investigation” prepared by Coastal Technology Corporation, February 29, 2012.

1.1 REGIONAL GEOLOGY

The Florida Peninsula occupies a portion of a much larger geologic unit called the Florida Plateau. Deep water in the Gulf of Mexico is separated from deep water of the Atlantic Ocean by this partially submerged platform, nearly 500 miles long, that varies from 250 to 450 miles wide. In the last 200 million years, the plateau has been alternately dry land or covered by shallow seas. During that time up to 20,000 feet of carbonate and marine sediments were deposited. There has been a tilting of the Florida Plateau about its longitudinal axis. The west coast is partially submerged, as indicated by the wide estuaries and offshore channels, while the east coast is correspondingly elevated, showing the characteristics of an emergent coastline (Randazzo and Jones, 1997).

During the last million years, a series of four glacial periods, or ice ages, brought about significant changes in sea level, as shown in **Figure 1**. As a result of these sea level fluctuations, the Florida peninsula was again covered and uncovered by shallow seas. Following the first glacial period, sea level rose 270 feet above its present level. Dry land on the Florida peninsula was then restricted to a few small islands along the central Florida ridge and in northeast Florida.

About 100,000 years ago, the last glacial period began. Sea level fell to 300 feet below its present level and the Florida Plateau emerged as dry land. Approximately 15,000 years ago, sea level began its most recent rise towards present sea level (Shackleton, 1987). Sea level rose at an average rate of 30 feet per 1,000 years. About 7,000 years ago, the rate of sea level rise slowed when the sea level was about 30 feet below its present level (Smith et al., 2011). It was during this most recent slowing of sea level rise that the modern barrier islands of southeast peninsular Florida formed.

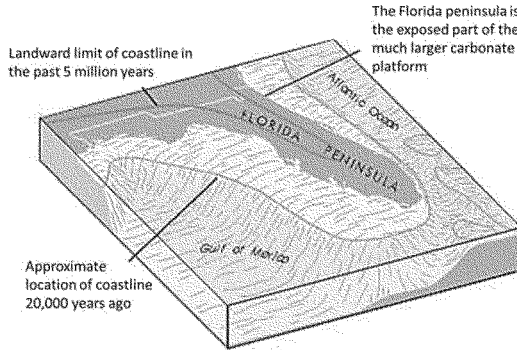


Figure 1. The Florida Peninsula, including the present coastline, previous sea level stands, and the extent of the carbonate platform.

Offshore of the beaches and modern barrier islands is the continental shelf. It is a broad, shallow, low relief shelf that extends from 80 miles offshore near Jacksonville, to only a few miles offshore near Miami. The shelf contains relic Pleistocene and Holocene terraces and submerged beach sand ridges. The wave climate and sediment transportation system creates a linear sandy coastline. The linear coastline is modified locally by inlets. An exception to the linear coastline is the cape structure located at Cape Canaveral which formed in response to a different wave and sand sediment transport system in the southern portion of the state.

The east coast of Florida, from the state line at the Georgia border to Miami Beach (350 miles), consists of a series of sandy barrier islands broken occasionally by inlets, as shown in **Figure 2**. The barrier islands are characterized by dunes and shore parallel beach ridges. Many of the islands display relic beach ridges formed during higher stands of sea level. The barrier islands often have a distinctive drumstick-shape with an accreting bulbous end and a slender eroding end. These barrier islands were formed from waves and longshore currents reworking marine and fluvial sediments. Lagoons and marshes are typically located between the barrier islands and the mainland.

The quartz component of the modern barrier island sand was deposited from sand migrating southward along the Atlantic coast, from the reworking of the Pamlico Sand that was previously deposited over the entire region. The remaining component of coastal sediments are typically carbonates, locally produced by calcite-producing plants and animals. Additional carbonate materials are from reworked materials from outcropping Pleistocene formations offshore (Duane and Meisburger, 1969).

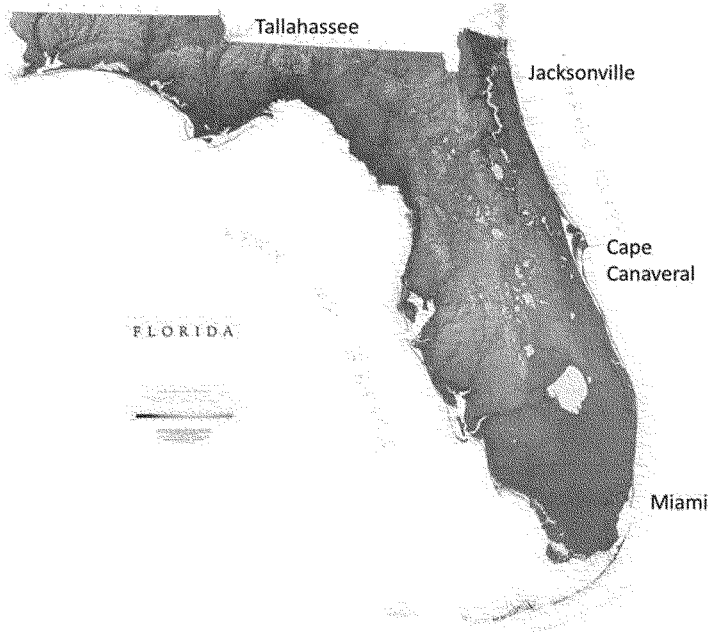


Figure 2. Map of Florida, including points of interest on the Atlantic Coastal Plain.

1.2 LOCAL GEOLOGY

The project is located on the barrier island beach, South Hutchinson Island, in southern St. Lucie County, in the Atlantic Coastal Plain physiographic unit. The formations exposed at the surface are undifferentiated sediments of Pleistocene and Recent age overlying the Anastasia Formation (Scott, et al., 2001). These deposits consist of fine to medium quartz sand and lenses of shell and clay of varying thickness. Thick shell beds and erosion of the outcropping Anastasia formation near the coast have been firmly cemented to form coquina. This formation is underlain by Upper Miocene or Pliocene deposits of interbedded lenses of marine, fine to medium sand, shell and green, calcareous, silty clay. This is underlain by the Hawthorne Formation of early and middle Miocene age, the surface of which is approximately 250 feet below sea level. The Hawthorne Formation consists of gray to green, plastic, phosphatic, sandy clay and marl, interbedded with lenses of phosphatic sand, pebbles and sandy limestone. The Hawthorne Formation is underlain by limestone formations of Eocene age (Reese, 2004).

South Hutchinson Island (**Figure 3**) is part of a chain of sandy barrier islands separated by narrow inlets from Cape Canaveral to Palm Beach. These barrier islands rarely exceed one mile

2 NATIVE BEACH

2.1 GENERAL

The native beach on South Hutchinson Island was sampled by Coastal Tech in February 2007 to characterize the recent native beach sediments and assess compatibility with the potential sand source material. The fill template extends from Florida Department of Environmental Protection (FDEP) survey monument R-98 south to the county line, as depicted on **Plate B - 1**.

Between March 2013 and May 2013, approximately 635,000 cubic yards of sand were placed within the proposed fill template (R-98 to the Martin County line) by St. Lucie County. The sand source for the 2013 project was a portion of the St. Lucie Shoal, located approximately three miles offshore.

2.2 NATIVE BEACH SAMPLING AND ANALYSIS

Sixty native beach sediment samples were obtained from R-77, R-80, R-85, R-90, R-95, R-98, R-100, R-105, R-110, and R-115. Samples were collected from the toe of dune, mid-berm, mean high water, mean low water and near the -3 foot contour **Figure 4**. Samples were obtained from approximately 5" below the surface (Coastal Tech, 2010).

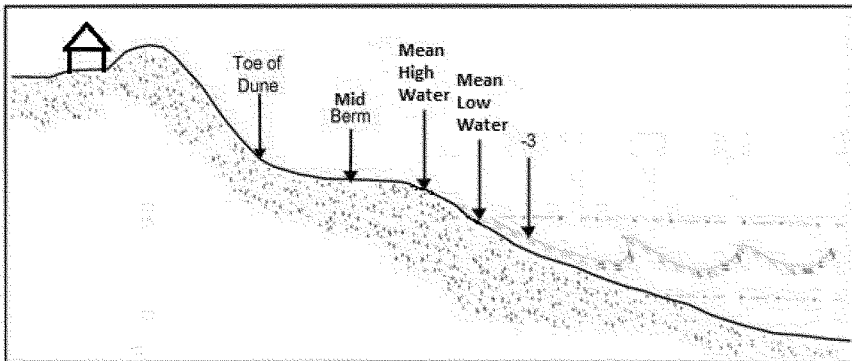


Figure 4. Beach Transect with Beach Sampling Locations

Gradation analysis was performed using 20 sieves ranging from $\frac{3}{4}$ -inch to No. 230 at $\frac{1}{2}$ phi intervals, including the No. 4 and No. 200 sieves. Compositional analyses through Loss on Ignition, as well as Munsell color analysis were performed. These data show that, in 2007, the

native South Hutchinson Island beach consisted of light gray to very pale brown, moderately to poorly sorted, medium grained sand with 50% carbonate. The grain size analysis results are summarized in **Table 1** in the **Sub-Appendix**. The gradation curves are available upon request.

Table 1. South Hutchinson Island, Grain Size Statistics Summary

	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Percent Carbonate (%)	Munsell Color
South Hutchinson Island Beach Composite	0.50	1.08	1.52	0.23	0.94	52.37	10YR 7/2

*Retained in the #4 Sieve, **Passing the #200 Sieve

3 SAND SOURCES

This report is based on the data collected by Coastal Tech during a geotechnical investigation of the St. Lucie Shoal in 2011 and described in the following sub-sections. Ninety-two (92) vibracores were obtained from the portion of the St. Lucie Shoal in Federal waters **Plate B - 2** and **Plate B - 3**. These vibracoring locations were chosen based on a review of the bathymetric data, a cultural resources survey, and previously obtained vibracores. The portion of the St. Lucie Shoal in Federal water lies on the Inner Shelf Plain of the Florida Continental Shelf, three to seven miles offshore from the proposed fill template and has not previously been dredged.

A total of 438 sediment samples were selected for analysis using standard laboratory methods to characterize texture, composition, and color. Geologic cross-sections have been developed to delineate the proposed sand source boundaries and preliminary dredging limits. The lithology shown on the cross-sections is based on the vibracore logs; however, if a soil classification in a vibracore log is different with that from the lab data, the classification from the lab tests are used for the cross-sections. The vibracore logs, gradation curves, and statistical analysis of data from those samples are available upon request.

3.1 SAND SOURCE INVESTIGATIONS

3.1.1 Historic Investigations

In 2006, Coastal Planning & Engineering (CPE) conducted offshore geotechnical investigations to identify sand sources in association with the South County Beach Project. CPE identified five potential sand sources in state waters, including four nearshore linear shoals and the landward portion of St. Lucie Shoal.

St. Lucie County authorized Coastal Tech to conduct geotechnical investigations to identify additional beach-compatible sand sources for the long-term nourishment of St. Lucie County

beaches. In 2007 and 2008, Coastal Tech examined the portion of the St. Lucie Shoal in Federal water and Pierce Shoal in State water.

On December 4, 2008 a total of five (5) vibracores were obtained from the long axis of Pierce Shoal, in State water, and eleven (11) vibracores were obtained from the St. Lucie Shoal in Federal water. Sixty-two (62) line miles of bathymetric surveys were also collected. In addition, data were reviewed from a series of eighteen (18) existing vibracores previously obtained in association with the FGS/MMS cooperative study entitled "A Geological Investigation of Sand Resources Along Florida's Central-East Coast".

A total of 84 sediment samples were selected for analysis using standard laboratory methods to characterize: (1) texture, (2) composition, and (3) color. Sediment texture was quantified using nested sieves and described in accordance with the Unified Soils Classification (USC) system. Composition was determined through Loss on Ignition, and color analysis was performed using the Munsell color chart. The results of this investigation indicated that the Pierce Shoal had a limited volume of beach quality sand due to the high percentage of gravel and darker colored sand. Coastal Tech estimated that the Federal portion of St. Lucie Shoal may contain up to 21.13 million cubic yards of beach quality sand (Coastal Tech, 2010).

3.1.2 Recent Investigations

In 2011, Coastal Tech conducted a plans and specifications-level study of the St. Lucie Shoal in Federal water. This study included approximately 152 line miles of bathymetric and seismic surveys, 81 20-foot vibracores and 11 10-foot vibracores as well as a cultural resources survey (Coastal Tech, 2012). Vibracore locations are shown on **Plate B - 2** and **Plate B - 3**.

A broadly spaced bathymetric survey was performed in August 2007. The survey was performed along transects spaced 1000 feet apart, perpendicular to the long axis of the shoals. About 53 line miles of bathymetric data were acquired during this survey on both St. Lucie Shoal in Federal water and Pierce Shoal in state water. In May 2011, this survey was supplemented with a more tightly spaced bathymetric survey concentrated on St. Lucie Shoal. The line spacing for this survey was 250 feet for a total of approximately 152 line miles of data.

A seismic survey was conducted in May 2011 for the purpose of establishing the extent of the upper layer of sand throughout the area. Sub-bottom profile data were collected and analyzed for acoustic reflectors and anomalies that can indicate the presence and quantities of beach re-nourishment resources. The surveys were conducted along approximately 152 track-line miles collected on 250-foot centers.

A cultural resources survey was performed in June 2008 for the purpose of identifying the presence or absence of submerged cultural resources within the proposed sand sources.

A total of 438 sediment samples were selected for analysis using standard laboratory methods to characterize texture, composition, and color. Sediment texture was quantified using nested sieves and described in accordance with the USC System. Gradation analysis was performed using 20 sieves ranging from ¾-inch to No. 230 at ½ phi intervals, including the No. 4 and No. 200 sieves. Composition was determined through Loss on Ignition, and color analysis was performed using the Munsell color chart.

Sand source delineation and compatibility of the sediment for use as beach fill was assessed: (1) through analysis of vibracore sedimentology (i.e., texture, composition, color) and stratigraphy, (2) by computing volume weighted composite vibracore and borrow area granularmetrics and organic / carbonate contents, (3) by computing composite native beach granularmetrics and carbonate content and (4) calculating Overfill Factor (Ra) as outlined in the Coastal Engineering Manual (USACE, 2003). The vibracore logs and gradation curves are available upon request.

3.2 PROPOSED OFFSHORE SAND SOURCE

The proposed offshore sand source is the portion of the St. Lucie Shoal located in Federal water, approximately three to seven miles offshore of the proposed fill template (**Plate B - 1**). The proposed preliminary sand source locations and associated vibracores are depicted on **Plate B - 2** and **Plate B - 3**. Coastal Tech (2012) subdivided the St. Lucie Shoal into three primary sand sources, identified as A, B and C. After reviewing the data, the three sand sources were reconfigured into two; North St. Lucie Shoal and South St. Lucie Shoal. In general, the beach-quality material encountered within the St. Lucie Shoal consists of olive brown to olive gray, fine to medium-grained skeletal sand with few to some fine-grained quartz and few to some gravel-size shell.

3.2.1 North St. Lucie Shoal

The North St. Lucie Shoal sand source is centered approximately 5.5 miles offshore of R-98, at the northern end of the proposed placement area. The sand source covers an area of approximately two (2) square miles (**Plate B - 2**). The grain size statistics show the mean grain sizes of individual samples range from 0.26 mm to 0.82 mm with an overall average of 0.44 mm (1.21 phi). The silt content (passing #230 sieve) in individual samples ranges from 0.01 % to 3.98 %, having an average of 0.68%. The fine gravel content varies from 0 % to 10.23 %, having an average of 1.05 %. The standard deviation values range from 0.6 phi to 1.67 phi, with an average of 0.93 phi, representing moderately well sorted to poorly sorted sediments. The moist Munsell color of the materials is predominately a value of 6 or lighter; occasionally there are some samples with a Munsell value of 5. A summary of the composite sediment statistics of the North St. Lucie Shoal is shown in **Table 2**. The North St. Lucie Shoal contains approximately 8.3 million cubic yards of beach-quality material.

Table 2. North St. Lucie Shoal Sediment Summary

	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color
North St. Lucie Shoal	0.44	1.21	1.05	0.68	0.93	2.5Y 6/2

*Retained in the #4 Sieve **Passing the #230 Sieve

Geologic cross-sections were developed for the North St. Lucie Shoal using the 2011 geotechnical data. The geologic cross-section of the North St. Lucie Shoal, from north (A) to south (A'), is shown on **Figure 5**. Two east-west geologic cross-sections of the North St. Lucie Shoal (B to B' and C to C') are shown on **Figure 6** and **Figure 7**, respectively. The thickness of beach-quality sand averages approximately 9 feet with a minimum of 1.9 feet and a maximum thickness of 16.6 feet. The vibracore logs, gradation curves, and statistical analysis of data from those samples are available upon request.

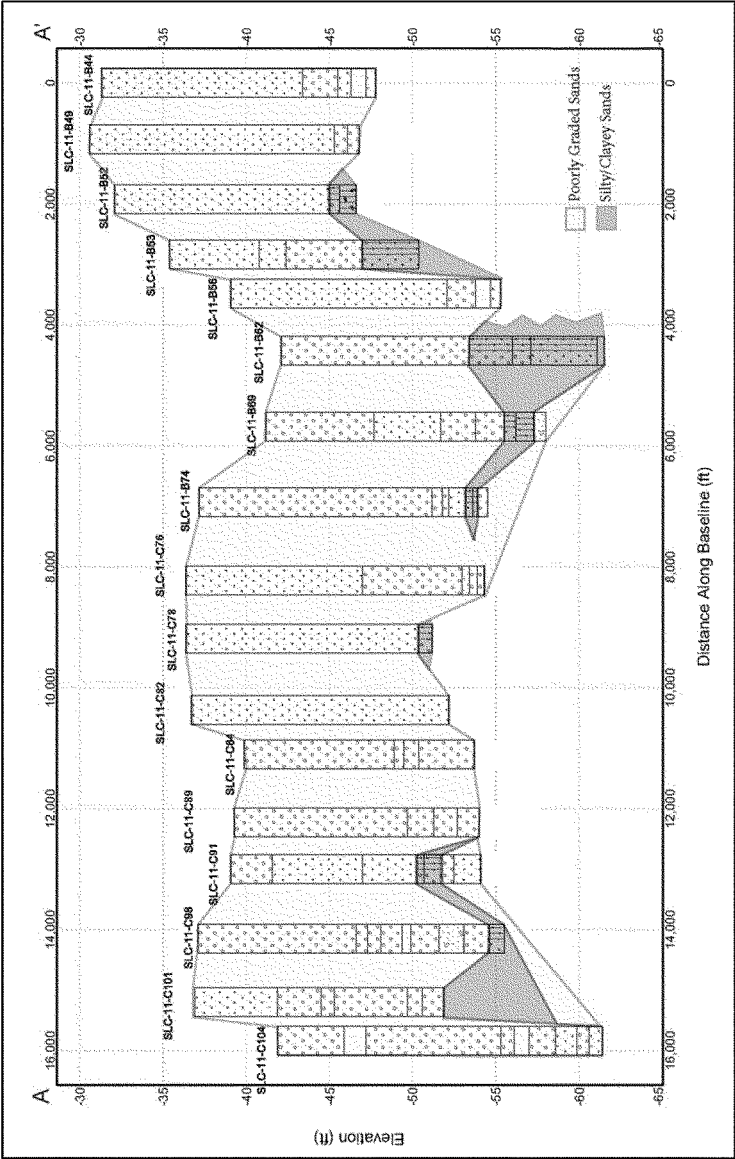


Figure 5. Geological cross section along the axis A - A' - North St. Lucie Shoal

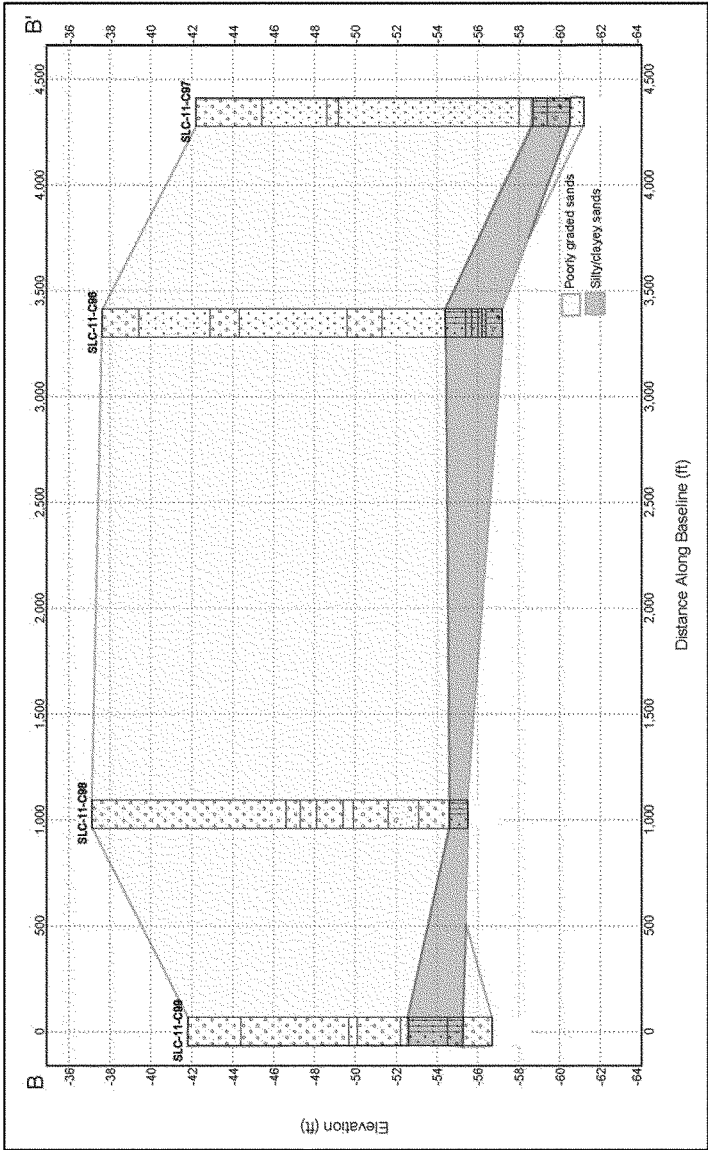


Figure 6. Geological cross section along the axis B - B' - North St. Lucie Shoal

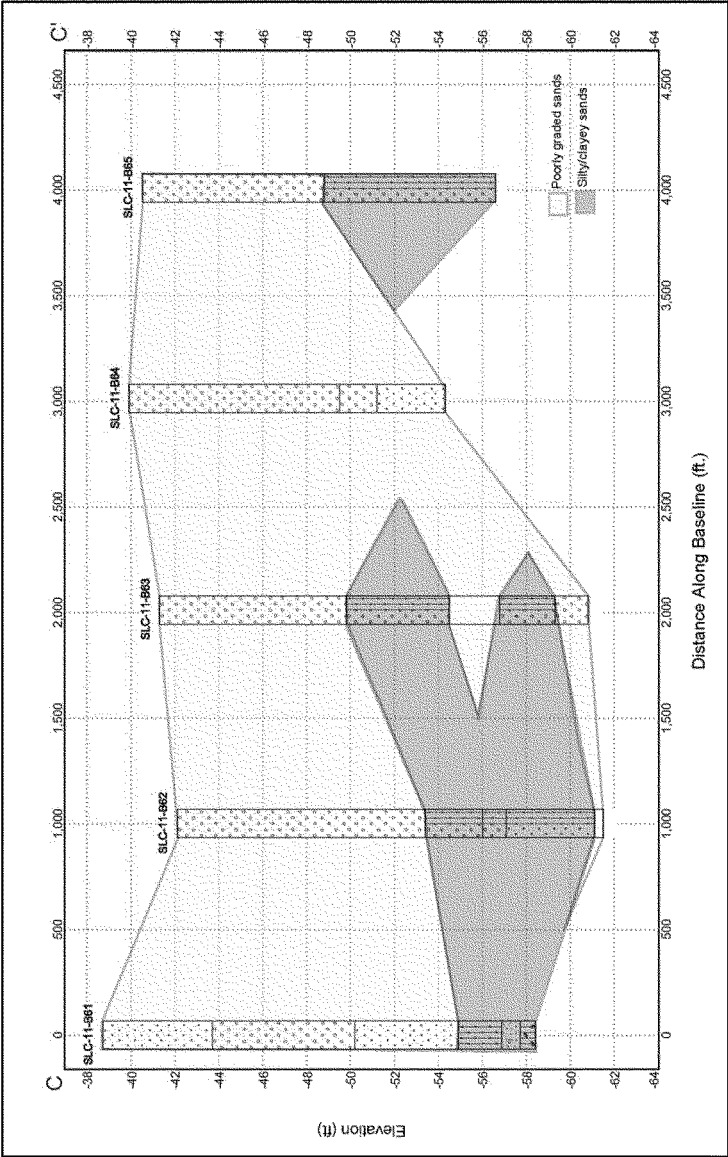


Figure 7. Geological cross section along the axis C - C' - North St. Lucie Shoal

3.2.2 South St. Lucie Shoal

The South St. Lucie Shoal sand source is centered approximately 4.0 miles offshore of R-106, roughly in the middle of the proposed placement area. The sand source covers an area of approximately 1.2 square miles (**Plate B - 3**). The grain size statistics show the mean grain sizes of individual samples range from 0.27 mm to 0.95 mm with an overall average of 0.47 mm (1.15 phi). The silt content (passing the #230 sieve) in individual samples ranges from 0.0% to 3.95%, having an average of 0.93%. The fine gravel content varies from 0.0% to 8.86%, having an average of 0.95%. The standard deviation values range from 0.55 phi to 1.63 phi, with an average of 0.91 phi, representing moderately well sorted to poorly sorted sediments. The moist Munsell color of the materials is predominantly a value of 6 or lighter; occasionally there are some samples with a Munsell value of 5. A summary of the composite sediment statistics of the North St. Lucie Shoal is shown in **Table 3**. The South St. Lucie Shoal contains approximately 2.3 million cubic yards of beach-quality material.

Table 3. South St. Lucie Shoal Sediment Summary

	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color
South St. Lucie Shoal	0.47	1.15	0.95	0.93	0.91	2.5Y 6/2

*Retained in the #4 Sieve **Passing the #230 Sieve

Geologic cross-sections were developed for the South St. Lucie Shoal using the 2011 geotechnical data. The geologic cross-section of the South St. Lucie Shoal, from north (A) to south (A'), is shown on **Figure 5**. One east-west geologic cross-section of the South St. Lucie Shoal (B to B') is shown on **Figure 9**. The thickness of beach-quality sand averages approximately 12.5 feet with a minimum of 6.3 feet and a maximum thickness of 18.0 feet. The vibrocore logs, gradation curves, and statistical analysis of data from those samples are available upon request.

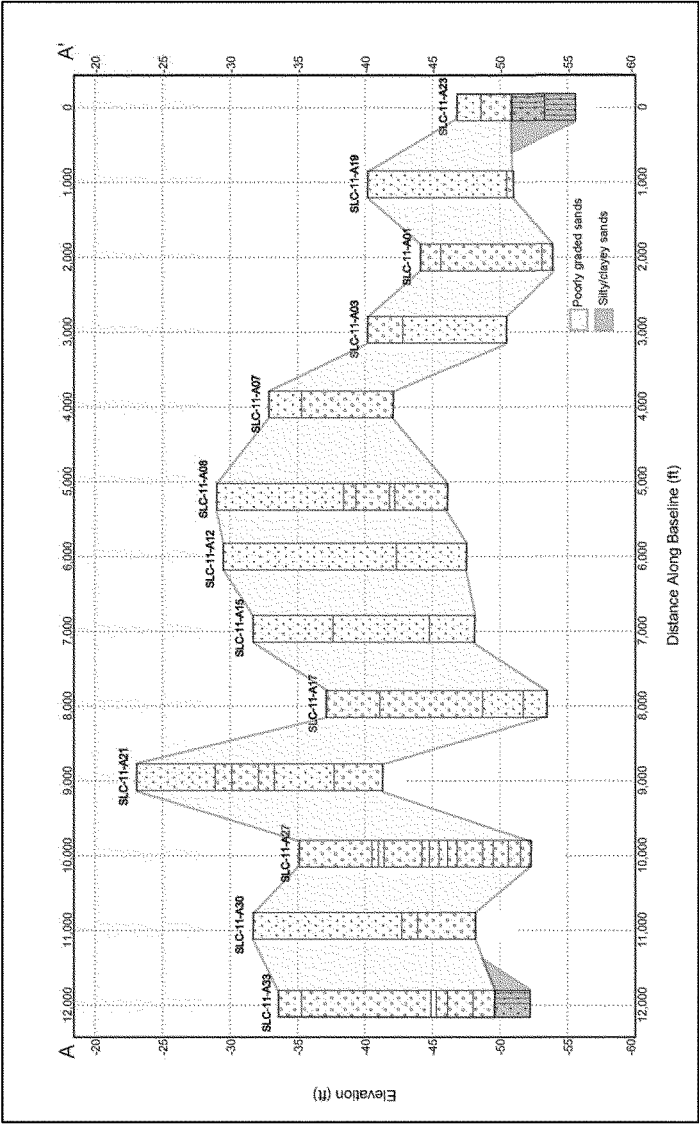


Figure 8. Geological cross section along the axis A - A' - South St. Lucie Shoal

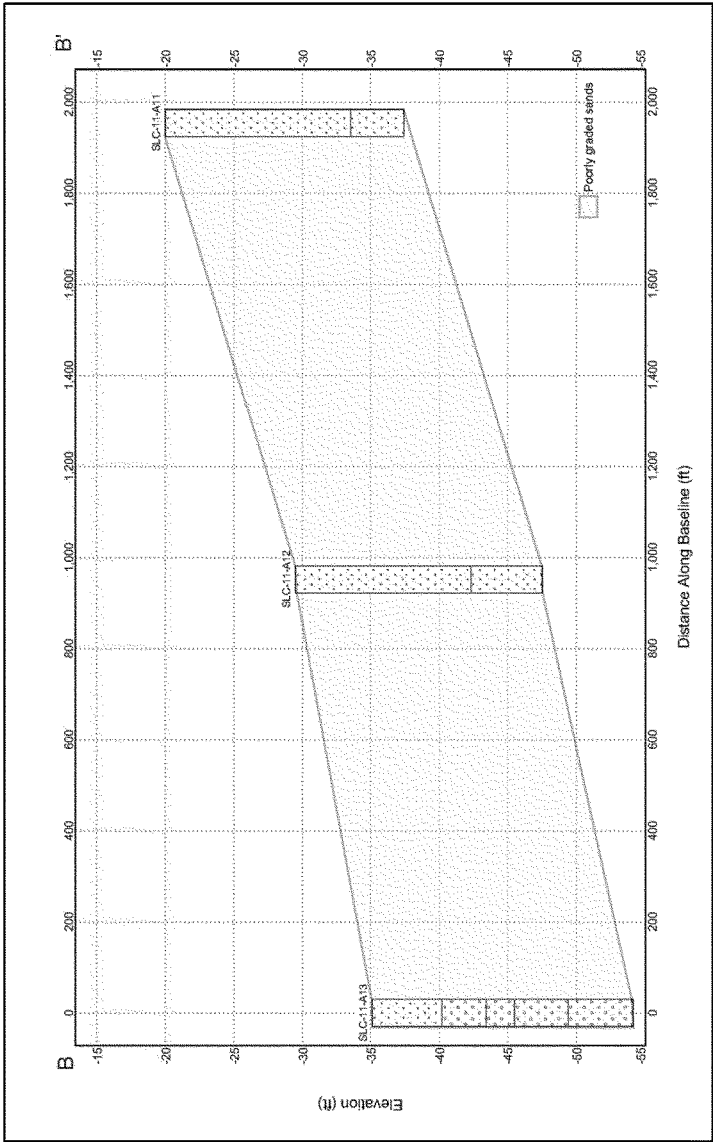


Figure 9. Geological cross section along the axis B - B' - South St. Lucie Shoal

4 COMPATIBILITY OF THE SAND SOURCES WITH THE BEACHES

Florida Administrative Code (F.A.C.) 62B-41.007(2)(j) requires that beach fill meets the following requirements:

- Predominately carbonate or quartz with a particle size distribution ranging between 0.062 mm (4 phi) and 4.76mm (-2.25 phi);
- Contain less than 5% silt passing the #230 sieve;
- Contain less than 5% gravel sized shell retained on the #4 sieve;
- Not contain coarse gravel, cobbles, or material retained on the ¾" sieve in a percentage greater than the native beach
- Be free of construction debris, toxic material, or other foreign matter;
- Be similar in color and grain size distribution; and
- Not result in cementation of the beach.

The proposed sand sources meet the requirements of the sand rule criteria, as outline above, and in 62B-41.007(2)(j), F.A.C. Grain size distribution and Overfill Factor are also used to determine compatibility between the proposed sand sources and the beaches of South Hutchinson Island.

4.1 GRAIN SIZE DISTRIBUTION

Grain size analyses were performed on beach samples from South Hutchinson Island and on discrete samples of the proposed offshore sand sources. An arithmetic composite sample was calculated from the granulometric results. The composite sample results for the beach and offshore sand sources are summarized in **Table 4** and discussed below.

The native South Hutchinson Island beach consisted of light gray to very pale brown, moderately to poorly sorted, medium grained sand. The material from the proposed offshore sand sources consists of olive brown to olive gray, fine to medium-grained skeletal sand with few to some fine-grained quartz and few to some gravel-size shell.

The testing results show that the material from the St. Lucie Shoal sand sources are very similar and compatible with the existing beach and also meet the requirements of Florida state regulation, 62B-41.007(2)(j), F.A.C. The color of this material is slightly darker than the native beach but will typically lighten when exposed to the sun. The most dissimilar characteristic is the mineral composition due to the higher shell content of the shoal material.

Table 4. Sediment Analysis Summary of Proposed Sand Sources.

Sand Source Composite	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color
North St. Lucie Shoal	0.44	1.21	1.05	0.68	0.93	2.5Y 6/2
South St. Lucie Shoal	0.47	1.15	0.95	0.93	0.91	2.5Y 6/2
Beach	0.50	1.08	1.52	0.23	0.94	10YR 7/2

*Retained in the #4 Sieve **Passing the #230 Sieve

4.2 OVERFILL AND RENOURISHMENT FACTOR

The Overfill and Renourishment Factors were calculated to estimate the predicted performance of the sand sources with respect to the native beach materials, both during initial beach stabilization and over the long term. Thus, they help in choosing the best available material. The factors also are used to calculate fill construction volume and renourishment volumes.

Overfill and Renourishment Factors are calculated using the sediment mean grain size and standard deviation of the native beach and the sand source in phi units.

4.2.1 Overfill Factor

The Overfill Factor (R_A) is primarily a volume factor which may be used to calculate an intentional overfill to compensate for volume loss during the initial construction. The R_A is used to determine which of the proposed sand sources will provide the lowest placement volume, and thus is most compatible with the existing beach.

The R_A for South Hutchinson Island was calculated using the USACE Coastal Engineering Manual (CEM) software program for each of the sand sources, and the results are in

Table 5. As a rule of thumb, for native beach material with a composite median grain diameter exceeding 0.2 mm, sand source material with a composite median diameter within plus or minus 0.02 mm of the native median grain diameter is considered compatible (US Army Corps of Engineers, 2003). The proposed sand sources from the St. Lucie Shoal are slightly finer than the native beach. However, both proposed sand sources are suitable for placement on the beaches of South Hutchinson Island.

Table 5. Summary of Overfill Factors for South Hutchinson Island

	Native Beach	North St. Lucie Shoal	South St. Lucie Shoal
Mean (mm)	0.50	0.44	0.47
Mean (phi)	1.08	1.21	1.15
Sorting / St. Dev (phi)	0.94	0.93	0.91
Overfill Factor, R_A (Native)	n/a	1.18	1.10

4.2.2 Renourishment Factor

The Renourishment Factor (R_j) estimates long term relative erosion rates of sand source materials with respect to native materials. This is done by assuming all grains have a finite residence time in the local littoral system before being transported offshore or alongshore. Larger grains remain longer. The R_j is primarily a measure of relative long-term stability.

The R_j for South Hutchinson Island was calculated using the USACE CEM software program for each of the sand sources, and the results are shown in **Table 6**. R_j values greater than one predict the sand source will erode at a higher rate than the native beach. Conversely, values of less than one predict the sand source is more stable than the native beach. Both proposed sand sources are suitable for placement on the beaches of South Hutchinson Island.

Table 6. Summary of Renourishment Factors for South Hutchinson Island

	Native Beach	North St. Lucie Shoal	South St. Lucie Shoal
Mean (mm)	0.50	0.44	0.47
Mean (phi)	1.08	1.21	1.15
Sorting / St. Dev (phi)	0.94	0.93	0.91
Renourishment Factor, R_j (Native)	n/a	1.16	1.11

4.3 COMPATIBILITY SUMMARY

The portion of the St. Lucie Shoal in Federal water contains significant volumes of beach quality sand that can be excellent sources for beach nourishment, although the materials in both sand sources are slightly finer than that at the project beach. In general, the materials in the North St. Lucie Shoal sand source are coarser than that in the South St. Lucie Shoal sand source.

Grain size distribution, Overfill Factor and Renourishment Factor computations were used to determine if the proposed offshore sand sources are compatible with the South Hutchinson Island beaches. The compatibility analysis results for South Hutchinson Island are summarized in

Table 5 and Table 6. The grain size analyses revealed that the sediments of the St Lucie Shoal are composed of olive brown to olive gray, fine to medium-grained skeletal sand with few to some fine-grained quartz and few to some gravel-size shell. The native beach is composed of light gray to very pale brown, moderately to poorly sorted, medium grained sand with 50% carbonate.

The Overfill and Renourishment Factors for South Hutchinson Island were calculated for each of the sand sources using the USACE CEM software program. The proposed sand sources within the St. Lucie shoal showed acceptable Overfill Factors and Renourishment Factors and are therefore suitable for placement on South Hutchinson Island's beaches.

5 REFERENCES

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PLATES

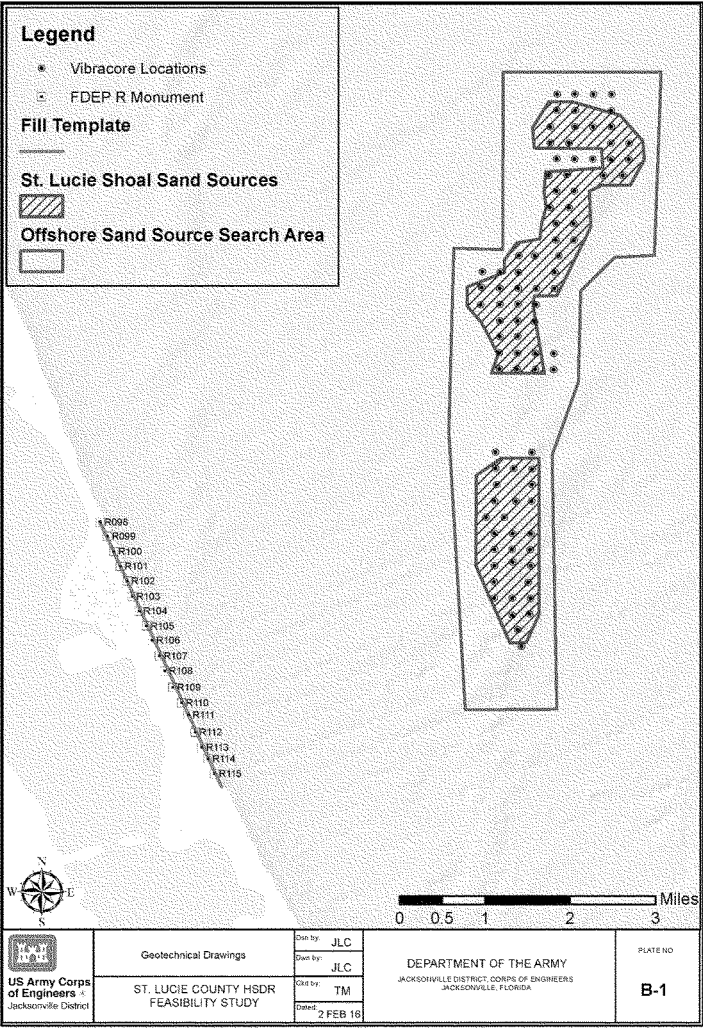


Plate B - 1. Overview of South Hutchinson Island, St. Lucie County, Florida and Proposed Sand Source Locations.

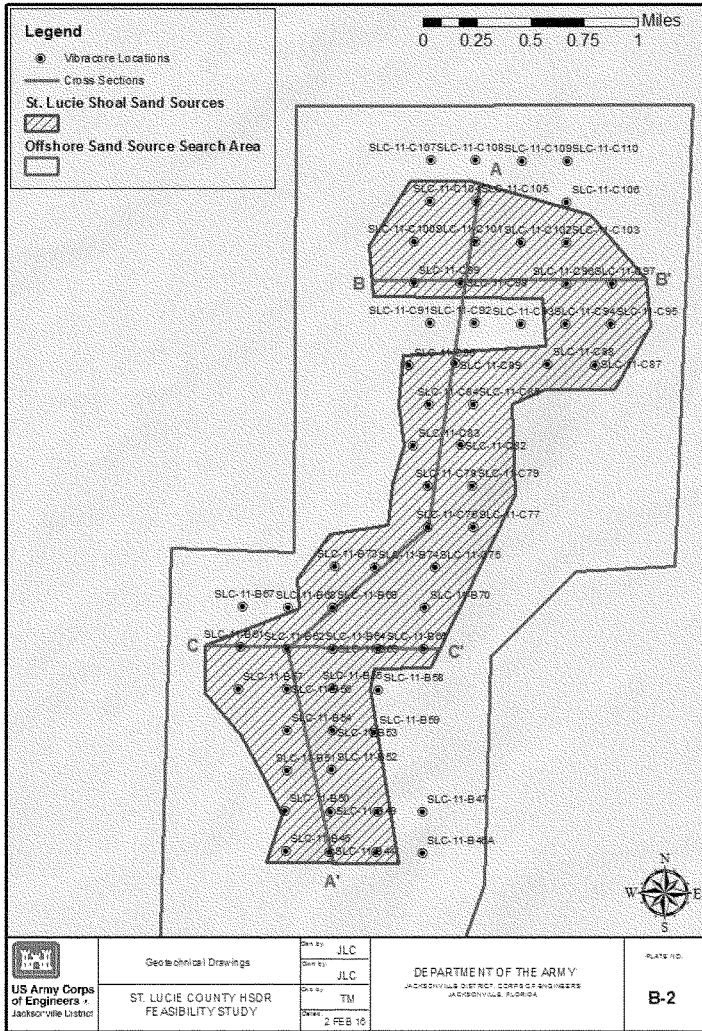


Plate B - 2. Proposed North St. Lucie Shoal Sand Source, Geological Cross Sections, and Vibracore Boring Locations.

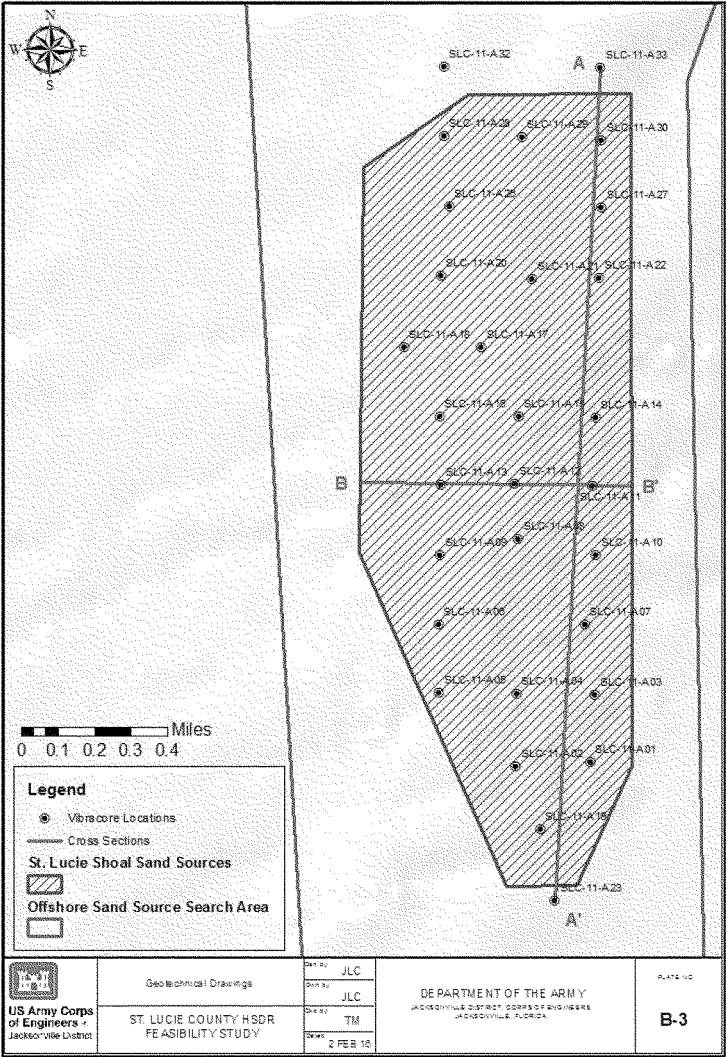


Plate B - 3. Proposed South St. Lucie Shoal Sand Source, Geological Cross Sections, and Vibracore Boring Locations.

SUB-APPENDIX

GRAIN SIZE ANALYSIS RESULTS FOR SOUTH HUTCHINSON ISLAND

Table D - 1. South Hutchinson Island, Grain Size Statistics

FDEP R-Monument	Sample Location	Mean (mm)	Mean (phi)	Percent Fine Gravel*	Percent Silt** (%)	Sorting / St. Dev (phi)	Percent Carbonate (%)	Munsell Color
R-98	Toe of Dune	0.46	1.12	0.00	0.28	0.76	51.80	10YR 7/2
	Mid-Berm	0.56	0.84	0.00	0.27	0.67	59.60	10YR 7/2
	MHW	0.47	1.09	0.24	0.29	0.87	41.60	10YR 7/2
	MLW	0.41	1.29	0.00	0.15	0.96	49.40	10YR 7/2
	-5	0.28	1.84	0.46	0.46	1.20	49.00	10YR 7/2
R-100	Toe of Dune	0.44	1.18	0.33	0.27	0.96	44.10	10YR 7/2
	Mid-Berm	0.39	1.36	0.03	0.23	0.72	44.40	10YR 7/2
	MHW	0.41	1.29	0.38	0.57	0.76	46.20	10YR 7/2
	MLW	0.38	1.40	0.14	0.02	0.67	44.30	10YR 7/2
	-5	0.74	0.43	14.03	0.29	2.05	66.00	10YR 7/2
R-105	Toe of Dune	0.49	1.03	3.07	0.08	0.99	48.80	10YR 7/2
	Mid-Berm	0.63	0.67	1.21	0.06	1.13	64.00	10YR 7/2
	MHW	0.63	0.67	0.00	0.00	0.98	65.60	10YR 7/3
	MLW	0.39	1.36	0.00	0.11	0.69	46.90	10YR 7/2
	-5	1.16	-0.21	4.58	0.23	1.18	85.00	10YR 7/2
R-110	Toe of Dune	0.55	0.86	0.00	0.25	0.82	55.10	10YR 7/2
	Mid-Berm	0.35	1.51	0.00	0.00	0.60	37.10	10YR 7/2
	MHW	0.40	1.32	0.00	0.14	0.77	47.70	10YR 7/3
	MLW	0.44	1.18	0.04	0.04	0.80	47.60	10YR 7/2
	-5	0.21	2.25	0.78	0.15	0.88	39.00	10YR 7/2
R-115	Toe of Dune	0.42	1.25	0.46	0.35	0.78	44.80	10YR 7/2
	Mid-Berm	0.55	0.86	0.40	0.44	0.83	60.00	10YR 7/3
	MHW	0.38	1.40	0.00	0.01	0.83	49.80	10YR 7/2
	MLW	0.47	1.09	0.48	0.03	0.84	49.50	10YR 7/2
	-5	1.00	0.00	11.33	0.93	1.69	72.00	10YR 7/2
South Hutchinson Island Composite		0.50	1.08	1.52	0.23	0.94	52.37	10YR 7/2

*Retained in the #4 Sieve, **Passing the #230 Sieve

GRAIN SIZE ANALYSIS RESULTS FOR NORTH ST. LUCIE SHOAL SAND SOURCES

Table D - 2. Sediment Analysis Results from Vibracores in North St. Lucie Shoal

Boring Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-B43	0.5	0.38	1.38	0.63	0.15	1	2.5Y 6/2
SLC-11-B44	0.5	0.44	1.2	0	0.04	0.65	2.5Y 6/3
	5	0.44	1.2	0	0.06	0.69	2.5Y 6/2
	10	0.42	1.26	0	0.39	0.77	2.5Y 6/2
	13	0.36	1.46	0.08	3.8	0.92	5Y 6/2
SLC-11-B45	1	0.44	1.19	1.13	0.09	0.87	2.5Y 6/2
	5	0.67	0.57	1.35	0.11	0.97	2.5Y 6/2
	9	0.38	1.39	0.31	0.41	0.9	2.5Y 6/2
SLC-11-B48	0.5	0.35	1.53	0.02	0.2	0.83	2.5Y 6/2
	4	0.35	1.51	0.25	0.21	0.84	2.5Y 6/2
SLC-11-B49	0.5	0.39	1.36	0.11	0.13	0.81	2.5Y 6/3
	4.5	0.43	1.21	0	0.21	0.76	2.5Y 6/2
	7.5	0.40	1.33	0	0.6	0.71	2.5Y 6/2
	12.5	0.48	1.06	0.34	0.47	0.8	2.5Y 6/2
SLC-11-B51	0.5	0.38	1.4	0.77	0.17	0.92	2.5Y 6/2
	5	0.44	1.17	0	0.44	0.71	2.5Y 6/2
	8.5	0.31	1.67	0	0.54	0.72	2.5Y 6/2
	11.5	0.35	1.53	0.27	3.52	0.88	5Y 6/2
SLC-11-B52	0.5	0.46	1.11	0.17	0.07	0.85	2.5Y 6/2
	4	0.36	1.47	0.35	0.19	0.73	2.5Y 6/2
	7.5	0.47	1.1	0.44	0.27	0.92	2.5Y 6/2
	11	0.39	1.37	0.05	1.29	0.85	5Y 6/2
SLC-11-B53	0.5	0.45	1.16	0.59	0.1	0.88	5Y 6/3
	4	0.32	1.65	0	0.19	0.75	5Y 5/2
	6	0.26	1.94	0	0.28	0.63	5Y 5/2
	9.5	0.48	1.07	3.04	0.59	1.26	5Y 6/2
SLC-11-B54	0.5	0.67	0.58	4.17	0.16	1.24	5Y 6/3
	3	0.53	0.92	2.05	0.27	1.12	5Y 6/2
	5.5	0.31	1.71	0.22	0.4	0.89	2.5Y 6/2
	9	0.34	1.55	0.03	0.44	0.73	2.5Y 6/2
	10.2	0.46	1.11	1.35	0.62	1.14	2.5Y 6/2
	14	0.36	1.47	0.05	0.99	0.85	2.5Y 6/2
SLC-11-B55	0.5	0.54	0.9	3.12	0.08	1.24	2.5Y 6/2

Boring Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-B55	4	0.64	0.65	0.81	0.32	0.92	2.5Y 6/2
	8	0.27	1.88	0.26	0.56	0.75	2.5Y 5/2
	11.5	0.50	0.99	4.64	1.66	1.59	5Y 6/2
	13.5	0.27	1.91	0.14	1.94	0.88	2.5Y 5/2
SLC-11-B56	0.5	0.50	1.01	1.65	0.78	0.97	2.5Y 6/2
	4	0.40	1.33	0.18	0.63	0.76	2.5Y 6/2
	7.5	0.41	1.29	0.04	0.57	0.74	2.5Y 6/2
	11.5	0.43	1.21	0.08	0.6	0.79	2.5Y 5/2
SLC-11-B57	0.5	0.45	1.16	0.36	0.07	0.81	2.5Y 6/2
	5.5	0.33	1.58	0	0.23	0.6	2.5Y 6/2
	9	0.43	1.22	0.67	0.82	0.92	5Y 6/2
SLC-11-B59	0.5	0.51	0.96	2.21	0.09	1.12	2.5Y 6/2
	4	0.48	1.06	1.07	0.14	1.03	2.5Y 6/2
	7.5	0.34	1.54	0	0.38	0.88	2.5Y 6/2
	10.5	0.63	0.66	10.23	3.69	1.67	2.5Y 5/1
	12	0.40	1.31	0.02	0.14	0.79	2.5Y 5/1
SLC-11-B61	0.5	0.38	1.38	0.25	0.23	0.78	2.5Y 6/2
	4	0.40	1.34	0	0.2	0.6	2.5Y 6/2
SLC-11-B62	0.5	0.40	1.32	0.92	0.1	0.87	2.5Y 6/2
	4	0.34	1.54	0.72	0.68	0.88	5Y 7/1
	7	0.37	1.42	0.97	1.43	1.21	5Y 6/2
SLC-11-B65	1.5	0.53	0.91	0.14	0.43	0.98	2.5Y 6/2
	5.5	0.46	1.12	0.37	1.15	0.95	2.5Y 6/1
SLC-11-B69	0.5	0.40	1.33	1.14	0.17	1.02	2.5Y 6/2
	4.5	0.44	1.18	0.54	0.44	1.05	5Y 7/1
SLC-11-B70	2.3	0.50	1.01	2.02	0.3	1.16	2.5Y 6/2
	6.3	0.48	1.05	0.75	0.47	1.04	2.5Y 6/1
	8.3	0.31	1.68	0.21	0.84	0.78	5Y 7/1
SLC-11-B73	1	0.56	0.83	3.84	0.32	1.37	2.5Y 6/2
	4.5	0.42	1.24	0.07	0.59	1.02	2.5Y 6/2
	7	0.36	1.47	0.64	0.86	0.97	2.5Y 6/2
SLC-11-B74	0.5	0.61	0.71	2.8	0.11	1.12	2.5Y 6/3
	4.5	0.40	1.31	0.08	0.38	0.76	2.5Y 6/2
	7.5	0.54	0.88	3.6	0.61	1.24	2.5Y 6/2
	12	0.39	1.36	0	0.9	0.98	2.5Y 6/2
	14	0.32	1.64	0.1	2.33	0.93	5Y 6/2

Boring Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel*	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-C100	0.5	0.65	0.63	5.84	0.17	1.51	2.5Y 6/2
	3	0.38	1.4	1.86	0.35	1.08	2.5Y 6/2
SLC-11-C101	0.5	0.63	0.67	0.11	0.45	0.91	2.5Y 6/3
	4	0.45	1.14	0.06	0.38	0.79	2.5Y 6/2
	6.5	0.32	1.65	0.07	0.82	0.86	2.5Y 6/2
SLC-11-C102	0.5	0.46	1.13	0	0.02	0.7	2.5Y 6/2
	4.5	0.48	1.07	0.22	0.08	0.85	2.5Y 6/2
	7	0.37	1.45	0	0.12	0.67	2.5Y 6/2
	11	0.33	1.58	0.03	0.22	0.63	2.5Y 6/2
	15.5	0.32	1.66	0	0.74	0.64	2.5Y 6/2
SLC-11-C103	0.5	0.51	0.96	1.05	0.23	1.09	2.5Y 6/2
SLC-11-C104	1	0.57	0.82	1.57	0.08	1.06	2.5Y 6/2
SLC-11-C110	0.5	0.37	1.43	0.23	0.26	0.85	2.5Y 6/2
	4.5	0.38	1.41	1	0.16	1.04	5Y 6/1
SLC-11-C75	0.5	0.51	0.97	0.61	0.37	0.9	2.5Y 6/2
	4	0.56	0.83	0.6	0.94	1.05	2.5Y 6/2
	7	0.47	1.09	0.16	0.8	0.89	2.5Y 6/3
SLC-11-C76	0.5	0.62	0.7	0.64	0.19	0.96	2.5Y 6/3
	4	0.39	1.36	0.2	0.51	0.77	2.5Y 6/2
	7	0.37	1.42	0.36	0.44	0.74	2.5Y 6/2
	10	0.42	1.24	0.06	0.59	0.87	2.5Y 6/2
	14	0.33	1.59	0.33	1.87	1.07	5Y 6/2
	16	0.31	1.7	0.04	2.99	0.89	5Y 6/2
SLC-11-C77	0.5	0.58	0.78	0.17	0.06	0.81	2.5Y 6/3
	4.5	0.42	1.25	0.05	0.44	0.72	2.5Y 6/2
	7	0.53	0.92	0.37	0.46	0.88	2.5Y 6/2
	10	0.46	1.12	0.23	0.71	0.93	5Y 6/2
	14	0.39	1.35	0	1.58	0.8	2.5Y 6/2
	16	0.39	1.37	0.06	3.4	0.91	5Y 7/2
SLC-11-C78	0.5	0.59	0.77	7.37	0.18	1.06	2.5Y 6/2
	4.5	0.41	1.28	0.09	0.26	0.84	2.5Y 6/2
	7	0.45	1.14	0.01	0.37	0.83	2.5Y 6/2
	10	0.33	1.58	0.31	0.93	0.83	5Y 6/1
	13	0.28	1.82	0	1.53	0.77	5Y 6/2
SLC-11-C79	0.5	0.55	0.86	1.13	0.07	0.94	2.5Y 6/3
	4	0.54	0.89	8.02	0.31	0.99	5Y 6/2

Boring Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-C79	7	0.40	1.32	0.07	0.6	0.77	2.5Y 6/2
	10	0.46	1.13	0.07	0.24	0.93	2.5Y 6/2
	14.5	0.35	1.5	0.14	1.34	0.79	5Y 6/2
SLC-11-C82	0.5	0.63	0.67	0	0.01	0.82	2.5Y 6/3
	4	0.37	1.45	0	0.46	0.69	2.5Y 6/2
	7	0.40	1.31	0.57	0.66	0.91	2.5Y 6/2
	10	0.38	1.39	0.09	1.54	0.85	2.5Y 6/2
	14.5	0.36	1.49	0.38	3.98	0.97	5Y 7/2
SLC-11-C84	0.5	0.60	0.73	0.56	0.1	0.89	2.5Y 6/3
	4.5	0.54	0.89	0.22	0.42	0.97	2.5Y 6/2
	7	0.43	1.22	1.26	1.19	1.09	2.5Y 6/2
	10	0.67	0.57	6.37	1.06	1.6	2.5Y 6/2
	12	0.29	1.77	0.55	2.58	1.06	2.5Y 6/1
SLC-11-C85	0.5	0.55	0.85	0	0.06	0.66	2.5Y 6/3
	4	0.52	0.93	0.71	0.23	0.95	2.5Y 6/2
	7	0.39	1.35	0.28	0.32	0.67	2.5Y 6/2
	10	0.53	0.92	0.33	1.31	0.79	2.5Y 6/2
	14	0.40	1.31	0.08	2.39	0.94	2.5Y 6/2
SLC-11-C87	0.5	0.41	1.28	0.9	0.04	0.91	2.5Y 6/3
	4.5	0.31	1.7	0	0.21	0.66	2.5Y 6/2
SLC-11-C88	0.5	0.41	1.27	1.02	0.08	0.96	2.5Y 6/2
	4	0.70	0.52	0.05	0.26	0.87	2.5Y 6/3
	6.5	0.36	1.49	0	0.44	0.69	5Y 6/1
SLC-11-C89	0.5	0.77	0.38	7.18	0.19	1.34	2.5Y 6/3
	4	0.43	1.21	0	0.63	0.72	2.5Y 6/2
	7	0.48	1.05	0.27	1.34	1.05	2.5Y 6/2
	11.3	0.30	1.75	0.07	2.53	0.98	5Y 6/1
	12.5	0.64	0.64	2.9	1.46	1.39	2.5Y 7/1
	14	0.26	1.94	0.16	3.17	1	2.5Y 5/2
SLC-11-C94	0.5	0.57	0.81	3.09	0.04	1.18	2.5Y 6/2
	5	0.40	1.32	0.45	0.59	0.89	5Y 6/2
SLC-11-C95	0.5	0.34	1.54	0.61	0.16	0.88	5Y 6/2
	4.5	0.34	1.57	0	0.22	0.73	2.5Y 6/2
SLC-11-C96	0.5	0.42	1.26	1	0.13	1.02	2.5Y 6/2
	4.5	0.33	1.59	0	0.19	0.67	2.5Y 6/2
	6	0.47	1.09	0.12	0.18	0.96	2.5Y 6/2

Boring Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-C97	1	0.75	0.42	6.79	0.1	1.43	2.5Y 6/3
	4.5	0.30	1.72	0	0.19	0.65	2.5Y 6/2
	6.4	0.49	1.02	5.98	0.22	1.33	2.5Y 6/2
	12.5	0.27	1.9	0	0.66	0.74	2.5Y 6/2
SLC-11-C98	0.5	0.82	0.28	7.47	0.03	1.38	2.5Y 6/2
	5.5	0.47	1.08	0	0.18	0.79	2.5Y 6/2
	9.5	0.64	0.64	0.84	0.36	1.07	2.5Y 6/2
	10.5	0.73	0.45	6.4	3.34	1.44	2.5Y 6/2
SLC-11-C99	1	0.69	0.54	6.2	0.11	1.38	2.5Y 6/2
	4	0.36	1.49	1.86	1.76	1.17	2.5Y 6/2
	6.5	0.42	1.26	0.06	0.46	0.81	2.5Y 6/2
	9	0.34	1.57	0.03	0.7	1	5Y 6/1
North St. Lucie Shoal Composite		0.44	1.21	1.05	0.68	0.93	2.5Y 6/2

GRAIN SIZE ANALYSIS RESULTS FOR SOUTH ST. LUCIE SHOAL SAND SOURCES**Table D - 3. Sediment Analysis Results from Vibracores in South St. Lucie Shoal**

Sample Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-A01	0.5	0.44	1.18	1.35	0.21	1.03	2.5Y 6/2
	4	0.47	1.1	0.15	0.68	0.86	5Y 5/2
	7	0.41	1.27	0.3	0.96	0.86	5Y 5/2
SLC-11-A02	0.5	0.50	0.99	0.06	0.17	0.78	2.5Y 6/2
	3.5	0.46	1.12	0.1	0.11	0.7	2.5Y 6/3
	6	0.39	1.35	0.45	0.35	0.86	5Y 5/2
	9.5	0.40	1.34	0.63	1.58	1	5Y 6/2
SLC-11-A03	0.5	0.48	1.07	0.29	0	0.86	2.5Y 6/2
	4.5	0.36	1.47	0.13	0.56	0.79	5Y 5/2
	8	0.46	1.11	1.71	0.59	0.97	5Y 5/2
SLC-11-A04	0.5	0.59	0.77	0.34	0.23	0.84	2.5Y 6/2
	4.5	0.43	1.23	0.29	0.47	0.7	5Y 7/1
	7	0.36	1.47	0	0.78	0.66	2.5Y 6/2
	11	0.41	1.3	0.07	1.59	0.99	5Y 7/1
	14.5	0.48	1.07	0.23	1.03	0.93	5Y 7/1
	17	0.45	1.16	0.49	1.04	0.99	5Y 7/1
SLC-11-A05	0.5	0.47	1.08	0.77	0.09	0.87	2.5Y 6/2
	3.5	0.68	0.56	5.56	0.21	1.35	2.5Y 7/1
	6	0.40	1.32	0.14	0.45	0.75	5Y 5/2
	7.5	0.70	0.51	6.02	2.43	1.44	2.5Y 7/1
SLC-11-A06	0.5	0.46	1.13	1.16	0.25	0.95	2.5Y 6/2
	4.5	0.35	1.53	0.1	0.3	0.74	5Y 5/2
	8	0.45	1.14	1.85	1.34	1.19	5Y 5/1
	9.5	0.52	0.95	2.83	3.7	1.29	5Y 6/1
	11	0.42	1.26	0.09	1.22	0.84	5Y 6/1
SLC-11-A07	0.5	0.40	1.32	0.23	0.09	0.71	2.5Y 6/2
	4.5	0.32	1.63	0.2	0.96	0.95	5Y 5/2
	7	0.39	1.36	0.78	0.66	0.94	5Y 5/2
SLC-11-A08	0.5	0.49	1.03	0.15	0.04	0.77	2.5Y 6/2
	5	0.48	1.07	0.04	0.08	0.71	2.5Y 6/2
	8.5	0.46	1.13	1.49	0.21	0.96	2.5Y 7/1
	9.5	0.80	0.32	8.86	1.63	1.63	2.5Y 7/1
	14.5	0.41	1.29	0.68	0.8	0.89	2.5Y 6/2

Sample Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel*	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-A09	0.5	0.5	0.61	0.72	5.86	0.15	1.2
	5	5	0.44	1.18	0.49	0.2	0.85
	8.5	8.5	0.69	0.53	5.99	2.04	1.4
	11.5	11.5	0.45	1.16	0.11	0.74	0.91
SLC-11-A10	0.5	0.5	0.49	1.04	0.34	0.14	0.79
	4.5	4.5	0.45	1.14	0.03	0.33	0.77
	7.5	7.5	0.47	1.09	0.09	0.44	0.76
	11	11	0.33	1.6	0	0.99	0.71
SLC-11-A11	0.5	0.5	0.64	0.64	1.09	0.06	0.94
	4.5	4.5	0.59	0.75	0.52	0.06	0.9
	8	8	0.38	1.41	0.15	0.76	0.64
	12	12	0.34	1.57	0.29	3.54	0.75
	15.5	15.5	0.30	1.76	0	2.89	0.72
SLC-11-A12	0.5	0.5	0.45	1.15	2.35	0.08	1.18
	7	7	0.63	0.66	0.16	0.17	0.74
	11	11	0.44	1.18	0.19	0.79	0.83
	15	15	0.27	1.88	0.06	3.08	0.83
SLC-11-A13	0.5	0.5	0.58	0.79	1.14	0.1	0.89
	4	4	0.53	0.92	0.47	0.1	0.8
	6	6	0.78	0.36	4.26	0.2	1.26
SLC-11-A14	0.5	0.5	0.63	0.66	0.12	0.13	0.7
	4.5	4.5	0.55	0.85	0.13	0.09	0.73
	8	8	0.63	0.66	0	0.09	0.72
	12.5	12.5	0.55	0.85	0.63	0.39	0.89
	14.1	14.1	0.30	1.73	0	2.62	0.63
	17	17	0.52	0.94	0.27	0.42	0.88
SLC-11-A15	0.5	0.5	0.54	0.88	0.29	0.09	0.78
	4	4	0.61	0.72	0.11	0.1	0.8
	10	10	0.40	1.32	0	3.26	0.79
	15	15	0.32	1.66	0	3.95	0.59
SLC-11-A16	0.5	0.5	0.52	0.93	0.29	0.17	0.78
	6.5	6.5	0.42	1.26	0.07	0.11	0.72
	10	10	0.37	1.42	0	0.26	0.86
	14.5	14.5	0.57	0.8	2.69	2.61	1.36
SLC-11-A17	0.5	0.5	0.49	1.04	0.62	0.09	0.95
	4.5	4.5	0.56	0.83	0.33	0.12	0.96

Sample Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel* (%)	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-A17	8	0.38	1.38	0.17	0.34	0.82	5Y 5/2
	12.5	0.42	1.26	0.03	0.82	0.8	2.5Y 5/1
SLC-11-A18	0.5	0.68	0.56	1.12	0.23	1.07	2.5Y 7/1
	4	0.37	1.42	0	0.41	0.76	2.5Y 5/1
	6.5	0.36	1.49	0	0.44	0.81	5Y 5/2
SLC-11-A19	0.5	0.37	1.43	0	0.07	0.61	2.5Y 6/2
	4	0.37	1.43	0	0.96	0.8	5Y 5/2
	7.5	0.42	1.25	0	0.5	0.83	5Y 5/2
SLC-11-A20	0.5	0.56	0.84	2.21	0.31	1.1	2.5Y 6/3
	4	0.50	1	0.87	0.48	0.92	5Y 5/2
	5.5	0.58	0.79	1.57	1	1.19	5Y 5/2
	8	0.33	1.59	0.28	1.02	0.91	2.5Y 5/1
	12	0.30	1.75	0	0.45	0.67	5Y 5/2
	15.5	0.33	1.62	0	2.15	0.79	2.5Y 5/1
SLC-11-A21	0.5	0.49	1.04	0	0.13	0.55	2.5Y 6/3
	4	0.57	0.8	0.04	0.47	0.75	2.5Y 6/3
	7.5	0.47	1.1	0.61	0.37	1.02	5Y 5/2
	9.5	0.95	0.07	7.37	0.5	1.31	2.5Y 7/1
	13.5	0.36	1.48	0	1.82	0.69	5Y 5/2
	16.5	0.34	1.54	0	0.91	0.91	2.5Y 5/1
SLC-11-A22	0.5	0.45	1.15	0	0.11	0.73	2.5Y 6/2
	4.5	0.39	1.36	0.27	0.77	0.86	5Y 5/2
	8	0.37	1.42	0.28	1.11	0.99	5Y 5/2
	13	0.33	1.59	0	0.65	0.75	5Y 5/2
	16.5	0.32	1.63	0	2.19	1.01	2.5Y 5/1
SLC-11-A26	0.5	0.63	0.67	0.78	0.18	0.83	2.5Y 6/3
	4.5	0.48	1.07	2.19	3.14	1.11	5Y 5/2
	7	0.59	0.77	3.36	3.23	1.19	5Y 5/2
	8.2	0.65	0.62	2.63	0.84	1.29	2.5Y 7/1
	13	0.28	1.84	0	0.97	0.8	2.5Y 5/1
SLC-11-A27	0.5	0.45	1.16	0.21	0.32	0.78	2.5Y 6/2
	4.5	0.48	1.05	0.53	1.11	1.06	5Y 5/2
	5.4	0.30	1.72	0	0.78	0.76	2.5Y 5/1
	8	0.31	1.67	0.33	1.02	1	2.5Y 5/1
	9.4	0.55	0.85	5.72	1.48	1.53	5Y 5/2
	11.7	0.32	1.63	0.15	1.13	0.95	5Y 5/1

Sample Number	Sample Depth (ft)	Mean (mm)	Mean (phi)	Percent Fine Gravel*	Percent Silt** (%)	Sorting / St. Dev (phi)	Munsell Color (moist)
SLC-11-A29	1	0.46	1.12	1.75	0.17	1.06	2.5Y 6/2
	4.5	0.54	0.89	0.42	0.15	0.79	2.5Y 6/3
	7.5	0.38	1.38	0.28	2.82	0.84	2.5Y 6/2
	9.3	0.43	1.22	0.24	3.26	0.99	2.5Y 6/2
	14	0.45	1.16	2.09	2.7	1.15	2.5Y 6/2
SLC-11-A30	1	0.42	1.24	0.19	0.01	0.71	2.5Y 6/2
	4.5	0.42	1.24	0	0.17	0.77	2.5Y 6/3
	7.5	0.37	1.44	0.12	0.38	0.76	2.5Y 6/2
	11.5	0.55	0.85	4.13	3.39	1.43	2.5Y 6/2
	15.5	0.40	1.31	0.09	1.22	0.97	2.5Y 6/2
SLC-11-A33	0.5	0.49	1.02	0.33	0.36	0.87	2.5Y 6/2
	3	0.36	1.49	0.54	1.09	0.85	2.5Y 6/2
	7.5	0.47	1.1	2.87	3.27	1.29	2.5Y 6/2
	13	0.47	1.1	2.02	3.24	1.17	2.5Y 6/2
South St. Lucie Shoal Composite			0.47	1.15	0.95	0.93	0.91

*Retained in the #4 Sieve, **Passing the #230 Sieve

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX E

Real Estate Plan



**US Army Corps
of Engineers**
Jacksonville District

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REAL ESTATE PLAN

1. STATEMENT OF PURPOSE

This Real Estate Plan (REP) is in support of the St. Lucie County, Florida Coastal Storm Risk Management (CSRM) Feasibility Study and Environmental Assessment. The study focuses on the erosion problems and potential storm vulnerability of structures on the southern portion of Hutchinson Island along the shoreline bordering the Atlantic Ocean in St. Lucie County, Florida.

This Real Estate Plan is tentative in nature and is intended for planning purposes only. Both the final real property lines and estimates of value are subject to change even after approval of this report.

2. PROJECT AND STUDY AUTHORIZATION

A Reconnaissance Study (Section 905(b), WRDA 1986 Analysis) was initiated on 25 February 2002 as an initial response to two Resolutions by the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The two resolutions are listed below:

Resolution Docket 2634 St. Lucie County, Florida Shore Protection dated 11 April 2000 states: *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County in the area north of the Ft. Pierce Inlet, the southern five miles of St. Lucie County, and adjacent shorelines."*

Resolution Docket 2757 St. Lucie County, Florida Shore Protection dated 23 July 1998 states: *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County from the current project for Ft. Pierce Beach, Florida southward to the Martin County Line."*

The final St. Lucie County, Florida Section 905(b) Reconnaissance Study was approved on 1 August 2003 and resulted in the finding that there was a Federal interest in proceeding into the feasibility phase.

The authority for conducting this feasibility study is contained in a memorandum dated 1 August 2003 from USACE South Atlantic Division (SAD) stating the following:

"The Section 905(b) analysis for St. Lucie County, Florida, and the letter of intent are approved for proceeding into the feasibility phase of planning for the five southernmost miles of the study area."

3. PROJECT LOCATION

St. Lucie County is located along the east coast of south-central Florida, approximately 225 miles south of Jacksonville and 100 miles north of Miami (**Figure E-1 – Project Location**). The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island, bordered by the Atlantic Ocean to the east, and the Indian River Lagoon (Atlantic Intracoastal Waterway) to the west. Hutchinson Island is split by Fort Pierce Inlet into North Hutchinson Island and South Hutchinson Island.



Figure E-1 Project Location

4. PROJECT DESCRIPTION

a. The study area is a 5 mile stretch of shoreline which is located on Hutchinson Island. This area extends along the southern region of St. Lucie County's Atlantic coastline, from FDEP survey range monuments¹ R-77 through R-115, southward to the St. Lucie County/Martin County line. **(Figure E-2 – Study Area)**

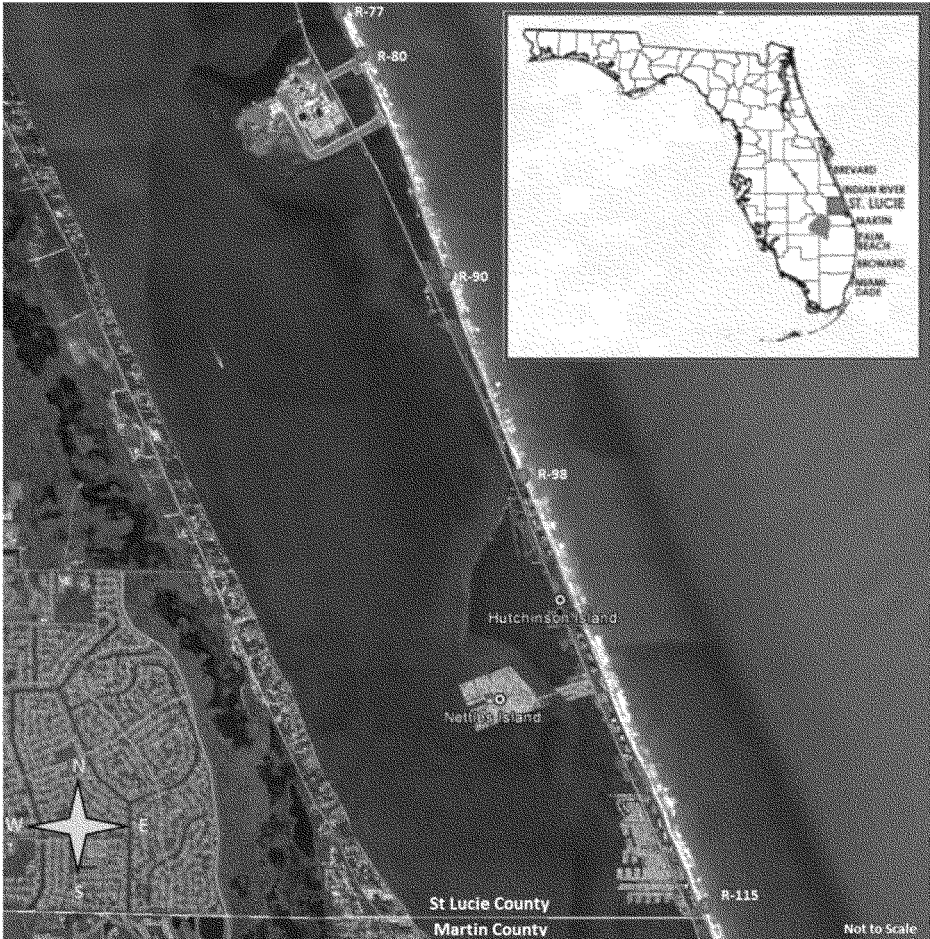


Figure E-2 Study Area

¹ FDEP reference (R) monuments are located approximately every 1000 feet along the shoreline and serve as geographic reference points for historic and contemporary shoreline monitoring. They are used as reference points throughout this report.

b. The recommended plan covers 3.3 miles of the shoreline between FDEP monuments R-98.5 and the Martin County line with tapers extending to the north from R-98.5 to R-97.5 and to the south from R-1 to R-2. **(Figure E-3 – Project Maps)** This design plan provides for a 20 foot berm extension from the existing dune. The expected volume of beach-fill material for the initial construction of the design beach profile will require an average of 422,000 cubic yards of material.

The borrow areas are located in the Atlantic Ocean off the shores of the St. Lucie County. The north borrow area sand source is approximately 5 miles offshore at the northern end of the proposed placement area. The south borrow area sand source is approximately 4 miles offshore roughly in the middle of the proposed placement area. **(Figure E-4 – Borrow Area Map)**

Figure E-3 - Project Map (Map 1 of 4)

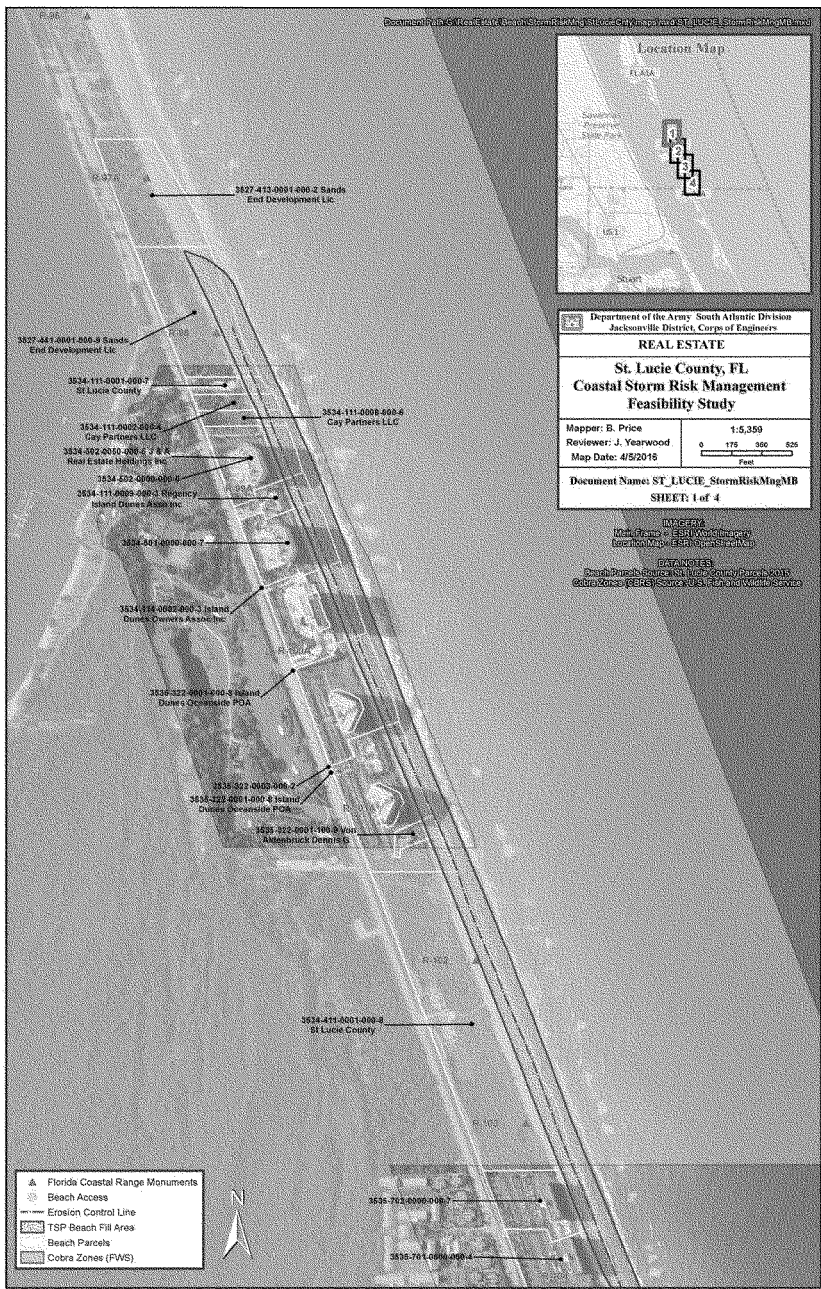


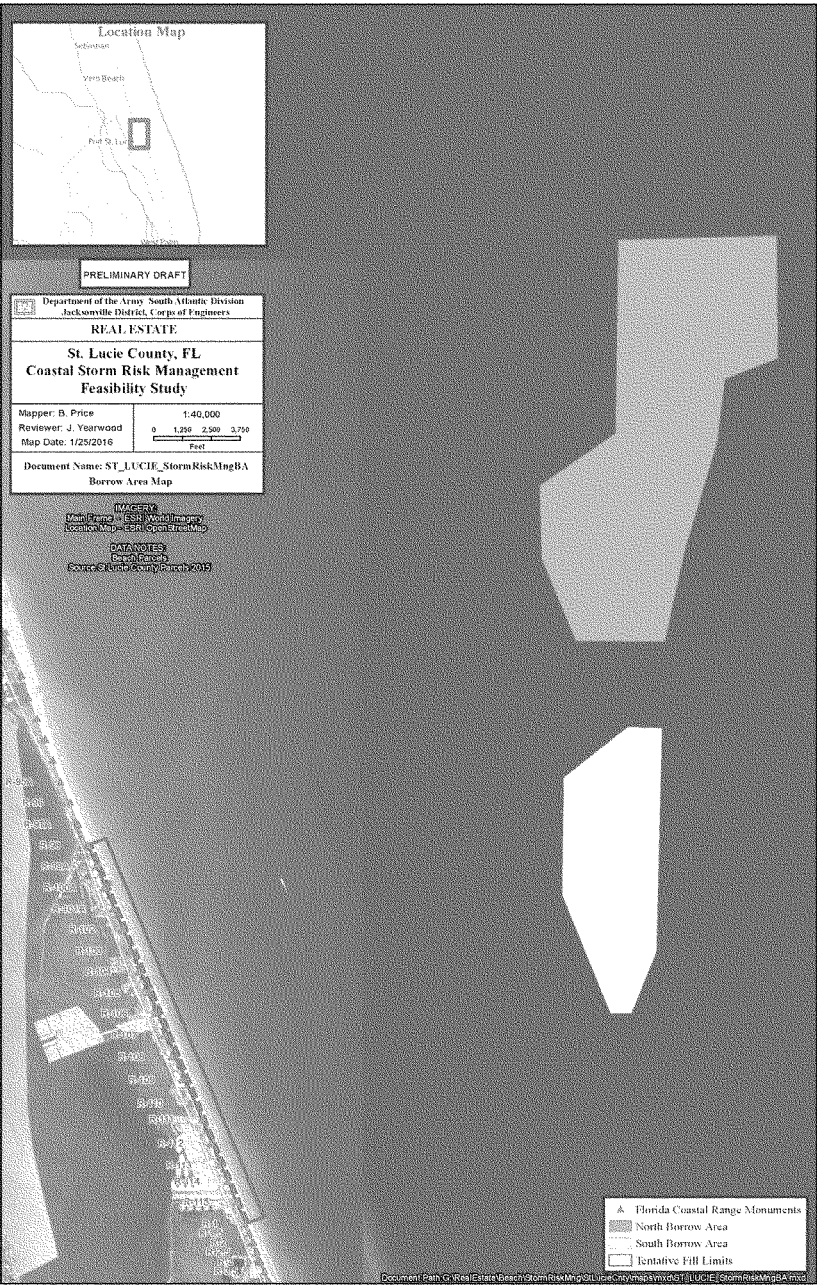
Figure E-3 - Project Map (Map 2 of 4)



Figure E-3 - Project Map (Map 4 of 4)



Figure E-4 – Borrow Area Map



5. REAL ESTATE REQUIREMENTS

The State of Florida beach nourishment, beach restoration, and erosion control projects are established pursuant to Florida Statute, Section 161.141, Property Rights of State and Private and Private Upland Owners in Beach Restoration Project Areas. The Statute requires a mean high water boundary line be determined between state sovereign lands and the adjacent upland property. The line is referred to as an erosion control line (ECL). Florida Statute, Section 161.191, Vesting of Title to Lands, states that titles to all lands seaward of the ECL shall be vested to the state by right of its sovereignty. The lands landward of the ECL remain vested to the upland owner.

The Erosion Control Line (ECL) has been established, and in accordance with the Interagency Coordination Agreement for Civil Works Projects, executed by the Florida Department of Environment Protection and the U.S. Army Corps of Engineers, Mobile and Jacksonville Districts, on February 28, 2006, the State of Florida issues a Sovereign Submerged Lands Authorization (SSLA) to the project sponsor. The SSLA is contained within the Consolidated Joint Coastal (CJC) Permit for placement areas located seaward of the ECL. The State of Florida issues the permit in ten year increments in connection with the use of these lands.

Perpetual beach storm damage reduction easements will be required over approximately 52 parcels. There are approximately 48 privately owned parcels and 4 public access/parking parcels owned in fee by the non-federal sponsor located within the current project footprint.

A noncompetitive negotiated agreement will be required from the Bureau of Ocean Energy Management (BOEM) in accordance with Outer Continental Shelf Lands Act for the mining of sand from the offshore borrow areas. A sample is located behind Exhibit E

Staging areas will require temporary work area easements, if not located within the perpetual storm damage reduction easement areas. Staging areas have not yet been identified. Access to the project and the staging areas will be by public roads and non-federal sponsor owned lands situated within the project area.

6. STANDARD ESTATES

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 United States, for use by the United States, 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.

7. NON STANDARD ESTATES

As noted in Section 5, Real Estate Requirements; The State of Florida will issue a Consolidated Joint Coastal Permit and Sovereign Submerged Lands Authorization for use of lands seaward of the ECL. The Consolidated Joint Coastal Permit and Sovereign Submerged Lands Authorization are considered non-standard estate. A sample of the Consolidated Joint Coastal Permit is attached as Exhibit C and a sample of Sovereign Submerged Lands Authorization is attached as Exhibit D.

A Memorandum of Agreement between the Bureau of Ocean Energy Management, the U.S. Army Corps of Engineers, and the non-federal sponsor will be executed pursuant to 43 United States Code, Section 1337(k) (2) Agreements for Use of Resources for Shore Protection, Beach or Coastal Wetlands Restoration, or other Projects, "the Secretary may negotiate with any person an agreement for the use of the Outer Continental Shelf sand, gravel and shell resources for (1) for use in a program of, or project for, shore protection, beach restoration, or local government agency, or (2) for use in a construction project,

that is funded in whole or in part by or authorized by the Federal Government. A sample of the document is attached as Exhibit E.

8. FEDERALLY GOVERNMENT-OWNED LAND

There are no Federal Government known lands in the project area.

9. NON-FEDERALLY OWNED LAND

The non-Federal lands are owned by the non-federal sponsor, private landowners and commercial landowners.

10. NON-FEDERAL OPERATION AND MAINTAINANCE RESPONSIBILITIES

St. Lucie County is the Non-Federal Sponsor (NFS) for the project. The non-federal sponsor has the responsibility to acquire all real estate interests required for the Project. The non-federal sponsor will have operation and maintenance responsibility for the project once construction has been completed. Future periodic nourishments are considered construction and will be performed in accordance with the Project Partnership Agreement, when approved.

11. NON-FEDERAL SPONSOR'S AUTHORITY TO PARTICIPATE IN PROJECT

St. Lucie County, Florida is a political subdivision of the State of Florida as provided by Florida Statute Title XI, Chapter 161, Section 141, Beach and Shore Preservation to, "establish and administer programs of housing, slum clearance, community redevelopment, conservation, flood and beach erosion control, air pollution control, and navigation and drainage and cooperate with governmental agencies and private enterprises in the development and operation of such programs."

The non-federal sponsor has been an integral part of the Project Delivery Team (PDT) from the conception of the project. At each step of the process, the NFS has contributed to the available information and participated in the formulation of this study. The Assessment of the NFS Real Estate Acquisition Capability is attached as Exhibit A. The Risk Letter is attached as Exhibit B, and advises the non-federal sponsor that lands should not be acquired for the project prior to execution of the Project Partnership Agreement (PPA).

12. NAVIGATION SERVITUDE

In accordance with CECC-R Bulletin 14-05, Availability of the Navigation Servitude for Coastal Storm Damage Reduction Projects dated April 9, 2014, navigational servitude is not applicable to this project.

13. ATTITUDE OF THE LANDOWNERS

The St. Lucie County, private landowners, commercial landowners, and local communities fully support the project.

14. MINERALS

Preliminary assessment indicates no known present or anticipated mineral or sub-surface mineral extraction activities within the vicinity of the proposed area which may affect construction, operation, or maintenance of the project.

15. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

There are no known HTRW identified within the project area.

16. INDUCED FLOODING

There will be no induced flooding directly associated with this project.

17. ZONING ORDINANCES

Application or enactment of zoning ordinances will not be used in lieu of acquisition.

18. RELOCATIONS ASSISTANCE (PUBLIC LAW 91-646)

No persons, businesses or structures will be impacted by the project. There will be no relocations under PL 91-646 for this project.

19. RELOCATIONS, ALTERATIONS, VACATIONS, AND ABANDONMENTS (UTILITIES, STRUCTURES AND FACILITIES, CEMETERIES, AND TOWNS).

There are no structural facilities to be affected by the construction of the project.

20. STANDING TIMBER AND VEGETATIVE COVER

Existing dune vegetation will be impacted during construction. The Tentatively Selected Plan includes planting dune vegetation on newly constructed areas as well as re-vegetating areas disturbed during construction. It is assumed that dune planting will only be necessary for initial construction and that vegetation will spread naturally to any areas that are re-nourished in the future.

21. RECREATION RESOURCES

There are no separable recreational lands identified for this project.

22. CULTURAL RESOURCES

There are no known cultural resources identified as affected by the project.

23. OUTSTANDING RIGHTS

There are no known outstanding rights in the project area.

24. MITIGATION

There is no mitigation required.

25. ACQUISITION/ADMINISTRATIVE COSTS

Revision to Policy Guidance Letter No. 11, Credit for Lands, Easements, Right-of-Way (LERR) at Shore Protection Projects, dated 21 April 1989, and ER 405-1-12, Real Estate Handbook, directs lands subject to shore erosion required for project purposes be appraised considering special benefits. The intent is to preclude credit for lands needed for shore protection projects, when the increase in value of the remaining lands would offset compensation for the property as well as any severance damages. Erodeable land protected by a Federal project is valued at zero as it will be enhanced post-project.

The estimate of the Federal real estate acquisition administrative cost including a contingency is \$556,000.00. This cost includes project real estate planning, mapping, review, oversight, monitoring, crediting review costs of approximately 52 acquisitions, certification of lands required for project purposes, real estate analysis or other requirements that may be necessary during Planning, Engineering and Design (PED). The non-Federal sponsor will receive credit towards its share of real estate administrative project cost incurred for certification.

The estimate of the non-federal sponsor administrative costs associated with the acquisition including a contingency is \$834,000.00. The non-Federal Sponsor has been provided with requirements regarding acquisition policies and procedures, including compliance with Public Law 91-646, as amended, Land, Easement, Right-of-Way, relocation and Disposal (LERRD) crediting procedures, and milestones for the land acquisition.

26. SUMMARY OF PROJECT REAL ESTATE COSTS

The following cost figures are subject to change prior to construction.

a. Lands and Damages		\$0
b. Acquisition Administrative costs		\$1,390,000
Federal*	\$556,000	
Non-Federal	\$834,000	
c. Total Estimated Real Estate Cost		\$1,390,000
d. Contingency (28%)		\$389,200
e. Total Estimated Real Estate Cost with Contingency		\$1,779,200

* Includes Corps Real Estate planning, monitoring, oversight, and coordination with the SFWMD sponsor.

27. ACQUISITION SCHEDULE

The NFS is responsible for acquiring real estate interests required for the project. The Perpetual Storm Damage Reduction Easements, Consolidated Joint Coastal Permit, and the BOEM Agreement and Sovereign Submerged Lands Easement will take approximately 6 -18 months to acquire once final plans and specifications have been completed and the Project Partnership Agreement has been executed. The Project Sponsor, Project Manager and Real Estate Technical Lead will formulate the milestone schedule upon project approval to meet dates for advertisement and award of the construction contract.

28. REAL ESTATE CHART OF ACCOUNTS

01	Lands & Damages	\$ 0
01B--	Acquisition/Admin	
01B20	By Project sponsor (LS)	\$834,000
01B40	Review of Project sponsor	\$556,000
TOTAL REAL ESTATE COST EXCLUDING CONTINGENCY		\$1,390,000
	CONTINGENCY (28%)	\$389,200
TOTAL PROJECT REAL ESTATE COST		\$1,779,200

Exhibit A

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION
CAPABILITY FOR ST. LUCIE COUNTY
COASTAL STORM RISK MANANGMENT PROJECT

- 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 of eminent domain for this project? YES
 - c. Does the sponsor have "quick-take" authority for this project? YES
 - d. Are any of the lands/interests in land required for the 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 technical 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 IIa. is "yes," has a reasonable plan been developed to provide such training? N/A
 - 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? YES
 - 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? NO
- 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? Project milestone will be developed during PED, will be joint effort between RE, PM and NFS
- IV. Overall Assessment:
 - a. Has the sponsor performed satisfactorily on other USACE projects? YES

b. With regard to this project, the sponsor is anticipated to be: Highly Capable

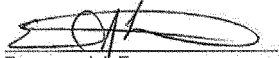
V. Coordination:

a. Has this assessment been coordinated with the sponsor? YES

b. Does the sponsor concur with this assessment? YES

Date: 4/21/16

Prepared by:



Emmanuel J. Freeman
Realty Specialist
Real Estate Division
Jacksonville District

Reviewed by:



Hansler A. Bealyer
Chief, Acquisition Branch
Real Estate Division
Jacksonville District

Reviewed and approved by:



Audrey C. Ormerod
Chief, Real Estate Division
Real Estate Division
Jacksonville District

Exhibit B



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

APR 25 2016

REPLY TO
ATTENTION OF

Real Estate Division

Subject: St. Lucie County Coastal Storm Risk Management Project

Mr. Richard A. Bouchard, P.E.
St. Lucie County Engineering
2300 Virginia Avenue
2nd Floor Annex, Room 229
Ft. Pierce, FL 34982-5652

Dear Mr. Bouchard:

The intent of this letter is to formally advise the St. Lucie County sponsor for the 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:

- a. Congress may not appropriate funds to construct the proposed project;
- b. The proposed project may otherwise not be funded or approved for construction;
- c. A PPA mutually agreeable to the non-Federal sponsor and the Government may not be executed and implemented;
- d. 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;
- e. 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;
- f. 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

g. 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 your participation in this project. Should you have questions or concerns pertaining to this letter please feel free to contact Emmanuel Freeman at (904) 232-1636.

Sincerely,

A handwritten signature in black ink, appearing to read "Audrey C. Ormerod". The signature is fluid and cursive, with the first name "Audrey" and last name "Ormerod" clearly distinguishable.

Audrey C. Ormerod
Chief, Real Estate Division

Exhibit C

((SAMPLE) Consolidated Joint Coastal Permit)


**FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION**

MARJORY STONEMAN DOUGLAS BUILDING
3900 COMMONWEALTH BOULEVARD
TALLAHASSEE, FLORIDA 32399-3000

RICK SCOTT
GOVERNOR

HERSCHEL T. VINYARD JR.
SECRETARY

**CONSOLIDATED JOINT COASTAL PERMIT AND
SOVEREIGN SUBMERGED LANDS AUTHORIZATION**
PERMITTEE:

U.S. Army Corps of Engineers
Jacksonville District
Attn: Eric P. Summa, Chief
Environmental Branch
PO Box 4970
Jacksonville, FL 32232-0019

PERMIT INFORMATION:

Permit Number: 030774-002-JC

Project Name: Bal Harbor Nourishment

County: Miami-Dade

Issuance Date: July 11, 2013

Expiration Date: July 11, 2028

REGULATORY AUTHORIZATION:

This permit is issued under the authority of Chapter 161 and Part IV of Chapter 373, Florida Statutes (F.S.), and Title 62, Florida Administrative Code (F.A.C.). Pursuant to Operating Agreements executed between the Department of Environmental Protection (Department) and the water management districts, as referenced in Chapter 62-113, F.A.C., the Department is responsible for reviewing and taking final agency action on this activity.

PROJECT DESCRIPTION:

The project involves the periodic nourishment of 0.9 miles of eroding shoreline at Bal Harbor. Fill material for the project will be excavated from the Bakers Haulover Inlet ebb shoal.

PROJECT LOCATION:

The borrow area is located approximately 800 feet east of Bakers Haulover Inlet. The beach nourishment site is located south of Bakers Haulover Inlet, and extends from DEP Range monument R-27 to approximately 350 feet south of R-31, in Miami-Dade County, Sections 23, 26 and 35, Township 52 South, Range 42 East, Atlantic Ocean, Class III Waters.

PROPRIETARY AUTHORIZATION:

This activity also requires a proprietary authorization, as the activity is located on sovereign submerged lands held in trust by the Board of Trustees of the Internal Improvement Trust Fund (Board of Trustees), pursuant to Article X, Section 11 of the Florida Constitution, and Sections 253.002 and 253.77, F.S. The activity is not exempt from the need to obtain a proprietary authorization. The Board of Trustees delegated, to the Department, the responsibility to review and take final action on this request for proprietary authorization in accordance with

**Joint Coastal Permit
Bal Harbor Nourishment
Permit No. 030774-002-JC
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Section 18-21.0051, F.A.C., and the Operating Agreements executed between the Department and the water management districts, as referenced in Chapter 62-113, F.A.C. This proprietary authorization has been reviewed in accordance with Chapter 253, F.S., Chapter 18-21, F.A.C., and the policies of the Board of Trustees.

As staff to the Board of Trustees, the Department has reviewed the project described above, and has determined that the beach nourishment activities qualify for a Letter of Consent to use sovereign, submerged lands, as long as the work performed is located within the boundaries as described herein and is consistent with the terms and conditions herein. Pursuant to the Interagency Coordination Agreement (dated February 28, 2006), activities by the U.S. Army Corps of Engineers (Corps) on sovereign submerged lands that do not fall within one of the federal powers listed in the Sovereign Submerged Lands Act under 43 USC 1311 (d) or 43 USC 1314 will require proprietary authorization from the State, and "the parties agree that authorization to use sovereignty submerged lands may be issued to the project local sponsor." Therefore, consent is hereby granted to Miami-Dade County's Department of Regulatory and Economic Resources (RER), the project's local sponsor, pursuant to Chapter 253.77, F.S., to perform the activity on the specified sovereign submerged lands.

The Department has also determined that the use of the offshore borrow area for more than 5 years requires a public easement for the use of those lands, pursuant to Chapter 253.77, F.S. The Department intends to issue the public easement to RER, the project's local sponsor, subject to the conditions outlined in the previously issued *Consolidated Intent to Issue* and in the Recommended Proprietary Action (entitled *Delegation of Authority*).

The final documents required to execute the easement have been sent to the Division of State Lands. The Department intends to issue the easement upon satisfactory execution of those documents. **You may not begin construction of this activity on state-owned, sovereign submerged lands until the easement has been executed to the satisfaction of the Department.**

COASTAL ZONE MANAGEMENT:

This permit constitutes a finding of consistency with Florida's Coastal Zone Management Program, as required by Section 307 of the Coastal Zone Management Act.

WATER QUALITY CERTIFICATION:

This permit constitutes certification of compliance with state water quality standards pursuant to Section 401 of the Clean Water Act, 33 U.S.C. 1341.

LOCAL SPONSOR AGREEMENT:

The Department will enter into a contractual agreement with the local project sponsor, RER, under which RER will be responsible for conducting monitoring, for the protection of hardbottom, nesting marine turtles, their hatchlings and their habitat. The agreement is enforceable against RER and is independent of this permit. In the event that RER does not conduct all necessary marine turtle protection and monitoring requirements, the Permittee is still

**Joint Coastal Permit
 Bat Harbor Nourishment
 Permit No. 030774-002-JC
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responsible for those marine turtle protection measures specified by the applicable U.S. Fish & Wildlife Service Biological Opinion and the National Marine Fisheries Service Biological Opinion for this project.

AGENCY ACTION:

The above named Permittee is hereby authorized to construct the work outlined in the activity description and activity location of this permit and shown on the approved permit drawings, plans and other documents attached hereto. This agency action is based on the information submitted to the Department as part of the permit application, and adherence with the final details of that proposal shall be a requirement of the permit. **This permit and authorization to use sovereign submerged lands are subject to the General Conditions and Specific Conditions, which are a binding part of this permit and authorization.** Both the Permittee and their Contractor are responsible for reading and understanding this permit (including the permit conditions and the approved permit drawings) prior to commencing the authorized activities, and for ensuring that the work is conducted in conformance with all the terms, conditions and drawings.

GENERAL CONDITIONS:

1. This permit, including its general and specific conditions, must be construed in light of the February 28, 2006 Interagency Coordination Agreement for Civil Works Projects (ICA) between the Department and the Corps. As recognized in the ICA, the Department has the authority to include reasonable conditions in this permit. All of the conditions in this permit, both general and specific, are enforceable to the extent sovereign immunity has been waived under 33 U.S.C. §§ 1323 and 1344(t). The ICA is incorporated herein by reference.
2. All activities approved shall be implemented as set forth in the drawings incorporated by reference and in compliance with the conditions and requirements of this document. The Corps shall notify the Department in writing of any anticipated changes in:
 - a) operational plans;
 - b) project dimensions, size or location;
 - c) ability to adhere to permit conditions;
 - d) project description included in the permit;
 - e) monitoring plans.

If the Department determines that a modification to the permit is required then the Corps shall apply for and obtain the modification. Department approval of the modification shall be obtained prior to implementing the change, unless the change is determined by the Department to reduce the scope of work from that authorized under the original permit, and will not affect compliance with permit conditions or monitoring requirements.

**Joint Coastal Permit
 Bal Harbor Nourishment
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3. If, for any reason, the Corps does not comply with any condition or limitation specified herein, the Corps shall immediately provide the Department with a written report containing the following information:

- a) a description of and cause of noncompliance;
- b) the period of noncompliance, including dates and times;
- c) impacts resulting or likely to result from the non-compliance;
- d) steps being taken to correct the non-compliance; and
- e) the steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.

Compliance with the provisions of this condition shall not preclude the Department from taking any enforcement action allowed under state law with respect to any non-compliance.

- 4. The Corps shall obtain any applicable licenses, permits, or other authorizations which may be required by federal, state, local or special district laws and regulations. Nothing herein constitutes a waiver or approval of other Department permits or authorizations that may be required for other aspects of the total project.
- 5. Nothing herein conveys to the Corps or creates in the Corps any property right, any interest in real property, any title to land or water, constitutes State recognition or acknowledgment of title, or constitutes authority for the use of Florida's sovereign submerged lands seaward of the mean high-water line or an established erosion control line, unless herein provided, and the necessary title, lease, easement, or other form of consent authorizing the proposed use has been obtained from the State.
- 6. Any delineation of the extent of a wetland or other surface water submitted as part of the application, including plans or other supporting documentation, shall not be considered specifically approved unless a specific condition of this authorization or a formal determination under section 373.421(2), F.S., provides otherwise.
- 7. Nothing herein authorizes any entrance upon or activities on property which is not owned or controlled by the Corps or local sponsor, or conveys any vested rights or any exclusive privileges.
- 8. This document or a copy thereof, complete with all conditions, attachments, modifications, and time extensions shall be kept at the work site of the authorized activity. The Corps shall require the contractor to review this document prior to commencement of the authorized activity.
- 9. The Corps specifically agrees to allow Department personnel with proper identification, at reasonable times and in compliance with Corps specified safety standards access to the premises where the authorized activity is located or conducted for the purpose of

**Joint Coastal Permit
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ascertaining compliance with the terms of this document and with the rules of the Department and to have access to and copy any records that must be kept; to inspect the facility, equipment, practices, or operations regulated or required; and to sample or monitor any substances or parameters at any location reasonably necessary to assure compliance. Reasonable time may depend on the nature of the concern being investigated.

10. At least forty-eight (48) hours prior to the commencement of authorized activity, the Corps shall submit to the Department a written notice of commencement of activities indicating the anticipated start date and the anticipated completion date.
11. If historic or archaeological artifacts such as, but not limited to, Indian canoes, arrow heads, pottery or physical remains, are discovered at any time on the project site, the Corps shall immediately stop all activities in the immediate area which disturb the soil and notify the Department and the State Historic Preservation Officer. In the event that unmarked human remains are encountered during permitted activities, all work shall stop in the immediate area and the proper authorities notified in accordance with Section 872.05, *Florida Statutes*.
12. Within a reasonable time after completion of construction activities authorized by this permit, the Corps shall submit to the Department a written statement of completion. This statement shall notify the Department that the work has been completed as authorized and shall include a description of the actual work completed. The Department shall be provided, if requested, a copy of any as-built drawings required of the contractor or survey performed by the Corps.

SPECIFIC CONDITIONS:

1. All reports or notices relating to this permit shall be sent to the JCP Compliance Officer (E-mail: JCPCCompliance@dep.state.fl.us), unless otherwise specified in the permit condition. **All submittals shall clearly indicate the project name (Bal Harbor Nourishment), permit number (0307741-002-JC) and relevant permit condition numbers.**
2. At least **28 days** prior to construction, and at least **14 days** prior to the pre-construction meeting (referenced above), the Permittee shall submit, for review by the Department, one (1) electronic copy of detailed **final construction plans** and one (1) electronic copy of the **final construction specifications** that are consistent with the Activity Description of this permit and the approved permit drawings. Any significant deviations from the permit or permit drawings, and any significant changes made during construction, as necessitated by field conditions, shall be addressed pursuant to General Condition #2. At a minimum, the final construction plans and specifications should include the following:

**Joint Coastal Permit
Bal Harbor Nourishment
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- a. A written summary of the construction schedule, the specific type of dredge equipment and construction methods to be used and the (final) anticipated volume of material to be dredged from each borrow area;
 - b. A plan view of all staging and beach access areas, overlaid on a recent aerial photograph;
 - c. The names, credentials and contact information for the individuals who will conduct the turbidity monitoring and biological monitoring;
 - d. A copy of the Contractor's Environmental Protection Plan, or equivalent, that provides **project-specific** details of the Best Management Practices (BMPs) that will be implemented to prevent erosion, turbidity and the release of hazardous substances at the dredge, pump-out and pipeline locations and staging areas; and
 - e. A Grade Stake Recovery Plan (for beach areas).
3. At least **14 days** prior to the commencement of project construction, the Permittee shall conduct a conference to review the specific conditions and monitoring requirements of this permit and the Local Sponsor Agreement with the Permittee's contractors (including the authorized marine turtle handler), a Local Sponsor (RER) representative, the area or district engineer of record, the Florida Fish and Wildlife Conservation Commission (FWC) and the Department's JCP Compliance Office (or their designee). This condition can be best met at the pre-construction conference arranged by the Permittee. In order to ensure that appropriate representatives are available, the Permittee is advised to contact the Department and other agency representatives at least 14 days prior to the intended meeting date. Once the required participants have confirmed their availability, the Permittee shall provide written notification, at least **seven (7) days** in advance of the meeting, to the following offices advising of the agreed-upon date, time, location and teleconference information for the pre-construction meeting:

JCP Compliance Officer
Email: JCPCompliance@dep.state.fl.us

FWC Imperiled Species Management Section
620 South Meridian Street
Tallahassee, Florida 32399-1600
Phone: (850) 922-4330
Fax: (850) 921-4369

DEP Southeast District Office
Submerged Lands & Environmental Resources Program
400 N. Congress Avenue, Suite 200
West Palm Beach, FL 33401

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Phone: (561) 681-6600
Fax: (561) 681-6755

4. Construction shall not commence until the public easement for the borrow area has been executed to the satisfaction of the Department and a Local Sponsor Agreement between the Department and RER (DRAFT attached) that adopts a final, Department-approved Physical and Biological Monitoring Plan for this project has also been executed. Additionally, **construction shall not commence** until the local sponsor has completed all pre-construction requirements of the approved Monitoring Plan. The plans include provisions for turtle and shorebird nest monitoring, scarp monitoring and leveling, sand compaction monitoring and tilling, reef/hardbottom impact assessment and coral relocation, and topographic/bathymetric monitoring of the beach placement and excavation areas. Such activities will take place before, during and after construction, as outlined in the plans.
5. In the event RER does not conduct all necessary monitoring requirements under the Local Sponsor Agreement, the Corps will abide by the terms and conditions specified by the applicable Biological Opinions issued by the U. S. Fish and Wildlife Service and NOAA National Marine Fisheries Service.
6. Best management practices (BMPs) shall be utilized where appropriate and maintained at all times during project construction to minimize turbidity generation, and to prevent the spillage of hazardous substances into waters of the state from the dredge and scows. When discharging slurried sand onto the beach from a pipeline, the Permittee shall use shore-parallel sand dikes on the beach berm, seaward of the pipeline discharge point, to maximize settlement of suspended sediment on the beach before return water from the dredged discharge reenters the Atlantic Ocean.
7. The Permittee shall not store or stockpile project-related tools, equipment, materials, etc., within littoral zones or elsewhere within surface waters of the state, unless it is done within work area specifically approved by the Department under this permit or within established anchorage areas or port/marina facilities.
8. Storage, stockpiling or access of equipment on, in, over or through seagrass (or other aquatic vegetation) beds or wetlands is prohibited. Anchoring or spudding of vessels and barges within beds of aquatic vegetation or over hardbottom areas is also prohibited.
9. In accordance with Rule 62B-41.008(1)(k)4, F.A.C., a sediment quality control/quality assurance plan for this project was submitted and has been approved. The plan will ensure that the sediment from the borrow area will meet the standards in Rule 62B-41.007(2)(j), F.A.C. The Department requires compliance with the approved plan. Any occurrences of unacceptable material shall be handled according to the protocols set forth in the Sediment QA/QC plan. The sediment testing result shall be submitted to the Department within 90 days following the completion of beach construction.

The Sediment QC/QA plan includes the following:

- a. If during construction, the Permittee or Engineer determines that the beach fill material does not comply with the sediment compliance specifications, measures shall be taken to avoid further placement of noncompliant fill, and the sediment inspection results shall be reported to the Department.
- b. The Permittee shall submit post-construction sediment testing results and an analysis report as outlined in the Sediment QC/QA plan to the Department within 90 days following beach construction. The sediment testing results shall be certified by a P.E. or P.G. from the testing laboratory. A summary table of the sediment samples and test results for the sediment compliance parameters as outlined in Table 1 of the Sediment QC/QA plan shall accompany the complete set of laboratory testing results. A statement of how the placed fill material compares to the sediment analysis and volume calculations from the geotechnical investigation shall be included in the sediment testing results report.
- c. A post-remediation report containing the site map, sediment analysis, and volume of noncompliant fill material removed and replaced shall be submitted to the Department within 7 days following completion of remediation activities.

THREATENED AND ENDANGERED SPECIES

10. The following measures shall be taken to protect marine turtles from impacts if construction occurs during the marine turtle nesting season (March 1 to November 30). Certain turtle-related tasks, such as nest monitoring, will be performed by RER under the Local Sponsor Agreement, and conditions are outlined in that document (attached).
 - a. Beach nourishment may proceed during the sea turtle nesting season, provided early morning surveys for sea turtle nests are conducted daily by RER from March 1 through September 15 or until two weeks after the last documented crawl. A series of stakes and highly visible survey ribbon or string will be installed to establish a 10-foot radius around the nest. No project activity shall occur within this area that could result in impacts to the nest.
 - b. Construction activity shall not commence until completion of the marine turtle survey each day.
 - c. During marine turtle nesting season, staging areas for construction equipment shall be located off the beach to the maximum extent possible. Nighttime storage of construction equipment not in use shall be off the beach to minimize disturbance to sea turtle nesting and hatching activities. All construction pipes that are placed on the beach shall be located as far landward as possible without

compromising the integrity of the existing or reconstructed dune system or interfering with shorebird nesting.

- d. The Permittee shall arrange a meeting between representatives of the contractor, the Department, the FWC, and the permitted person responsible for marine turtle nest monitoring at least 30 days prior to the commencement of work on this project. At least 15 days advance notice shall be provided prior to conducting this meeting. This will provide an opportunity for explanation and/or clarification of the sea turtle protection measures.
- e. In the event a sea turtle nest is excavated during construction activities, all work shall cease in that area immediately and the permitted person responsible for egg relocation for the project shall be notified so the eggs can be moved to a suitable relocation site.
- f. For construction during marine turtle nesting season, all project lighting shall be limited to the immediate area of active construction only and shall be the minimal lighting necessary to comply with U.S. Coast Guard and/or OSHA requirements. Stationary lighting on the beach and all lighting on the dredge shall be minimized through reduction, shielding, lowering, and appropriate placement of lights to minimize illumination of the nesting beach and water (Figure 1).

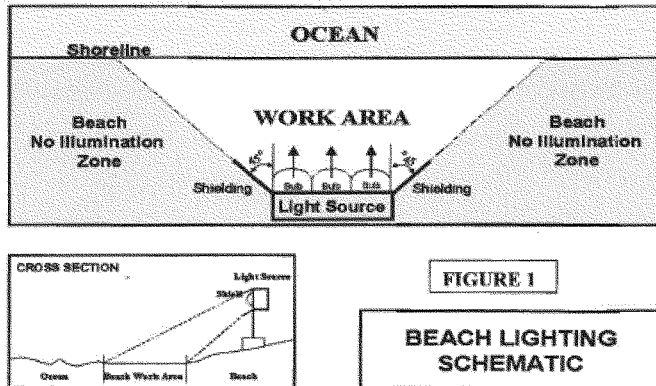


FIGURE 1

BEACH LIGHTING
SCHEMATIC

Figure 1.

- g. Upon locating a dead, injured, or sick endangered or threatened sea turtle specimen by project personnel, initial notification must be made to the FWC at 1-888-404-FWCC. Care should be taken in handling sick or injured specimens to ensure effective treatment and care and in handling dead specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.
- h. In the event a hopper dredge is utilized, the following requirements shall be met in addition to the Terms and Conditions of the appropriate NMFS Biological Opinion:
 - i. Handling of sea turtles captured during hopper dredging projects shall be conducted only by persons with prior experience and training in these activities and who is duly authorized to conduct such activities through a valid permit issued by the FWC, pursuant to Florida Administrative Code 68E-1.
 - ii. *Dredging Pumps:* To prevent impingement of sea turtles within the water column, every effort should be made to keep the dredge pumps disengaged when the dragheads are not firmly on the bottom.
 - iii. *Sea Turtle Deflecting Draghead:* A sea turtle deflecting draghead is required for all hopper dredging during the months that turtles may be present, unless a waiver is granted by the Corps (South Atlantic District) in consultation with NMFS.
 - iv. The Sea Turtle Stranding and Salvage Network (STSSN) Coordinator, Dr. Allen Foley, shall be notified at (904) 573-3930 of the start-up and completion of hopper dredging operations.
 - v. If required, non-capture trawling, as authorized by NMFS, shall be undertaken at all projects where **any** of the following conditions are met; however, other ongoing projects not meeting these conditions **are not** required to conduct relocation trawling:
 - Two or more turtles are taken in a 24-hour period in the project.
 - Four or more turtles are taken in the project.

If applicable, the Permittee shall fax (850-921-6988) or e-mail (Meghan.Conti@MyFWC.com) weekly reports to the Imperiled Species Management

section on Friday each week that relocation trawling is conducted in Florida water. These faxes shall include: the species and number of turtles captured in Florida waters, general health, and release information. A summary of all turtles captured in Florida waters, including all measurements, the latitude and longitude (in decimal degrees) of captures and tow start-stop points, and times for the start-stop points of the tows, including those tows on which no turtles are captured shall be submitted to the ISM by January 15 of the following year.

11. The following measures shall be taken to protect migratory shorebirds from impacts if construction occurs during the shorebird nesting season (generally April 1 to September 1). Certain shorebird-related tasks, such as nest monitoring, will be performed by RER under the Local Sponsor Agreement, and conditions are outlined in that document.
 - a. *Buffer Zones.* Within the project area, RER will establish a buffer zone around any location where shorebirds have been engaged in nesting behavior, including territory defense. Designated buffer zones will be posted with clearly marked signs around the perimeter. Any and all construction activities, including movement of vehicles, shall be prohibited in the buffer zone. No construction activities, movement of vehicles, or stockpiling of equipment shall be allowed within the buffer area.
 - b. *Travel Corridors.* Travel corridors, approved in consultation with FWC, shall be designated and marked by RER outside the buffer areas. Heavy equipment, other vehicles, or pedestrians may transit past nesting areas in these corridors. However, other activities such as stopping or turning shall be prohibited within the designated travel corridors adjacent to the nesting site. To the degree possible, the Permittee should maintain some activity within these corridors on a daily basis, without directly disturbing any shorebirds documented on site or interfering with sea turtle nesting, especially when those corridors are established prior to commencement of construction. Passive methods to modify nesting site suitability must be approved by FWC Regional Biologist for that region.
 - c. *Notification.* If shorebird nesting occurs within the project area, a bulletin board shall be placed and maintained by the Permittee in the construction area with the location map of the construction site showing the bird nesting areas and a warning, clearly visible, stating that "BIRD NESTING AREAS ARE PROTECTED BY THE FLORIDA THREATENED AND ENDANGERED SPECIES ACT AND THE STATE AND FEDERAL MIGRATORY BIRD ACTS".
 - d. *Placement of Equipment and Sand.* If it will be necessary to extend construction pipes past a known shorebird nesting site, then whenever possible those pipes should be placed landward of the site before birds are active in that area. No pipe

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 Bal Harbor Nourishment
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or sand shall be placed seaward of a known shorebird nesting site during the shorebird nesting season.

12. The Permittee shall comply with the following conditions intended to protect manatees from direct project effects:
 - a. All personnel associated with the project shall be instructed about the presence of manatees and manatee speed zones, and the need to avoid collisions with and injury to manatees. The Permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act, the Endangered Species Act, and the Florida Manatee Sanctuary Act.
 - b. All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels shall follow routes of deep water whenever possible.
 - c. Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.
 - d. All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, shall be shutdown if a manatee(s) comes within 50 feet of the operation. Activities shall not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals shall not be herded away or harassed into leaving.
 - e. Any collision with or injury to a manatee shall be reported immediately to the FWC Hotline at 1-888-404-3922. Collision and/or injury shall also be reported to the U.S. Fish and Wildlife Service in Jacksonville (1-904-731-3336) for north Florida or Vero Beach (1-772-562-3909) for south Florida, and to FWC at ImperiledSpecies@myFWC.com.
 - f. Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the Permittee upon completion of the project. Temporary signs that have already been approved for this use by the FWC must be used. One sign which reads *Caution: Boaters - Watch for Manatees* must be posted. A second sign measuring at least 8 ½" by 11" explaining the requirements for "Idle Speed/No Wake" and the shut down of in-water operations must be posted in a location prominently visible to all

personnel engaged in water-related activities. These signs can be viewed at MyFWC.com/manatee. Questions concerning these signs can be sent to the email address listed above.

- g. After sunset, movement of any vessel associated with work authorized by this permit within the Biscayne Bay Aquatic Preserve should be minimized to the greatest extent possible under normal operating procedures, as the likelihood of spotting submerged animals is limited.

MONITORING REQUIRED:

13. Water Quality - Turbidity shall be monitored as follows:

Units: Nephelometric Turbidity Units (NTUs).

Frequency: Sampling shall occur three times per day, at least 2 hours apart, during the periods of peak project related turbidity generation, which may be related to pumping rates. Sampling shall be conducted while the highest project-related turbidity levels are crossing the edge of the mixing zone. The compliance samples and the corresponding background samples shall be collected at approximately the same time, i.e., one shall immediately follow the other.

Location: Background: At surface and mid-depth, clearly outside the influence of any artificially generated turbidity plume.

Nourishment Site: approximately 500 meters upcurrent from any portion of the beach that has been, or is being, filled during the current construction event, at the same distance offshore as the associated compliance sample.

Borrow Site: At least 500 meters upcurrent from the source of turbidity at the dredge site.

Compliance: At surface and mid-depth, within the densest portion of any visible turbidity plume generated by this project.

Nourishment Site: Samples shall be collected in the densest portion of the turbidity plume, at a distance of 150 meters downcurrent from the point where the return water from the dredged discharge reenters the Atlantic Ocean. For each sampling event, compliance samples shall be collected within the area of highest turbidity. *Note: If the plume flows parallel to the shoreline, the densest portion of the plume may be too*

close to shore to access by boat. In that case, it may be necessary to access the sampling location from the shore.

Borrow Site: Samples shall be collected 150 meters downcurrent from the dredge head, **and** from any other source of turbidity generated by the dredge, in the densest portion of any visible turbidity plume. If no plume is visible, follow the likely direction of flow.

Analysis of turbidity samples shall be performed in compliance with DEP-SOP-001/01 FT 1600 Field Measurement of Turbidity:

<http://publicfiles.dep.state.fl.us/dear/sas/sopdoc/2008sops/ft1600.pdf>

Calibration: The instruments used to measure turbidity shall be fully calibrated with primary standards within one month of the commencement of the project, and at least once a month throughout the project. Calibration with secondary standards shall be verified each morning prior to use, and after each time the instrument is turned on, and after field sampling using two secondary turbidity "standards" that bracket the anticipated turbidity samples. If the post-sampling calibration value deviates more than 8% from the previous calibration value, results shall be reported as estimated and a description of the problem shall be included in the field notes.

14. If the turbidity monitoring protocol specified above prevents the collection of accurate data, the person in charge of the turbidity monitoring shall contact the JCP Compliance Officer to establish a more appropriate protocol. Once approved in writing by the Department, the new protocol shall be attached to the permit and shall be implemented without the need for a permit modification.
15. The compliance locations given above shall be considered the limits of the turbidity mixing zone allowed during construction. If monitoring reveals compliance turbidity levels greater than 29 NTUs above the associated background at the dredge site or beach placement site, construction activities shall **cease immediately** and not resume until corrective measures have been taken and turbidity has returned to acceptable levels. Any such occurrence shall also be immediately reported to the Department via email at JCP.Compliance@dep.state.fl.us. The subject line of the email shall state "TURBIDITY EXCEEDANCE".

Any project-associated discharge other than dredging or fill placement (e.g., scow or pipeline leakage) shall be monitored as close to the source as possible. If the turbidity level exceeds 29 NTUs above background, the construction activities related to the exceedance shall **cease immediately** and not resume until corrective measures have been taken and turbidity has returned to acceptable levels. This turbidity monitoring shall continue every hour until background turbidity levels are achieved or until otherwise

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Bal Harbor Nourishment
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directed by the Department. The Permittee shall notify the Department, by separate email to the JCP Compliance Officer, of such an event within 24 hours of the time the Permittee first becomes aware of the discharge. The subject line of the email shall state "PROJECT-ASSOCIATED DISCHARGE-OTHER".

When reporting a turbidity exceedance, the following information shall also be included:

- a. the Project Name;
- b. the Permit Number;
- c. location and level (NTUs above background) of the turbidity exceedance;
- d. the time and date that the exceedance occurred; and
- e. the time and date that construction ceased.

Prior to re-commencing the construction, a report shall be emailed to the Department with the same information that was included in the "Exceedance Report", plus the following information:

- a. turbidity monitoring data collected during the shutdown documenting the decline in turbidity levels and achievement of acceptable levels;
- b. corrective measures that were taken; and
- c. cause of the exceedance.

16. **Turbidity Reports.** All turbidity monitoring data shall be submitted within one week of analysis. The data shall be presented in tabular format, indicating the measured turbidity levels at the compliance sites for each depth, the corresponding background levels at each depth and the number of NTUs over background at each depth. Any exceedances of the turbidity standard (29 NTUs above background) shall be highlighted in the table. In addition to the raw and processed data, the reports shall also contain the following information:

- a. time of day samples were taken;
- b. dates of sampling and analysis;
- c. GPS location of sample
- d. depth of water body;

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- e. depth of each sample;
 - f. antecedent weather conditions, including wind direction and velocity;
 - g. tidal stage and direction of flow;
 - h. water temperature;
 - i. a digitized map, outlining key project features (preferably overlaid on an aerial photograph) indicating the sampling locations, dredging and discharge locations, and direction of flow;
 - j. a statement describing the methods used in collection, handling, storage and analysis of the samples;
 - k. a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection, calibration of the meter and accuracy of the turbidity and GPS data;
 - l. Monitoring will occur provided sea, wind, visibility, traffic and other conditions allow for the safe performance of the activity. Permittee or contracted designee agrees to document all instances where turbidity monitoring within the bounds of the above parameters could not be performed. When samples cannot be collected, include an explanation in the report. If unable to collect samples due to severe weather conditions, include a copy of a current report from a reliable, independent source, such as an online weather service.
17. Monitoring reports shall be submitted by email to the JCP Compliance Officer. In the subject line of the reports, on the cover page to the submittal and at the top of each page, include the Project Name, Permit Number and the dates of the monitoring interval. Failure to submit reports in a timely manner constitutes grounds for revocation of the permit.

**Joint Coastal Permit
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Executed in Tallahassee, Florida.

**STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION**



Marty K. Seeling, Administrator
Beaches, Inlets, and Ports Program

FILING AND ACKNOWLEDGMENT

FILED, on this date, pursuant to Section 120.52, Florida Statutes, with the designated
Department Clerk, receipt of which is hereby acknowledged.


Deputy Clerk
Date

Attachments: Permit Drawings (12 pages)
Biological Monitoring Plan (dated July 2013)
Local Sponsor Agreement (dated July 10, 2013)
Sediment QA/QC plan (dated May 2012)

Exhibit D

(SAMPLE) Sovereign Submerged Lands Easement
(State of Florida Borrow Areas)

This Instrument Prepared By:
James W. Wight
 Recurring Revenue Section
 Bureau of Public Land Administration
 3900 Commonwealth Boulevard
 Mail Station No. 125
 Tallahassee, Florida 32399

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND
 OF THE STATE OF FLORIDA

SOVEREIGNTY SUBMERGED LANDS EASEMENT

NO. 41341
 BOT FILE NO. 130235776
 PA NO. 02955427-001-JC

THIS EASEMENT is hereby granted by the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida, hereinafter referred to as the Grantor.

WITNESSETH: That for the faithful and timely performance of and compliance with the terms and conditions stated herein, the Grantor does hereby grant to Miami-Dade County, Florida, hereinafter referred to as the Grantee, a nonexclusive easement on, under and across the sovereignty lands, if any, contained in the following legal description:

A parcel of sovereignty submerged land 2.5 miles offshore,
 East of Section 14, Township 53 South, Range 42 East,
 in the Atlantic Ocean, Miami-Dade County, as is more particularly
 described and shown on Attachment A, dated April 13, 2011.

TO HAVE THE USE OF the hereinabove described premises for a period of 10 years from March 25, 2011, the effective date of this easement. The terms and conditions on and for which this easement is granted are as follows:

1. USE OF PROPERTY: The above described parcel of land shall be used solely for a subaqueous rock (spoil) disposal area and Grantee shall not engage in any activity except as described in the State of Florida Department of Environmental Protection Consolidated Joint Coastal Permit No. 0295427-001-JC, dated March 25, 2011, incorporated herein and made a part of this easement by reference. All of the foregoing subject to the remaining conditions of this easement.
2. EASEMENT CONSIDERATION: In the event the Grantor amends its rules related to fees and the amended rules provide the Grantee will be charged a fee or an increased fee for this activity, the Grantee agrees to pay all charges required by such amended rules within 90 days of the date the amended rules become effective or by a date provided by an invoice from the Department, whichever is later. All fees charged under this provision shall be prospective in nature; i.e. they shall begin to accrue on the date that the amended rules become effective.
3. WARRANTY OF TITLE/GUARANTEE OF SUITABILITY OF USE OF LAND: Grantor neither warrants title to the lands described herein nor guarantees the suitability of any of the lands for any particular use.
4. RIGHTS GRANTED: The rights hereby granted shall be subject to any and all prior rights of the United States and any and all prior grants by the Grantor in and to the submerged lands situated within the limits of this easement.
5. DAMAGE TO EASEMENT PROPERTY AND INTERFERENCE WITH PUBLIC AND PRIVATE RIGHTS: Grantee shall not damage the easement lands or unduly interfere with public or private rights therein.
6. GRANTOR'S RIGHT TO GRANT COMPATIBLE USES OF THE EASEMENT PROPERTY: This easement is nonexclusive, and the Grantor, or its duly authorized agent, shall retain the right to enter the property or to engage in management activities not inconsistent with the use herein provided for and shall retain the right to grant compatible uses of the property to third parties during the term of this easement.
7. RIGHT TO INSPECT: Grantor, or its duly authorized agent, shall have the right at any time to inspect the works and operations of the Grantee in any matter pertaining to this easement.
8. INDEMNIFICATION/INVESTIGATION OF ALL CLAIMS: The Grantee shall investigate all claims of every nature at its expense. Each party is responsible for all personal injury and property damage attributable to the negligent acts or omissions of that party and the officers, employees and agents thereof. Nothing herein shall be construed as an indemnity or a waiver of sovereign immunity enjoyed by any party hereto, as provided in Section 768.28, Florida Statutes, as amended from time to time, or any other law providing limitations on claims.

[47]

9. ASSIGNMENT OF EASEMENT: This easement shall not be assigned or otherwise transferred without prior written consent of the Grantor or its duly authorized agent and which consent shall not be unreasonably withheld. Any assignment or other transfer without prior written consent of the Grantor shall be null and void and without legal effect.

10. TERMINATION: The Grantee, by acceptance of this easement, binds itself, its successors and assigns, to abide by the provisions and conditions herein set forth, and said provisions and conditions shall be deemed covenants of the Grantee, its successors and assigns. In the event the Grantee fails or refuses to comply with the provisions and conditions herein set forth or in the event the Grantee violates any of the provisions and conditions herein, this easement may be terminated by the Grantor upon 30 days written notice to Grantee. If terminated, all of the above-described parcel of land shall revert to the Grantor. All notices required to be given to Grantee by this easement or applicable law or administrative rules shall be sufficient if sent by U.S. Mail to the following address:

Miami-Dade County, Florida
Dept. of Environmental Resource Management
701 NW 1st Court, 5th Floor
Miami, Florida 33136

The Grantee agrees to notify the Grantor by certified mail of any changes to this address at least ten (10) days before the change is effective.

11. TAXES AND ASSESSMENTS: The Grantee shall assume all responsibility for liabilities that accrue to the subject property or to the improvements thereon, including any and all drainage or special assessments or taxes of every kind and description which are now or may be hereafter lawfully assessed and levied against the subject property during the effective period of this easement which result from the grant of this easement or the activities of Grantee hereunder.

12. REMOVAL OF STRUCTURES/ADMINISTRATIVE FINES: If the Grantee does not remove said structures and equipment occupying and erected upon the premises after expiration or cancellation of this easement, such structures and equipment will be deemed forfeited to the Grantor, and the Grantor may authorize removal and may sell such forfeited structures and equipment after ten (10) days written notice by certified mail addressed to the Grantee at the address specified in Item 10 or at such address on record as provided to the Grantor by the Grantee. However, such remedy shall be in addition to all other remedies available to Grantor under applicable laws, rules and regulations including the right to compel removal of all structures and the right to impose administrative fines.

13. ENFORCEMENT OF PROVISIONS: No failure, or successive failures, on the part of the Grantor to enforce any provision, nor any waiver or successive waivers on its part of any provision herein, shall operate as a discharge thereof or render the same inoperative or impair the right of the Grantor to enforce the same upon any renewal thereof or in the event of subsequent breach or breaches.

14. RECORDATION OF EASEMENT: The Grantee, at its own expense, shall record this fully executed easement in its entirety in the public records of the county within which the easement site is located within fourteen (14) days after receipt, and shall provide to the Grantor within ten (10) days following the recordation a copy of the recorded easement in its entirety which contains the O.R. Book and pages at which the easement is recorded.

15. AMENDMENT/MODIFICATIONS: This easement is the entire and only agreement between the parties. Its provisions are not severable. Any amendment or modification to this easement must be in writing and must be accepted, acknowledged and executed by the Grantee and Grantor.

16. ACOE AUTHORIZATION: Prior to commencement of construction and/or activities authorized herein, the Grantee shall obtain the U.S. Army Corps of Engineers (COE) permit if it is required by the COE. Any modifications to the construction and/or activities authorized herein that may be required by the COE shall require consideration by and the prior written approval of the Grantor prior to the commencement of construction and/or any activities on sovereign, submerged lands.

17. ADDITIONAL STRUCTURES OR ACTIVITIES/EMERGENCY STRUCTURAL REPAIRS: No additional structures shall be erected and/or activities undertaken, including but not limited to, dredging, relocation/realignment or major repairs or renovations made to authorized structures, on, in or over sovereignty, submerged lands without the prior written consent from the Grantor, with the exception of emergency repairs. Unless specifically authorized in writing by the Grantor, such activities or structures shall be considered unauthorized and a violation of Chapter 253, Florida Statutes, and shall subject the Grantee to administrative fines under Chapter 18-14, Florida Administrative Code. If emergency repairs are required to be undertaken in the interests of public health, safety or welfare, the Grantee shall notify the Grantor of such repairs as quickly as is practicable; provided, however, that such emergency activities shall not exceed the activities authorized by this easement.

18. UPLAND RIPARIAN PROPERTY INTEREST: During the term of this easement, Grantee must have satisfactory evidence of sufficient upland interest as defined in subsection 18-21.003(60), Florida Administrative Code, to the extent required by paragraph 18-21.004(3)(b), Florida Administrative Code, in order to conduct the activity described in this easement. If at any time during the term of this easement, Grantee fails to comply with this requirement, use of sovereignty, submerged lands described in this easement shall immediately cease and this easement shall terminate and title to this easement shall revert to and vest in the Grantor immediately and automatically.

WITNESSES:
Barbara C Griffin
 Original Signature
Barbara C Griffin
 Printed Name of Witness
James E Wright
 Original Signature
James E Wright
 Printed Name of Witness

BOARD OF TRUSTEES OF THE INTERNAL
 IMPROVEMENT TRUST FUND OF THE STATE
 OF FLORIDA

BY: Jeffery M. Gentry (SEAL)
 Jeffery M. Gentry, Operations and Management Consultant
 Manager, Bureau of Public Land Administration, Division
 of State Lands, State of Florida Department of
 Environmental Protection, as agent for and on behalf of the Board
 of Trustees of the Internal Improvement Trust Fund of the State
 of Florida

STATE OF FLORIDA
 COUNTY OF LEON

"GRANTOR"

The foregoing instrument was acknowledged before me this 11th day of August, 2011, by
Jeffery M. Gentry, Operations and Management Consultant, Bureau of Public Land Administration, Division of State
Lands, State of Florida Department of Environmental Protection, as agent for and on behalf of the Board of Trustees of the
Internal Improvement Trust Fund of the State of Florida. He is personally known to me.

APPROVED AS TO FORM AND LEGALITY:

Jeffery M. Gentry
 Deputy Attorney

Barbara C Griffin
 Notary Public, State of Florida

Printed, Typed or Stamped Name Notary Public State of Florida
Kathy C Griffin
 My Commission Expires My Commission DD727892
Expires 10/30/2011
 Commission/Serial No. _____

WITNESSES:
Anna Bustamante
 Original Signature
Anna Bustamante
 Printed Name of Witness
Elizabeth Adorno
 Original Signature
Elizabeth Adorno
 Printed Name of Witness



Miami-Dade County, Florida (SEAL)
 BY: Jack Osterholt
 Original Signature of Executing Authority
Jack Osterholt
 Typed/Printed Name of Executing Authority
Density Mayor
 Title of Executing Authority

"GRANTEE"

STATE OF Florida
 COUNTY OF Miami-Dade

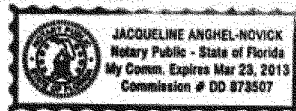
The foregoing instrument was acknowledged before me this 10th day of August, 2011, by
Jack Osterholt as Density Mayor, for and on behalf of Miami-Dade County, Florida. He is personally known to me or who has
 produced _____ as identification.

My Commission Expires: _____

Commission/Serial No. _____

Jacqueline Anghel-Novick
 Notary Public State of _____

Printed, Typed or Stamped Name



Page 3 of 7 Pages
 Easement No. 41341

Exhibit E

SAMPLE Memorandum of Agreement (Federal Borrow Areas)

**MEMORANDUM OF AGREEMENT
AMONG
THE BUREAU OF OCEAN ENERGY MANAGEMENT
OF THE DEPARTMENT OF THE INTERIOR
AND THE
CORPS OF ENGINEERS
OF THE DEPARTMENT OF THE ARMY
AND
MIAMI-DADE COUNTY
BOARD OF COUNTY COMMISSIONERS, FLORIDA**

**REGARDING THE USE OF OUTER CONTINENTAL SHELF SAND RESOURCES FOR BEACH
EROSION CONTROL AND HURRICANE PROTECTION
IN MIAMI-DADE COUNTY, FLORIDA**

BOEMRE Negotiated Agreement No. OCS - AXXXX

Title I. Explanatory Recitals

- A.** Pursuant to the authority and in accordance with the requirements of Flood Control Act of 1968 (H.D. No. 335/90/2), Water Resources Development Act (WRDA) of 1974 (Public Law 93-251, Section 69) and the WRDA of 1986 (Public Law 99-662), the Department of the Army, acting through the United States Army Corps of Engineers (USACE), with the cooperation of Miami-Dade County Board of County Commissioners (hereinafter referred as the County), are endeavoring to conduct a nourishment of beach along the Miami-Dade County, Florida shoreline.
- B.** USACE and the County have undertaken a project in furtherance of the abovementioned goals to renourish the shoreline along Miami-Dade County, Florida, (herein referred to as the "Project").
- C.** In accordance with the requirements of the Flood Control Act of 1968 (H.D. No. 335/90/2), Water Resources Development Act of 1974 (PL 93-251, Section 69) and the WRDA of 1986 (PL 99-662), the County has procured lands, easements, and rights-of-way (collectively, "Land Rights") as necessary from upland landowners, other property right holders, public entities, and other persons and entities as appropriate scope and duration for facilitate the Project.
- D.** USACE, which is acting as the project manager for the Project, now seeks to obtain sand in a manner that minimizes costs and leverages Federal resources.

Title II. Purpose and Authority

- A.** The Department of the Interior (DOI), acting through the Bureau of Ocean Energy Management, Regulation and Enforcement (Bureau) or any iteration of it's designation, enters into this Memorandum of Agreement (MOA) with the County and the USACE providing for the use of up to 500,000 cubic yards of Outer Continental Shelf sand resources ("OCS sand resources") for the Project under the authority of Section 8(k)(2) of the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. § 1337(k)(2)). The term "OCS sand resources" means the sediment deposits found on or below the surface of

the seabed on the Outer Continental Shelf (OCS), as defined in Section 2(a) of the OCSLA (43 U.S.C. § 1331(a)). This MOA authorizes the County or the USACE, as appropriate, to use OCS sand from the _____, as designated and delineated in Table 1 and on the attached map (Attachment 1), in accordance with the terms of this MOA. After removal of the sand from the OCS and placement of those resources as specified in this MOA, the Bureau has no jurisdiction over those sand resources unless they return to the OCS.

Table 1: _____ Borrow Area
Coordinates. Longitude and Latitude in Geographic
Coordinate System NAD 1983. Easting and Northing in
Florida State Plane Coordinate System (ft) NAD 1983.

	<u>Lat.</u>	<u>Long.</u>	<u>X (NAD83 FLE)</u>	<u>Y (NAD83 FLE)</u>
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				

B. The Bureau, under the authority delegated by the Secretary of the Interior, is authorized, pursuant to Section 8(k)(2) of the OCSLA (43 U.S.C. § 1337 (k)(2)) to enter into this MOA concerning the potential use of OCS sand resources.

The Bureau has determined that the Project meets the requirements of Section 8(k)(2)(A)(i) of the OCSLA. Therefore, in accordance with Section 8(k)(2), and subject to the terms and conditions as contained herein, the Bureau hereby authorizes the use of OCS sand resources from the _____ identified in Table 1 for the construction of the Project. The parties acknowledge that under the terms of Section 8(k)(2)(B), the Bureau will not assess any fee against the County or the USACE for the use of the OCS sand resources described herein.

Nothing in this MOA is intended to abrogate or diminish the Secretary of the Interior's authority under the OCSLA to oversee and regulate the removal of OCS sand.

C. USACE, which is undertaking this project pursuant to authority granted to it in accordance with Flood Control Act of 1968 (H.D. No. 335/90/2), Water Resources Development Act of 1974 (P.L. 93-251, Section 69) and the WRDA of 1986 (P.L. 99-662), enters into this MOA in compliance with requirements of section 8(k)(2)(D) of the OCSLA. The County, who has procured and assigned Land Rights of appropriate scope and duration to facilitate the Project, enters into this MOA in compliance with requirements of section 8(k)(2)(A)(i) of the OCSLA.

Nothing in this MOA is intended to impede or hinder the County's or the USACE's ability to complete the Project or abrogate or diminish either's authority or responsibilities under

applicable law, including but not limited to Section 101(b)(7) of the Water Resources Development Act of 1996, Public Law 104-303, National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Marine Mammal Protection Act (MMPA), National Historic Preservation Act (NHPA), or the Coastal Zone Management Act (CZMA).

Title III. Project Description

Designated, under Flood Control Act of 1968 (H.D. No. 335/90/2), Water Resources Development Act of 1974 (P.L. 93-251, Section 69) and the WRDA of 1986 (P.L. 99-662), as the Miami-Dade County Beach Erosion Control and Hurricane Protection Project, the Project is intended to restore the proper ecological function of a beach and facilitate beach stabilization. USACE anticipates extracting _____ cubic yards of sand resources to stabilize the shoreline and reconstruct the beach. The OCS sand resources will be extracted from the _____ Borrow Area, as designated and delineated on the attached map (Attachment 1).

Title IV. Provisions

A. The Bureau authorizes the use of OCS sand from the _____ Borrow Area. The USACE or its contractor(s) shall extract, transport, and place such OCS sand resources from the borrow area in accordance with the terms and conditions set forth below and in accordance with the Department of Environmental Protection - Consolidated Joint Coastal Permit and Sovereign Submerged Lands Authorization Permit No. _____. Except as provided above, the parties agree that all other aspects of the Project's execution and completion remain as described in the Local Cooperation Agreement between the Department of the Army and Miami-Dade County, FL for Construction of the Miami-Dade County Beach Erosion Control and Hurricane Protection Project entered into agreement on _____.

B. This MOA applies only to the extraction, transportation, and placement described above. The MOA shall terminate or expire upon (1) the USACE sending written notice to Chief, Bureau of Ocean Energy Management, Regulation and Enforcement, Leasing Division, 381 Elden Street, MS 4010, Herndon, Virginia 20170, that USACE has received sufficient sand to complete the Project, two years from the date of execution of this MOA, whichever occurs first. Upon request by USACE, the parties may agree to extend the terms of the MOA as necessary to provide USACE and its contractor(s) with additional time to complete the Project. The parties acknowledge that there may be a potential need for future OCS sand resources for periodic maintenance, augmentation or construction purposes. The Bureau, the USACE, and the County may enter into subsequent agreements, as may be required in the future, consistent with each party's respective responsibilities under applicable law.

C. The Bureau, the USACE, and the County recognize that planning and coordination among the three parties will ensure that responsibilities under the OCSLA, other applicable Federal laws, and this Congressionally-authorized Project are carried out and accommodated in an efficient and timely manner so that the project schedule will not be unnecessarily delayed or compromised. All parties recognize that the Bureau, as a bureau in the DOI, has certain responsibilities for the orderly, timely, and efficient recovery of OCS minerals using the best available technology while ensuring environmental stewardship and compliance. Moreover, the parties further recognize that USACE has certain stewardship and environmental compliance responsibilities that are separate and distinct from the responsibilities of the Bureau. To these ends, and with respect to the Project, the Bureau, USACE, and the County agree to the following terms:

1. Notification of Activity in or near the Borrow Areas

USACE will notify the Bureau at dredgeinfo@boemre.gov of the commencement and termination of the construction operations at _____ borrow area within 24 hours after USACE receives such notification from its contractor(s) for the Project. The Bureau will notify USACE in a timely manner of any OCS activity within the jurisdiction of the DOI that may adversely affect USACE's ability to use OCS sand for the Project.

2. Environmental Responsibilities and Environmental Compliance

USACE is the lead agency on behalf of the Federal government to ensure the Project complies with applicable environmental laws, including but not limited to the Endangered Species Act, Magnuson-Stevens Fishery Management and Conservation Act, Migratory Bird Treaty Act, National Historic Preservation Act, and Coastal Zone Management Act.

USACE will serve as the lead Federal agency for Endangered Species Act (ESA) Section 7 consultation concerning protected species under the purview of U.S. Fish and Wildlife Service (U.S. FWS) and National Marine Fisheries Service (NMFS). USACE will instruct its contractor(s) to implement the mitigation and monitoring terms, conditions, and measures required by the U.S. FWS, NMFS, Florida Department of Environmental Protection (FDEP), and the Bureau pursuant to applicable Federal and State laws and regulations. The required mitigation terms, conditions, and measures are reflected in the attached Biological Opinions, Conservation Recommendations (and related correspondence), and Joint Coastal Permit Final Order No. _____.

USACE is responsible for compliance with the Specific Conditions of the Joint Coastal Permit, including implementation of turbidity monitoring and the Sediment Quality Control/Quality Assurance Plan. Miami-Dade Department of Environmental Resources Management (DERM) is responsible for compliance with certain monitoring and contingency mitigation requirements for the Project, including implementation of the requirements of the Final Physical and Biological Monitoring Plan and Contingency Mitigation Plan. Prior to the commencement of the Project, USACE and DERM will invite the Bureau to participate in any conference with FDEP to review specific conditions and monitoring requirements. Construction shall not commence until the pre-construction requirements of the Final Physical and Biological Monitoring Plan have been completed.

Copies of all relevant correspondence, monitoring reports, and other technical reports shall be provided to the Bureau at dredgeinfo@boemre.gov within 30 days of its completion. If physical and/or biological monitoring confirms that unexpected adverse impacts are occurring in the vicinity of _____ borrow area, USACE and DERM will invite the Bureau to participate in any effort to further study the impacts and/or undertake corrective, remedial, and/or compensatory action.

3. Dredge Positioning

During all phases of the Project, USACE will ensure that the dredge and any bottom disturbing equipment is outfitted with an onboard global positioning system (GPS) capable of maintaining and recording location within an accuracy range of no more than plus or minus 3 meters. The GPS must be installed as close to the cutterhead or draghead as practicable. An exclusionary

buffer of _____ ft has been established around documented hardbottom and reef features adjacent to the proposed borrow area. The borrow area design reflects the required buffer. During dredging operations, USACE will immediately notify the Bureau at dredgeinfo@boemre.gov if dredging occurs outside of the approved borrow area. Anchoring, spudding, or other bottom disturbing activity is to be avoided outside the authorized borrow area on the OCS.

USACE will provide the Bureau all Dredging Quality Management (DQM) data acquired during the project using procedures jointly developed by the USACE's National Dredging Quality Management Data Program Support Center and the Bureau. USACE will submit the DQM data, including draghead status and depth, to dredgeinfo@boemre.gov biweekly. A complete DQM dataset will be submitted within 45 days of completion of the Project.

4. Local Notice to Mariners

USACE shall require its contractor(s) for the Project to place a notice in the U.S. Coast Guard Local Notice to Mariners regarding the timeframe and location of dredging and construction operations in advance of commencement of dredging.

5. Marine Pollution Control and Contingency Plan

USACE will require its contractor(s) and subcontractor(s) to prepare for and take all necessary precautions to prevent discharges of oil and releases of waste and hazardous materials that may impair water quality. In the event of an occurrence, notification and response will be in accordance with applicable requirements of 40 C.F.R. 300. All dredging and support operations shall be compliant with U.S. Coast Guard regulations and the Environmental Protection Agency's Vessel General Permit, as applicable. USACE will notify the Bureau of any occurrences and remedial actions and provide copies of reports of the incident and resultant actions at dredgeinfo@boemre.gov.

6. Encounter of Ordinance

If any ordinance is encountered while conducting dredging activities at _____ borrow area, USACE will report the discovery within 24 hours to Chief, BOEMRE Leasing Division, at (703) 787-1215 and dredgeinfo@boemre.gov.

7. Archeological Resources

Onshore Prehistoric or Historic Resources

If USACE discovers any previously unknown historic or archeological remains while accomplishing activity on Miami-Dade Beaches, USACE will notify the Bureau of any finding. USACE will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

Offshore Prehistoric or Historic Resources

In the event that the dredge operators discover any archaeological resource while conducting dredging operations in _____ borrow area, USACE shall require that dredge and/or pump-out operations be halted immediately within _____ of the area of discovery. USACE shall then immediately report the discovery to Chief, BOEMRE Leasing Division, at (703) 787-1215. If investigations determine that the resource is significant, the parties shall together determine how best to protect it.

8. Bathymetric Surveys

USACE will provide the Bureau with pre- and post-dredging bathymetric surveys of _____ borrow area. The pre-dredging survey will be conducted within 30 days prior to dredging. The post-dredging survey will be conducted within 30 days after the completion of dredging. USACE will also provide the Bureau a bathymetric survey performed between 1 year and 3 years following the completion of dredging. Hydrographic surveys will be performed in accordance with the USACE Hydrographic Surveying Manual EM 1110-2-1003 unless specified otherwise. One hundred percent coverage using interferometric swath or multibeam bathymetry data is preferred over single-beam data. All bathymetric data shall be roll, pitch, heave, and tide corrected. Survey lines of the specific dredge area, within Unnamed Shoal A, will be established at no greater than 50 m intervals perpendicular to a baseline. Three equidistant cross-tie lines will be established parallel to the same baseline. Survey lines will extend at least 50 m beyond the edge of the dredge areas. All data shall be collected in such a manner that post-dredging bathymetry surveys are compatible with the pre-dredging bathymetric survey data to enable the latter to be subtracted from the former to calculate the volume of sand removed, the shape of the excavation, and nature of post-dredging bathymetric change.

Copies of pre-dredging and post-dredging hydrographic data will be submitted to the Bureau via dredgeinfo@boemre.gov within thirty (30) days after each survey is completed. The delivery format for data submission is an ASCII file containing x,y,z data. The horizontal data will be provided in the North American Datum of 1983 (NAD '83) Florida State Plane, U.S. survey feet. Vertical data will be provided in the North American Vertical Datum of 1988 (NAVD '88), U.S. survey feet. An 8.5x11" plan view plot of the pre- and post-construction data will be provided showing the individual survey points, as well as contour lines at appropriate elevation intervals. These plots will be provided in PDF format.

9. Submittal of Production and Volume Information

USACE, in cooperation with the dredge operator, shall submit to the Bureau on a biweekly basis a summary of the dredge track lines, outlining any deviations from the original Plan. A color-coded plot of the cutterhead or drag arms will be submitted, showing any horizontal or vertical dredge violations. The dredge track lines shall show dredge status: hotelling, dredging, transiting, or unloading. This map will be provided in PDF format.

USACE will provide at least a biweekly update of the construction progress including estimated volumetric production rates to the Bureau. The biweekly deliverables will be provided electronically to dredgeinfo@boemre.gov. The project completion report, as described below, will also include production and volume information, including Daily Operational Reports.

10. Plans and Performance Requirements

USACE will provide the Bureau with a copy of the Project's "Construction Solicitation and Specifications Plan," including final project drawings, prior to construction (herein referred to as the "Plan"). No activity or operation authorized by the negotiated agreement (herein referred to as the Memorandum of Agreement or MOA) at _____ borrow area shall be carried out until the Bureau has had an opportunity to review the Plan, thus ensuring that each activity or operation is conducted in a manner that is in compliance with the provisions and requirements of the MOA. USACE will ensure that all operations at _____ borrow area are conducted in accordance with the final approved Plan and all terms and conditions in this MOA, as well as all applicable regulations, orders, guidelines, and directives specified or referenced herein.

The preferred method of obtaining and conveying sediment from _____ borrow area involves the use of a hopper dredge. The MOA does not implicitly authorize use of a cutterhead dredge. USACE will allow the Bureau to review and comment on modifications to the Plan, including the use of a cutterhead dredge and/or submerged or floated pipelines to convey sediment that may affect the project area. Said comments shall be delivered in a timely fashion in order to not delay the USACE's construction contract or schedule.

Prior to the commencement of construction, USCAE shall provide a summary of the construction schedule. USACE, at the reasonable request of the Bureau, shall allow access, at the site of any operation subject to safety regulations, to any authorized Federal inspector and shall provide the Bureau any documents and records that are pertinent to occupational or public health, safety, or environmental protection as may be requested.

11. Responsibility for Damages

The Bureau does not warrant that the OCS sand resources used in this project are suitable for the purpose for which they are intended.

12. Project Completion Report

A project completion report will be submitted by USACE to the Bureau within 120 days following completion of the activities authorized under this MOA. This report and supporting materials should be sent to Chief, BOEMRE Leasing Division, 381 Elden Street, MS 4010, Herndon, Virginia 20170 and dredgeinfo@boemre.gov. The report shall contain, at a minimum, the following information:

- the names and titles of the project managers overseeing the effort (for USACE, the engineering firm (if applicable), and the contractor), including contact information (phone numbers, mailing addresses, and email addresses);
- the location and description of the project, including the final total volume of material extracted from the borrow area and the volume of material actually placed on the beach or shoreline (including a description of the volume calculation method used to determine these volumes);
- ASCII files containing the x,y,z and time stamp of the cutterhead or drag arm locations;
- a narrative describing the final, as-built features, boundaries, and acreage, including the restored beach width and length;
- a table, an example of which is illustrated below, showing the various key project cost elements;

	Project Cost Estimate (\$)	Cost Incurred as of Construction Completion (\$)
Construction		
Engineering and Design		
Inspections/Contract Administration		
Total		

- a table, an example of which is illustrated below, showing the various items of work construction, final quantities, and monetary amounts;

Item No.	Item	Estimated Quantity	Unit	Unit Price	Estimated Amount	Final Quantity	Bid Unit	Final Amount	% Over/
----------	------	--------------------	------	------------	------------------	----------------	----------	--------------	---------

							Price		Under
1	Mobilization and Demobilization								
2	Beach Fill								
3	Any beach or offshore hard structure placed or removed								

- a listing of construction and construction oversight information, including the prime and subcontractor(s), contract costs, etc.;
- a list of all major equipment used to construct the project;
- a narrative discussing the construction sequences and activities, and, if applicable, any problems encountered and solutions;
- a list and description of any construction change orders issued, if applicable;
- a list and description of any safety-related issues or accidents reported during the life of the project;
- a narrative and any appropriate tables describing any environmental surveys or efforts associated with the project and costs associated with these surveys or efforts;
- a table listing significant construction dates beginning with bid opening and ending with final acceptance of the project by USACE;
- digital appendices containing the as-built drawings, beach-fill cross-sections, and survey data; and any additional pertinent comments.

13. Sharing of Information

Consistent with the purpose stipulated by the parties in Title II, the USACE, the County, and Bureau agree to: (1) share all information needed for or generated from the Project, including the sharing of implementation and other applicable schedules; (2) provide such information to the requesting agency as expeditiously as possible; and (3) work to ensure that all required completion report information is received.

14. Resolution of Disputes

The parties agree to make every attempt to settle any disputes regarding this MOA at the lowest operational level. In the case of a (1) substantial disagreement between Bureau and the USACE or between Bureau and the County with respect to any aspect of the Bureau's authorization of the use of OCS sand resources in accordance with the terms and conditions as specified or (2) any alleged breach by a party of the terms and conditions as specified herein, the undersigned will designate a senior management official in their respective agencies to state the area(s) of disagreement or alleged breach in writing and present such statement to the other party for consideration. If resolution is not reached within 60 days, the undersigned shall request the active participation of the District Commander, Jacksonville District of the U.S. Army Corps of Engineers, the Associate Director, Offshore Energy and Minerals Management, Bureau, and the County Mayor.

15. Miscellaneous

This MOA shall not affect any pre-existing or independent relationships or obligations among the Departments of Interior, the USACE, and the County, including any other relationships or

obligations between Bureau and the USACE, or any other units of such Departments.

All rights in the _____ Borrow Area not expressly granted to the USACE and County by the OCSLA or this MOA are hereby reserved to the Bureau. The Bureau reserves the right to authorize other uses in the _____ Borrow Area that will not unreasonably interfere with activities authorized under this MOA. The Bureau will allow USACE and the County to review and comment on any proposed authorizations for the use of sand in the _____ Borrow Area while this MOA is in effect.

Nothing herein is intended to conflict with current USACE, County, or Bureau directives. If the terms of this MOA are inconsistent with existing directives of any of the parties entering into this MOA, then those portions of this agreement which are determined to be inconsistent shall be invalid, but the remaining terms and conditions not affected by the inconsistency shall remain in full force and effect. At the first opportunity for review of the MOA, all necessary changes will be accomplished either by an amendment to this MOA or by entering into a new MOA, whichever is deemed expedient to the interest of the parties.

 _____ for
 Offshore Energy and Minerals Management
 Bureau of Ocean Energy Management,
 Regulation and Enforcement
 Department of the Interior
 Date: _____

 Colonel, U.S. Army
 District Commander
 Jacksonville District
 U.S. Corps of Engineers
 Date: _____

 Mayor, Miami-Dade County
 Date: _____

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX F

Public Access and Cost Sharing



**US Army Corps
of Engineers**
Jacksonville District

I. Overview

This appendix outlines cost sharing for the Recommended Plan as determined by shoreline ownership and use. The plan spans from the Florida Department of Environmental Protection’s (FDEP) reference monuments R98.5 to R115 + 1000 feet, to the Martin County line (approximately R001) and consists of initial and periodic nourishments of the existing¹ dune profile and an additional 20-foot berm extension.

The current cost share estimates are based on policy guidance provided by Engineer Regulations (ER) 1105-2-100, Appendix E and ER 1165-2-130. The Water Resources Development Act (WRDA) of 1999 changed the cost sharing policy, previously provided by WRDA 1986, by setting a federal share of periodic nourishment, carried out after 1 January 2003, to 50% for projects authorized for construction after 31 December 1999. Therefore, costs assigned to developed lands (publicly or privately owned) are cost shared 65% federal and 35% non-federal for initial construction and 50% federal / 50% non-federal for periodic nourishment. Benefits from prevention of damages to transportation facilities are considered storm damage reduction benefits according to ER 1165-2-130 and are cost shared 65% federal and 35% non-federal for initial construction. “Transportation facilities” in the project area include street ends. Costs assigned to undeveloped, publicly owned lands are cost shared 65% federal and 35% non-federal. Costs assigned to undeveloped, privately owned lands, even publicly accessible, are not federally cost shared (100% non-federal). Note that, for the purposes of this report, “developed” indicates the presence of buildings and/or other infrastructure such as roadways. Parks, parking lots, and vacant lots are not considered to be “developed” lands. If lands are not within ¼ mile north or ¼ mile south of public access and public parking, then the associated costs will be 100% non-federal. The cost sharing for the project is determined to be 35% federal, 65% non-federal for initial construction. **Table 1** shows the cost sharing estimates for initial construction and subsequent periodic nourishments.

Table 1: General Cost Sharing Summary for Initial Construction

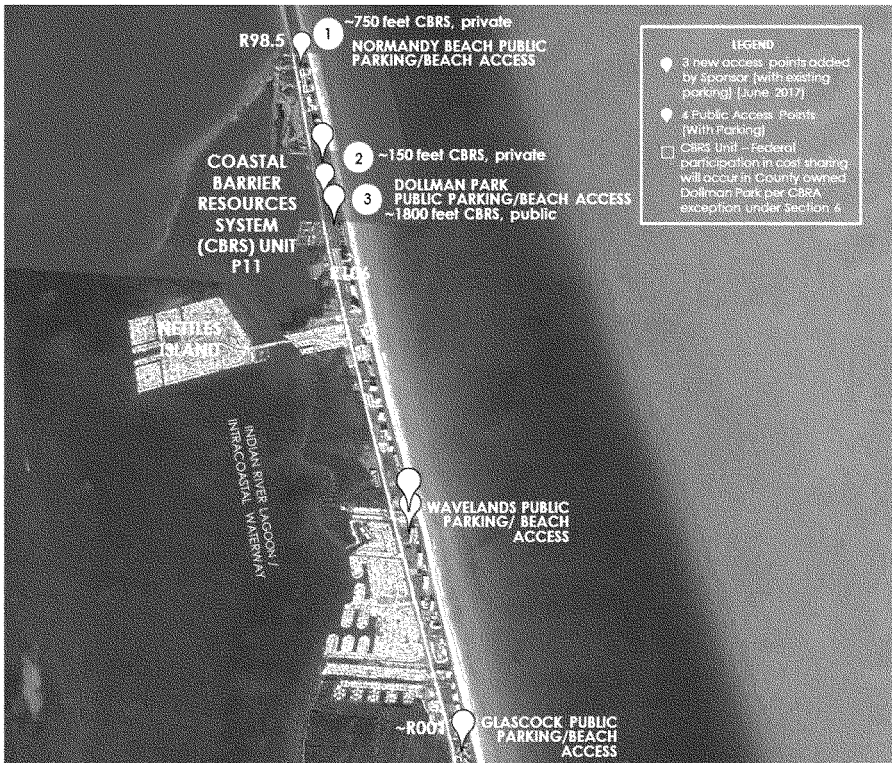
	Initial Construction Federal Participation	Initial Construction Non-Federal Participation	Periodic Nourishment Federal Participation	Periodic Nourishment Federal Participation
R98.5 feet to Martin County line	35%	65%	27%	73%

II. Segment Description

The total shoreline length for the recommended plan, based on shorefront length information provided by the St. Lucie County Property Appraiser’s office (verified using Google Earth), is estimated to be about 17,299 feet (or 3.3 miles) long. Federal cost-sharing is calculated for all parcels within ¼ mile north and ¼ mile south of public access points with parking throughout the segment. **Figure 1** includes public access and parking for the recommended plan area. There are currently 4 public access and parking sites within the recommended plan area, plus three additional access points created by St. Lucie County as of June 2017. From north to south: Walton Rocks, Ocean Bay, Herman’s Bay Beach, Normandy Beach, Dollman Park (which now includes not only the previous access point in the central portion of the park but also two new access points on the northern and southern boundary), Waveland Beach (which now includes not only the previous access point but also one on the northern boundary) and Glascock Beach, which is located on the Martin County line (approximately R-001).

¹ “Existing” in this reference is defined as the 2008 shoreline profile.

Figure 1: Shoreline image for subject area depicting FDEP R-monuments and public access points.



There are no federally owned lands in the subject segment. Coastal Barrier Resource System (CBRS) unit P-11 is within the recommended plan area. CBRS units were developed as part of the Coastal Barrier Resources Act of 1982 along the Atlantic and Gulf coasts to encourage the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance.

CBRS unit P-11 (described further in the Key Social and Environmental Factors section, as well as coordination with USFWS to support this discussion) has been taken into account for cost sharing purposes. There are two portions of P-11 in the recommended plan area, and one portion in the associated taper area.

Taper: The northern taper, at a maximum, will be from 97.5 to R98.5. If the taper extends beyond 200 feet north of R98.5, the cost sharing for this length would be allocated 100% non-federal sponsor cost due to the a. CBRS unit and b. privately developed parcel. This is noted in **Table 4-6** of the main report and if the taper extends into the CBRA, the cost sharing will be refined during Pre-construction, Engineering and Design (PED).

Recommended Plan: Unit P-11 is just north of Dollman Park for a length of approximately 150 feet. This portion has been allocated will be allocated 100% non-federal for that portion due to the presence of the CBRS unit. The third portion of P-11 is within Dollman Park (for a length of approximately 1800 feet), which is publically owned by St. Lucie County. Coordination with USFWS indicates that this portion is "exempt" from the CBRA under Section 6, and therefore Federal cost-sharing in this portion could occur. Therefore, this length has been allocated 65% Federal cost sharing and 35% non-federal cost sharing. More information on cost sharing can be found in the Public Access and Cost Sharing Appendix.

There are several parcels that are privately owned and not publicly accessible, i.e., they are not located within ¼ mile of public access and public parking. The combined shorefront length of these properties is 7,196 feet. These properties are not cost-shared, and therefore the costs associated with these areas are covered 100% by the non-federal sponsor. The costs associated with these areas are covered 100% by the non-federal sponsor. Per 1165-2-130, "all costs assigned to the prevention of losses of undeveloped private lands are non-federal, even though the beach may be public."

There are approximately 2130 feet of the shoreline composed of undeveloped public lands, which are cost-shared at 65% federal, 35% non-federal. Approximately 626 feet of shoreline is privately owned and undeveloped, which is not cost shared. The rest of the properties in the segment, totaling an estimated 7,196 feet are publicly accessible, developed private lands. Appendix E from ER 1105-2-100 and ER 1165-2-130 were used as references to determine these shares.

Overall, the cost share for the subject segment is estimated to be 35% Federal, 65% non-federal for initial construction and 27% Federal, 73% non-federal for periodic nourishment. As seen in **Table 2**, the cost share for periodic nourishment is lower than initial construction as a result of the WRDA 1999 that set a maximum Federal share of periodic nourishment, carried out after 1 January 2003, to 50% for projects authorized for construction after 31 December 1999. A detailed parcel-by-parcel list of shoreline ownership, used, and associated cost sharing is given in **Table 3**.

Table 2: Detailed Cost Sharing Summary for Initial Construction and Periodic Nourishment in the Recommended Plan

Shore Ownership and Project Purpose (as defined in EC 1105-2-100)	INITIAL CONSTRUCTION			PERIODIC NOURISHMENT		
	Maximum Level of Federal Participation in Construction Costs	Shoreline Length (feet)	Length of Federal Participation (feet)	Length of non-Federal Participation (feet)	% of Federal Participation for Periodic Nourishment	Length of non-Federal Participation (feet)
I. Federally Owned	100%	0	0	0	100%	0
II. Publically and Privately Owned, Protection Results in Public Benefits						
A. Coastal Storm Risk Management (CSRM) on Developed Lands	65%	7,196	4,678	2,519	50%	3,598
B. CSRM on Undeveloped Public Lands	65%	2130	1,385	746	50%	1,065
III. Privately Owned, Use Limited to Private Interests (No public access within ¼ mile)	0%	7,196	0	7,196	0%	7,196
IV. Privately owned, undeveloped	0%	626	0	626	0%	626
V. CBRA	0%	150	0	150	0%	150
	Total Distance:	17,299	6,062	11,237	Total Distance:	4,663
	Cost Shares:		35.0%	65.0%	Cost Shares:	27.0%

*Periodic nourishment is considered "construction."

**Non-Federal public shores dedicated to recreation or fish and wildlife purposes.

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX G **Environmental**

Attachment 1 – Section 404(b) Evaluation

Attachment 2 – Coastal Zone Management Consistency

**Attachment 3 – Essential Fish Habitat (EFH) Documents and
Mitigation Reports**



**US Army Corps
of Engineers**
Jacksonville District

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX G **Environmental**

Attachment 1 – Section 404(b) Evaluation



**US Army Corps
of Engineers**
Jacksonville District

**SECTION 404(B) EVALUATION
ST. LUCIE COUNTY COASTAL STORM RISK MANAGEMENT STUDY
ST. LUCIE COUNTY, FLORIDA**

I. Project Description

A. Location. The proposed work will occur along the Atlantic Ocean shoreline of St. Lucie County, Florida. The activity includes excavation of sand from a borrow area approximately three to five miles offshore of St. Lucie County and placement of beach fill along an estimated 3.4 miles (17,639 feet) of shoreline between FDEP reference monuments R-98 and the St. Lucie/Martin County line.

B. General Description. The project includes the following principal activities.

- (1) A hopper dredge will excavate beach-quality sand from the offshore borrow area (St. Lucie Shoal) located in Federal and State waters. The hopper dredge will transport dredged sand to a location in the Atlantic Ocean near the project site and pump the sand as slurry to the project beach. Placement of sand fill will occur within the dune and beach restoration template along the project beach.
- (2) The design beach fill template is characterized by a 20 foot berm extension (+7 ft-NAVD88) from the toe of the 2008 dune profile
- (3) Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-Federal sponsor provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, no additional mitigation is proposed.

C. Authority. A Reconnaissance Study (Section 905(b), WRDA 1986 Analysis) was initiated on 25 February 2002 as an initial response to two Resolutions by the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The two resolutions are listed below:

Resolution Docket 2634 St. Lucie County, Florida Shore Protection dated 11 April 2000 states: *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie*

County in the area north of the Ft. Pierce Inlet, the southern five miles of St. Lucie County, and adjacent shorelines."

Resolution Docket 2757 St. Lucie County, Florida Shore Protection dated 23 July 1998 states: *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers for Fort Pierce Beach, Florida, published as House Document 84, 89th Congress, 1st Session, and other pertinent reports with a view to determining if modifications to the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of shore protection and hurricane and storm damage reduction to the shoreline areas in St. Lucie County from the current project for Ft. Pierce Beach, Florida southward to the Martin County Line."*

The final St. Lucie County, Florida Section 905(b) Reconnaissance Study was approved on 1 August 2003 and resulted in the finding that there was a Federal interest in proceeding into the feasibility phase.

Approval for moving from the reconnaissance study phase into the feasibility study phase is contained in a memorandum dated 1 August 2003 from USACE South Atlantic Division (SAD) stating the following:

"The Section 905(b) analysis for St. Lucie County, Florida, and the letter of intent are approved for proceeding into the feasibility phase of planning for the five southernmost miles of the study area."

D. General Description of Dredged or Fill Material.

- (1) General Characteristics of Material. The native beach has a composite mean grain size of 0.49mm. South Hutchinson Island beach sand consists of light gray to very pale brown, moderately to poorly sorted, medium grained sand with 50.5% carbonate, 1% organic, 2.2% gravel and <1% fines content. The proposed borrow area for the initial project is estimated to have a composite mean grain-size of 0.42mm and a composite median grain size of 0.36mm, and less than 2% fines (material passing a #230 U.S. Standard Sieve).
- (2) Quantity of Material. Beach fill material includes an average of 422,000 cubic yards for initial construction of the design beach profile and approximately 2 renourishment events averaging 390,000 cubic yards each.
- (3) Source of Material. The proposed borrow area is located about three to five miles east of the project beach in Federal and State waters with water depths of about -40 feet NAVD88. Sand from these sources will conform to State of Florida standards, including compatibility with the native beach sand, for use as beach fill.

E. Description of the Proposed Discharge Site.

- (1) Location. Beach quality sand would be placed along the southern shoreline of Martin County, Florida.
- (2) Size. The beach nourishment area includes an estimated 3.4 miles (17,639 feet) of shoreline between FDEP reference monuments R-98 and the St. Lucie/Martin County line.
- (3) Type of Site. The beach nourishment site includes eroded recreational beach with naturally occurring hardbottom variously exposed between the approximate mean low water shoreline and about 1,000 ft offshore. As previously stated, approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-Federal sponsor provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, no additional mitigation is proposed.
- (4) Type of Habitat. The beach fill disposal site comprises dune, supratidal, tidal, and subtidal beach zones.
- (5) Timing and Duration of Discharge. The schedule of dredging and sand placement activities are unknown at this time, and are dependent on securing funding. In compliance with the USFWS Statewide Programmatic Biological Opinion, beach placement activities would begin November 1 or later and end before May 1 to avoid the peak sea turtle nesting season.

F. Description of Disposal Method. A hopper dredge will hydraulically pump sand from the ocean floor and transport the sand to a point offshore of the project beach. The hopper dredge will then hydraulically pump the sand from the ship through a pipeline lying on the ocean floor to the project beach. On the beach, the hydraulically pumped sand will discharge inside a shore-parallel berm, where the sand will settle and the water will flow back to the ocean. As the sand builds up, grading equipment will grade the sand into the desired template.

II. Factual Determinations

A. Physical Substrate Determinations.

- (1) Substrate Elevation and Slope. Schematic design plan view and cross section drawings area available in Appendix A.
- (2) Sediment Type. Sand from the borrow areas is fine to coarse grained quartz sand with varying amounts of small broken shell. See also D (1) above.

- (3) Dredge/Fill Material Movement. Cross-shore and longshore currents (principally to the south) will move some of the fill material.
- (4) Physical Effects on Benthos. The placement of sand on the beach face will result in the burial and loss of most of the beach infauna. Key components of these assemblages are surf clams, mole crabs, and polychaete worms. Assuming typical planktonic larval recruitment of these and other benthic species to the project site, surf zone infauna should recover within one or two years after completion of construction. Based on known characteristics of the dredged sand and the required quality control over the sand placed on the beach, the site should remain sufficiently similar in physical characteristics to recruit a similar infaunal community.

B. Water Circulation, Fluctuation, and Salinity Determination.

- (1) Water Column Effects. Fill placement will not have long-term or significant impacts on salinity, water chemistry, clarity, color, odor, taste, dissolved gas levels, nutrients, or eutrophication.
- (2) Current Patterns and Circulation. Currents in the project area are both tidal and longshore. Net movement of water due to the longshore current is typically north to south.
- (3) Normal Water Level Fluctuations and Salinity Gradients. Tides in the project area are semidiurnal. Elevations of mean high water and mean low water in St. Lucie County are approximately +0.4 ft NAVD88 and -3.0 ft NAVD88, respectively.

C. Suspended Particulate/Turbidity Determinations

- (1) Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site. A temporary increase in turbidity levels will occur in the waters adjacent to the hopper dredge during dredging and in the vicinity of the beach shoreline near the sand slurry discharge point. Short-term, localized turbidity increases should have no significant adverse impacts. Construction activities should not result in exceedance of State turbidity standards outside of the approved beach mixing zone or at the borrow site.
- (2) Effects on the Chemical and Physical Properties of the Water Column.
 - (a) Light Penetration. The placement and spread of fill on the beach will increase turbidity in the nearshore area during construction. The immediate nearshore area is a high energy system, subject to naturally occurring turbidity fluctuations. Temporary turbidity increases due to project construction should not prove significant. The State of Florida requires a nearshore turbidity

monitoring program during construction. Turbidity during construction outside of the mixing zone will not exceed State numeric standards.

- (b) Dissolved Oxygen. This project will not significantly alter dissolved oxygen levels.
- (c) Toxic Metals, Organics, and Pathogens. The project will release no toxic metals, organics, or pathogens.
- (d) Aesthetics. Construction activities (dredging and beach placement) will reduce aesthetic qualities during construction. The completed project will provide a long-term increase in aesthetic quality.

(3) Effects on Biota.

- (a) Primary Productivity and Photosynthesis. The level of suspended particles in the surf zone will temporarily increase during construction. During construction, suspended material will reduce the intensity of sunlight reaching existing algae, temporarily restricting photosynthesis and primary productivity in local areas. Post-construction monitoring of nearshore hardbottom communities will include assessment of potential project-related secondary impacts due to turbidity and sedimentation.
 - (b) Suspension/Filter Feeders. Suspension feeders will experience short-term impacts during construction, but no long-term adverse impact.
 - (c) Sight Feeders. Visual feeders will experience short-term impacts due to elevated turbidity, but no long-term adverse impact.
 - (d) Contaminant Determinations. Deposited fill material will not introduce, relocate, or increase contaminants.
 - (e) Aquatic Ecosystem and Organism Determinations. Grain size characteristics and composition of the proposed fill material closely match those of the existing beach sediments. Therefore, no sediment-related impacts are expected. The proposed fill material meets the exclusion criteria and therefore will require no additional chemical-biological testing.
1. Effects on Plankton. Although turbidity may result in short-term effects (e.g., clogging of feeding appendages) on plankton, no adverse long-term impacts to planktonic organisms are anticipated.
 2. Effects on Benthos. Non-motile benthic species unable to migrate away from the project area will be covered and lost. However, due to the high fecundity and turnover rates of benthic invertebrates, full recovery of the benthic community should occur within one to two years.

3. Effects on Nekton. Elevated turbidity related to the proposed project should not affect these species due their motility and ability to avoid undesirable conditions. No long-term adverse impacts are anticipated.
4. Effects on the Aquatic Food Web. The project will not likely create long-term adverse impacts to any trophic group in the food web.
5. Effects on Special Aquatic Sites.
 - a. Hardbottom Communities. As previously stated, approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-Federal sponsor provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, would not be mitigated.
 - b. Sanctuaries and Refuges. No sanctuaries or wildlife refuges occur within the proposed dredge and disposal areas.
 - c. Wetlands. No wetlands occur within the proposed dredge and disposal areas.
 - d. Mud Flats. No mud flats occur within the proposed dredge and disposal areas.
 - e. Vegetated Shallows. No seagrass beds occur within or adjacent to the dredge, beach fill, or mitigation reef sites.
6. Endangered and Threatened Species. The proposed project will affect 3.4 miles of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern United States. Project construction will occur outside of the peak sea turtle nesting season (May1 – October 31) and, therefore, will likely avoid impacts to nesting sea turtles during construction. The work may affect, but is not likely to adversely affect, loggerhead critical habitat (see Section 5.1.4 of the main report).

Research has shown that the principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project. Nesting success decreases during the year following nourishment as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent

years, and beach compaction and the frequency of escarpment formation will decline.

USACE will follow the reasonable and prudent measures recommended by the USFWS in its Statewide Programmatic Biological Opinion. These measures will help minimize impacts to sea turtles. Widening of an eroded beach with beach-compatible sand will increase the amount of suitable nesting area available to sea turtles.

7. Other Wildlife. No significant adverse impacts to terrestrial foraging mammals, reptiles, wading birds, or other wildlife are expected. These highly motile organisms are able to actively seek favorable environmental conditions for foraging and nesting. Restoring the project beach and dune will have a long-term benefit by providing additional habitat.
8. Actions to Minimize Impacts. Implementing all practical safeguards during project construction to preserve and enhance aesthetic, recreational, and economic values in the project area. The environmental permits and contractor specifications will include these measures.

(f) Proposed Disposal Site Determinations.

1. Mixing Zone Determination. The fill material will not cause unacceptable changes in the mixing zone specified in the State Water Quality Certificate in relation to: depth, current velocity (speed and direction), current variability, degree of turbulence, stratification, or ambient concentrations of constituents.
2. Determination of Compliance with Applicable Water Quality Standards. The project will not violate state water quality standards outside of the established mixing zone. At no time will nearshore turbidity levels exceed 29 NTUs above background levels.
3. Potential Effects on Human Use Characteristics.
 - a. Municipal and Private Water Supplies. Project implementation will not affect municipal or private water supplies.
 - b. Recreational and Commercial Fisheries. The disposal of dredged material on the beach project will not permanently impact recreational and commercial fisheries. The mitigation reef structures constructed in the project area nearshore waters have created increased or new opportunities for recreational fishing.
 - b. Water Related Recreation. Beach restoration will enhance beach recreation by increasing the area of beach for public use. Increased

turbidity in the vicinity of fill sites may temporarily affect nearshore snorkeling/SCUBA and fishing. The presence of construction-related equipment will create public safety risks at the beach sites. The creation of nearshore low relief mitigation reef has provided alternate snorkeling/SCUBA habitat accessible from the beach. Given the narrow scale of beach fill that the project will place immediately along the beach face, landward of locations where swimming and surfing occur, adverse impacts to swimming and surfing will not likely occur.

- c. Aesthetics. The stabilization of an eroding beach will improve aesthetics of the beach.
- d. Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The widening of an eroded beach will increase the area available for public recreation at the county park within the project area. Additionally, the proposed restoration will provide storm protection for this park.
- f. Determination of Cumulative Effects on the Aquatic Ecosystem. The proposed beach restoration project should not have any significant cumulative effects that would result in a major impairment of water quality of the existing aquatic ecosystem. Dredging at the borrow site should likewise result in no significant cumulative effects to the aquatic ecosystem.
- g. Determination of Secondary Effects on the Aquatic Ecosystem. Placement of the fill material will not likely cause adverse secondary effects on the aquatic ecosystem.

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. No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.
- C. After consideration of disposal site dilution and dispersion, the discharge of fill materials will not cause or contribute to, violations of any applicable State of Florida water quality standards for Class III waters. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act. **Error! Reference source not found..**
- D. The project will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse

modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

- E. The placement of fill material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.
- F. On the basis of the guidelines, the proposed disposal site for the discharge of dredged material is specified as complying with the requirements of these guidelines.

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX G **Environmental**

Attachment 2 – Coastal Zone Management Consistency



**US Army Corps
of Engineers**
Jacksonville District

**FLORIDA COASTAL ZONE MANAGEMENT PROGRAM
ST. LUCIE COUNTY COASTAL STORM RISK MANAGEMENT STUDY
ST. LUCIE COUNTY, FLORIDA**

1. Chapter 161, Beach and Shore Preservation. The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

Response: The proposed project plans and information have been submitted to the State in compliance with this chapter.

2. Chapters 186 and 187, State and Regional Planning. These chapters establish the State Comprehensive Plan, which sets goals articulating a strategic vision of the State's future. Its purpose is to define in a broad sense, goals, and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

Response: The appropriate Federal, State, and local agencies have participated in project review and comment during the planning process. The project meets the primary goal of the State Comprehensive Plan through preservation and protection of shorefront development and infrastructure.

3. Chapter 252, Disaster Preparation, Response and Mitigation. This chapter creates a state emergency management agency, with the authority to provide for the common defense; to protect the public peace, health, and safety; and to preserve the lives and property of the people of Florida.

Response: The proposed project involves the placement of beach compatible material onto an eroding beach as a means to protect residents, development, and infrastructure located along the Atlantic shoreline within St. Lucie County. Therefore, this proposed project is consistent with the efforts of the Division of Emergency Management.

4. Chapter 253, State Lands. This chapter governs the management of submerged state lands and resources within state lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; spoil islands; and artificial reefs.

Response: The proposed beach nourishment would increase recreational beach and potential sea turtle nesting habitat. No seagrass beds, swamps, marshes and other wetlands; mineral resources, unique natural features, spoil islands, or artificial reefs

occur within or adjacent to the areas proposed for dredging or beach fill placement. The proposed project would comply with the intent of this chapter.

5. Chapters 253, 259, 260, and 375, Land Acquisition. This chapter authorizes the state to acquire land to protect environmentally sensitive areas.

Response: This project proposes no land acquisition.

6. Chapter 258, State Parks and Aquatic Preserves. This chapter authorizes the state to manage state parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park property, natural resources, park programs, management, or operations.

Response: No state parks or preserves occur within the project area.

7. Chapter 267, Historic Preservation. This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

Response: A Phase I cultural resources survey was performed for the project in October 2007 (New South Associates, 2008). The survey extended from the Martin/St. Lucie County line to approximately 0.5 miles north of the St. Lucie County Nuclear Power Plant.

The Phase I survey consisted of background desktop research, field investigations including surface reconnaissance, systematic shovel testing, using a metal detector in areas adjacent to where historic shipwrecks have been recorded, artifact identification and analysis, and preparation of a report. With the exception of two shipwreck sites, all previously recorded historic and prehistoric sites are located on or west of the back dune along U.S. A1A or west of A1A, which is well outside of the project area. The field survey uncovered no evidence of the previously recorded sites.

The study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. The survey found no evidence of any new or previously recorded sites or artifacts over 50 years old in the project fill template. The final report recommended a finding of no project effect on cultural resources listed, or eligible for listing, in the National Register of Historic Properties, or otherwise of historical, archaeological, or architectural value; and recommended no further investigation of the area. The Florida Department of State – Division of Historical Resources reviewed the survey report and, in a letter to the U.S. Army Corps of Engineers (USACE) on April 15, 2008, concurred with the report findings and recommendations.

8. Chapter 288, Economic Development and Tourism. This chapter directs the state to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

Response: The proposed beach nourishment would provide more space for recreation and protect recreational facilities along the receiving beach. The project remains consistent with the goals of this chapter, which encourages creation of additional space for recreation.

9. Chapters 334 and 339, Public Transportation. This chapter authorizes the planning and development of a safe balanced and efficient transportation system.

Response: This project would not impact the public transportation system.

10. Chapter 370, Saltwater Living Resources. This chapter directs the state to preserve, manage and protect the marine, crustacean, shell and anadromous fishery resources in state waters; to protect and enhance the marine and estuarine environment; to regulate fishermen and vessels of the state engaged in the taking of such resources within or without state waters; to issue licenses for the taking and processing products of fisheries; to secure and maintain statistical records of the catch of each such species; and, to conduct scientific, economic, and other studies and research.

Response: Motile species such as fish and epifaunal crustaceans will be able to avoid the area during construction and seek favorable environmental conditions. Non-motile autotrophic organisms and infaunal invertebrates will be temporarily lost. However, these organisms are highly adapted to the periodic burial by sand in the intertidal zone. As demonstrated from past scientific investigations concerning the recolonization success of the benthic communities seaward of nourished beaches, the loss of nonmotile invertebrates is expected to be a short-term impact. These organisms are highly fecund and are expected to return to pre-construction levels within 1-2 years following construction.

Nourishment activities will occur outside of the peak sea turtle nesting season. The USFWS Statewide Programmatic Biological Opinion, FDEP permit and contract specifications will contain protective measures specifically designed to avoid adverse impacts to manatees and sea turtles that may be foraging in the area. It is not expected that sea turtles would be significantly impacted by this project. In fact, sea turtle nesting habitat should be increased as a result of increased beach width.

Approximately 0.57 acres of exposed nearshore hardbottom habitat within the study area was impacted by prior sand placement activities. The non-Federal sponsor provided mitigation to offset these impacts. The Recommended Plan, with its smaller placement area, would not exceed previous impacts and, therefore, additional mitigation is not proposed.

11. Chapter 372, Living Land and Freshwater Resources. This chapter establishes the Game and Freshwater Fish Commission and directs it to manage freshwater aquatic life and wild animal life and their habitat to perpetuate a diversity of species with densities and distributions which provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

Response: The project will have no significant effect on freshwater aquatic life or wild animal life.

12. Chapter 373, Water Resources. This chapter provides the authority to regulate the withdrawal, diversion, storage, and consumption of water.

Response: This project does not involve water resources as described by this chapter.

13. Chapter 376, Pollutant Spill Prevention and Control. This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

Response: The contract specifications will prohibit the contractor from dumping oil, fuel, or hazardous wastes in the work area and will require the contractor to adopt safe and sanitary measures for the disposal of solid wastes. Contract specifications will require an approved spill prevention plan before contractor receipt of a notice to proceed.

14. Chapter 377, Oil and Gas Exploration and Production. This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

Response: This project does not involve the exploration, drilling, or production of gas, oil or petroleum products. Therefore, this chapter does not apply.

15. Chapter 380, Environmental Land and Water Management. This chapter establishes criteria and procedures to assure that local land development decisions consider the regional impact nature of proposed large-scale development.

Response: The proposed renourishment project will not have any regional impact on resources in the area. Therefore, the project is consistent with the goals of this chapter.

16. Chapter 388, Arthropod Control. This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the state.

Response: The proposed project will not further the propagation of mosquitoes or other pest arthropods.

17. Chapter 403, Environmental Control. This chapter authorizes the regulation of pollution of the air and waters of the state by the Florida Department of Environmental Regulation (now a part of the Florida Department of Environmental Protection).

Response: A Draft Environmental Assessment addressing project impacts has been reviewed by the appropriate resource agencies including the FDEP. Environmental protection measures implemented by the project will ensure that no lasting adverse effects on water quality, air quality, or other environmental resources will occur. The state will provide project Water Quality Certification before construction starts. The project complies with the intent of this chapter.

18. Chapter 582, Soil and Water Conservation. This chapter establishes policy for the conservation of the state soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both onsite or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

Response: The proposed project will not occur near or on agricultural lands. Therefore, this chapter does no

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL ASSESSMENT

APPENDIX G **Environmental**

Attachment 3 – Essential Fish Habitat (EFH) Documents and Mitigation Reports



**US Army Corps
of Engineers**
Jacksonville District



UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office

263 13th Avenue South

St. Petersburg, Florida 33701-5505

<http://sero.nmfs.noaa.gov>

June 9, 2016

F/SER47:JK/pw

(Sent via Electronic Mail)

Colonel Jason A. Kirk, Commander
 Jacksonville District Corps of Engineers
 PO Box 4970
 Jacksonville, Florida 32232-0019

Attention: Paul E. Stodola

Dear Colonel Kirk:

NOAA's National Marine Fisheries Service (NMFS) reviewed *St. Lucie County, Florida, Coastal Storm Risk Management Project Draft Integrated Feasibility Report and Environmental Assessment (DIFR/EA)*, dated April 2016, and the corresponding letter dated May 11, 2016, initiating consultation under the essential fish habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). The Bureau of Ocean Energy Management (BOEM) is a cooperating agency under the National Environmental and Policy Act (NEPA) for the DIFR/EA because of the proposed use as beach fill of Outer Continental Shelf sand from the St. Lucie Shoal complex. The Jacksonville District proposes to increase beach and shoreline protection in the interest of hurricane protection, storm damage reduction, beach erosion control, and protection of public-trust natural resources for 3.4 miles of Atlantic shoreline from Florida Department of Environmental Protection (FDEP) Monument R-98 (just north of Normandy Beach Access) southward to the Martin County line. The tentatively selected plan (TSP) would excavate sand from the St. Lucie Shoal complex for three nourishment events with the initial nourishment event requiring 530,400 cubic yards of material and the two subsequent events requiring an average of 380,000 cubic yards of material. The District developed the project using a 50-year planning horizon with sea level rise considerations up to the year 2120. The Jacksonville District's and BOEM's initial determination is the proposed action would not have a substantial adverse impact on EFH or federally managed fisheries along the eastern coast of Florida, including live/hardbottom habitat, worm rock reef, and sandy shoals each designated a Habitat Area of Particular Concern by the South Atlantic Fishery Management Council (SAFMC). As the nation's federal trustee for the conservation and management of marine, estuarine, and anadromous fishery resources, the NMFS provides the following comments and recommendations pursuant to authorities of the Fish and Wildlife Coordination Act and the Magnuson-Stevens Act.

Consultation History and Impacts to Essential Fish Habitat

Consultation History: As noted in the DIFR/EA and EFH consultation letter, this project's history is complex because it includes an overlapping federal civil works project and a local initiative permitted in 2012 under the Clean Water Act and Rivers and Harbors Act (permit number SAJ-2009-03448). In response to a scoping request dated May 31, 2006, for issues germane to an Environmental Impact Statement (EIS) for a federal civil works project, the NMFS recommended, by letter dated June 29, 2006, evaluation of shoals and nearshore hardbottom habitats, including worm (*Phragmatopoma lapidosa*) rock reef, in the study area as foraging habitat for federally managed fishery resources. Subsequently, the EIS for the federal project was suspended and its components absorbed into the EIS for the permit application from the St. Lucie County Erosion Control District. The Jacksonville District released the EIS, entitled *St. Lucie County South Beach and Dune Restoration Project*, as draft in 2011 and as final in 2012.



Although the final EIS for the permitting action describes the project as “a one time, single and complete project,” the DIFR/EA tiers off the final EIS in an effort to complete the NEPA process for the federal project expeditiously.

The permit evaluation process included significant controversy. By letter dated July 18, 2011, the NMFS provided comments on the draft EIS affirming concerns expressed earlier about nearshore live/hardbottom, worm rock reef, and the St. Lucie Shoal complex. The NMFS notified the District by letters dated July 25, 2011, and August 22, 2011, the project would substantially and unacceptably impact aquatic resources of national importance (ARNI) and objected to project authorization under Part IV Sections 3(a) and 3(b) of the Clean Water Act Section 404(q) Memorandum of Agreement between the Department of Commerce and the Department of the Army, dated August 11, 1992 (MOA). By letter dated July 27, 2012, the NMFS removed its objection under the MOA based on a draft permit and statement of findings that included reductions in project scope¹, increases in mitigation, and more vigilant monitoring than originally proposed. This letter also records commitments the Jacksonville District made during several meetings about the draft permit after its receipt by the NMFS. As noted below, it appears key aspects of this agreement have not been implemented or have not been adequately addressed in the DIFR/EA.

Amount, depth, and performance criteria of compensatory mitigation reefs: Permit condition 23 requires 1.89 acres of mitigation reef. To increase the likelihood of the mitigation reef providing the same ecological functions as the impacted live/hardbottom habitat, the Jacksonville District and St. Lucie County committed to building this reef in waters less than 4.0 meters (13.1 feet). Permit conditions 32(c) and 46(c) specify successful mitigation must include no less than 6 percent cover by worm reef.

St. Lucie County deployed 1.1 acres of mitigation reefs between June 3 and July 17, 2015². Based on the *Bathymetric Survey of St. Lucie Mitigation Reef* (July 2015), it appears only a small area of reef was placed in waters less than 4.0 meters and the placement area differs from those provided to the NMFS by email dated July 24, 2012. The DIFR/EA states (page 4-13) “monitoring of the reef immediately after construction indicated permit requirements have been met. Specifically, the percent of net boulder cover within the mitigation site exceeds permit requirements. The non-federal sponsor will continue to monitor the mitigation reef during summer months for three years following construction.” The *St. Lucie County South County Beach and Dune Restoration Project Immediate Post-Construction Mitigation Reef Monitoring Report* (CSA, September 2015), which reports surveys conducted September 14, 2015, corroborates construction of 1.1 acres of mitigation reef³. To date, only qualitative biological observations have been reported, with no mention worm reef. Performance standards in both the federal and state permits require three years of quantitative biological monitoring of the mitigation reefs, and the first monitoring event is scheduled for the summer of 2016. Because this quantitative monitoring has not yet occurred, only 1.1 acres of the required 1.89 acres of reef have been deployed, and much of the deployed reef was in waters deeper than 4.0 meters, the NMFS believes it is premature for the DIFR/EA to conclude permit requirements have been met.

The NMFS recommends the final IFR/EA include a schedule for constructing the remaining 0.79 acres of mitigation reef and clearly state how much of the initial 1.1 acres and the still-to-be-deployed 0.79 acres is or would be within waters less than 4.0 meters. The NMFS also requests the final IFR/EA evaluate if additional mitigation is needed to account for longer than anticipated time lag between burial of nearshore

¹ Including avoiding impacts to 2.08 acres of nearshore live/hardbottom habitat by eliminating the northern segment of the project between FDEP Monuments R-87.7 and R-90.3.

² According to the *Florida Artificial Reef Materials Placement Report and Post-Deployment Notification* submitted to the Florida Fish and Wildlife Conservation Commission by St. Lucie County.

³ Specifically the 1.5-acre mitigation site is composed of 72.4 percent mitigation reef (i.e., 1.1 acres).

live/hardbottom in 2013 and completion of the mitigation reef (date to be determined) and for substantial amounts of the reef being in deeper waters than expected. Lastly, the final IFR/EA should indicate the degree to which the mitigation reef is trending towards success of the worm reef performance standard based on quantitative data collected and analyzed.

Biological monitoring of nearshore hardbottom required for the initial nourishment indicates unauthorized impacts occurred: Permit condition 44(i)(6) describes how monitoring results would be interpreted to determine if unanticipated impacts to nearshore live/hardbottom occurred and whether additional mitigation is needed. The condition reads “Based on the pre- and post-construction assessment, any adverse differences resulting from the project in any one of the following monitoring parameters will be considered an impact and assessed: hardbottom exposure nearshore hardbottom edge mapping, line-intercept sediment measurements, sediment depth measurements, examination of the biological communities present on the hardbottoms.”

Both federal and state permits require four post-construction monitoring events. Three of the four events (immediate post-construction, year 1 post-construction, and year 2 post-construction) have been completed and the fourth is planned for summer 2016. The year 2 monitoring report, *Year Two Post-Construction Nearshore Hardbottom Characterization Survey for the St. Lucie County South Beach Project* (CSA December 2015), notes a significant decrease in hardbottom relief from 2012 to 2015 in the project area. In addition, burial of permanent transect markers at the 0-m quadrats (i.e., the quadrats closest to shore) may signal project-related impacts are occurring. The hardbottom edge mapping also shows differences from the 2012 survey, with small scattered patches of hardbottom inshore of Transect R-100 and R-101 not located after construction (i.e., from 2013 to 2015). In 2015, the hardbottom edge mapped in this area was 30 to 60 meters eastward of the edge mapped in 2012. These observations are all consistent sand accumulating on live/hardbottom areas not authorized for burial.

According to the DIFR/EA, “elevated turbidity during construction is also anticipated to cause temporary impacts to nearshore hardbottom. Temporary impacts, calculated based on acreage of existing hardbottom between the predicted equilibrium toe-of-fill (ETOF) and FDEP approved mixing zone limits (65 m from shoreline), are estimated to total up to 1.0 acre of hardbottom. These temporary impacts would occur only during sand placement activities from the settling of sand particles [sedimentation]” (page 4-20). It is not clear why the DIFR/EA does not include a review of the ongoing monitoring required by the federal permit as input to the forecast for impacts from the federal civil works project. Specifically, a synthesis of the immediate post-construction, year 1 post-construction, and year 2 post-construction reports is absent. While the NMFS understands the year 3 monitoring event will be used by FDEP to determine permanent impacts, the monitoring information available suggests there have been, at a minimum, temporal impacts requiring additional mitigation. The NMFS recommends the final IFR/EA evaluates whether the County’s project is likely to be in compliance with permit condition 44(i)(6). The final IFR/EA should also provide a synthesis of the available post-construction monitoring to refine impact predictions in live/hardbottom habitats located seaward of the ETOF.

Biological monitoring design does not reflect agreements between NMFS and the Jacksonville District: Permit condition 39 describes biological monitoring of nearshore live/hardbottom habitat. The District agreed to improve the statistical design of the monitoring by increasing the number of reference transects to ten (Permit condition 39(a)). According to the year 2 post-construction monitoring report, twenty transects were located between FDEP Monuments R-77.7 to R-112 in St. Lucie County and two reference transects were located at R-1 and R-3 in Martin County. While the report notes eight additional reference transects were surveyed in 2012 (as part of the pre-construction baseline), the data from these additional reference transects were neither analyzed nor included in the 2012 report for budgetary reasons. These data and analyses were, however, included in the immediate post-construction surveys and report comparing 2012 and 2013 survey data. The NMFS recommends the District affirm reports provide full

evaluations of all data required by the federal permit. The NMFS also recommends the final IFR/EA summarize the results of this monitoring.

Infaunal monitoring at the borrow site: Permit condition 51 describes monitoring of infauna at the borrow site, coordination of the sample site locations with the NMFS, and hydrographic monitoring to determine infilling rates at 12, 24, and 26 months after the 2013 construction. The required coordination with the NMFS occurred. The final IFR/EA District should provide the results of this monitoring.

Dredging Best Management Practices: The DIFR/EA states control of the dredging profile within the shoals may minimize impacts to the St. Lucie Shoal complex. These best practices include not dredging in some of the areas with higher elevations (i.e., leaving a “refuge”), not excavating below the surrounding elevation (i.e., avoid creating pits), and orienting the dredge template with the shoal long axis. The NMFS also recommends limiting the dredging to the prevailing downdrift flanks of the shoals, limiting the depths of the dredge cuts to 3 to 6 feet, and limiting the dredging within the offshore borrow area to the portions of the shoal expected to fill in most quickly once dredging has stopped.

EFH Conservation Recommendations

Section 305(b)(4)(A) of the Magnuson-Stevens Act requires NMFS to provide EFH Conservation Recommendations for any federal action or permit which may result in adverse impacts to EFH.

Therefore, NMFS recommends the following to ensure the conservation of EFH and associated fishery resources:

- The Jacksonville District should not implement the St. Lucie County, Florida, Coastal Storm Risk Management Project until impacts authorized by permit SAJ-2009-03448 are determined and fully mitigated. Specifically:
 1. The remaining 0.79 acres of mitigation reef should be constructed as described in the federal permit in addition to any mitigation needed to offset the longer temporal lag that has resulted between burial of the live/hardbottom and establishment of the mitigation reefs.
 2. The final IFR/EA should describe quantitatively the status of the existing 1.1 acres of mitigation reef with regard to the established biological performance standards.
 3. The final IFR/EA should provide the amount of mitigation reef constructed in water depths less than 4.0 meters.
 4. The final IFR/EA should include a synthesis of the available post-construction monitoring reports and quantify direct and indirect impact predictions to live/hardbottom habitats seaward of the ETOF.
 5. The final IFR/EA should estimate temporal and direct impacts to nearshore live/hardbottom occurring as a result of project construction during 2013 based on the year 2 monitoring report (and year 3 if that information is available) and evaluate compliance with permit condition 44(i)(6).
 6. The year 3 monitoring report should reflect sampling and analysis of 10 reference areas the District agreed in July 2012.
 7. The final IFR/EA should summarize results from the infaunal monitoring at the borrow site.
 8. Dredging at the borrow site should limit dredging to the prevailing downdrift flanks of the shoals, limiting the depths of the dredge cuts to 3 to 6 feet, and limit the dredging to the portions of the shoal expected to fill in most quickly once dredging has stopped.
 9. A biological monitoring and adaptive management plan that reflects substantive input from NMFS for the nearshore hardbottom impacts is provided prior to the commencement of any new work in the project area.

Section 305(b)(4)(B) of the Magnuson-Stevens Act and implementing regulation at 50 CFR Section 600.920(k) require the Jacksonville District to provide a written response to this letter within 30 days of its receipt. If it is not possible to provide a substantive response within 30 days, in accordance with the “findings” with the Jacksonville District, an interim response should be provided to the NMFS. A detailed response then must be provided prior to final approval of the action. The detailed response must include a description of measures proposed by the Jacksonville District to avoid, mitigate, or offset the adverse impacts of the activity. If the response is inconsistent with the EFH conservation recommendations, the Jacksonville District must provide a substantive discussion justifying the reasons for not following the recommendations. As noted in the summary of the consultation history, this project may significant impact highly valued habitat. The regulations implementing Section 305(b) of the Magnuson-Stevens Act at 50 CFR 600.920(k)(2) allows the NOAA Assistant Administrator for Fisheries to request a meeting with the appropriate Department of Army headquarters official to discuss the proposed action and opportunities for resolving any disagreements. However, as provided for in the “findings” with the Jacksonville District, if the District’s decision is inconsistent with EFH conservation recommendations, the NMFS will endeavor to resolve any such issues at the field level wherever possible.

Thank you for the opportunity to provide these comments. Please direct related questions or comments to the attention of Jocelyn Karazsia at our West Palm Beach Field Office, 400 North Congress Ave, Suite 110, West Palm Beach, Florida 33401, or at (561) 249-1925.

Sincerely,



/ for

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

cc: COE, Paul.E.Stodola@usace.army.mil
BOEM, Douglas.Piatkowski@boem.gov
EPA, Miedema.Ron@epa.gov
USFWS, Ashleigh_Blackford@fws.gov
FDEP, Brendan.Biggs@dep.state.fl.us
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DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 SAN MARCO BOULEVARD
JACKSONVILLE, FLORIDA 32207-0019

REPLY TO
ATTENTION OF

DEC 28 2016

Planning and Policy Division
Environmental Branch

Ms. Virginia Fay
NOAA Fisheries Service
Southeast Regional Office
263 13th Avenue South
Saint Petersburg, Florida 33701

Dear Ms. Fay:

The U.S. Army Corps of Engineers, Jacksonville District (Corps) has received your Essential Fish Habitat (EFH) Conservation Recommendations provided by letter dated June 9, 2016, regarding the St. Lucie County, Florida, Coastal Storm Risk Management (CSRM) Study. The Corps and the Bureau of Ocean Energy Management (BOEM), Department of Interior, requested additional time to respond to your letter via email dated August 4, 2016. This extension was necessary in order for the Corps to re-evaluate the Federal interest (economic justification) of the northern reaches of the beach placement area. Please note that this analysis has resulted in the limitation of beach fill placement in that area between R-98 and R-99 to a transition from the design fill template near R-99 to no fill placement at R-98. Full beach fill placement is now proposed from R-99 to the St. Lucie and Martin County line. These changes with respect to beach fill placement have not resulted in significant changes to the offshore borrow area location and associated sediment volume needs located within the Outer Continental Shelf (OCS).

The Corps is the lead agency and BOEM is a cooperating agency under the National Environmental Policy Act for this study due to the proposed use of OCS sand resources located within a portion of the St. Lucie Shoal complex. BOEM is authorized under Public Law 103-426 [43 United States Code (U.S.C.) 1337 (k) (2)] to negotiate on a non-competitive basis the rights to OCS sand resources for shore protection projects. BOEM is expected to be requested to undertake a connected action (i.e., authorize use of the OCS borrow areas) that is related to, but unique from, the Corps' proposed action. BOEM's proposed action is to issue a negotiated agreement authorizing use of the sand source areas at the request of the local sponsor and the Corps. In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act and its implementing regulations at 50 CFR 600.920(k), the Corps and BOEM are jointly providing the attached responses to your recommendations.

We believe that the responses and associated commitments contained in this letter fulfill the EFH consultation requirements pursuant to the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.920. Please direct comments and questions concerning this letter to Mr. Paul Stodola at 904-232-3271 or Paul.E.Stodola@usace.army.mil.

Sincerely,

A handwritten signature in dark ink, appearing to read "Gina Paduano Ralph", with a stylized flourish at the end.

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch

Enclosures

cc:

Ms. Jocelyn Karazsia, National Marine Fisheries Service, 400 North Congress Avenue, Suite #110, West Palm Beach, Florida 33401

Mr. Doug Piatkowski, Bureau of Ocean Energy Management, 45600 Woodland Road, VAM OEP, Sterling, Virginia 20166

Mr. Pace Wilber, National Marine Fisheries Service, 217 Fort Johnson Road, Charleston, South Carolina 29412

St. Lucie County CSRM Study

Responses to EFH Conservation Recommendations

1. National Marine Fisheries Service (NMFS) Recommendation: The remaining 0.79 acres of mitigation reef should be constructed as described in the Federal permit in addition to any mitigation needed to offset the longer temporal lag that has resulted between burial of the live/hardbottom and establishment of the mitigation reefs.

Response: As reflected in the August 2015 “as-built survey (see attachment A)” and as cited in the corresponding September 18, 2015 “Mitigation Reef Certification Report (see Attachment B)”, a total of 1.93 acres of mitigation reef were constructed in 2013 & 2015 – in excess of the 1.89 acres required by the Corps permit (Permit No: SAJ-2009-03448 [IP-GGLJ]). In addition, note that as identified in the August 31, 2015 “AS-BUILT CERTIFICATION BY PROFESSIONAL ENGINEER” submitted to the Corps:

- Overall, the mitigation reef was built in substantial compliance with the plans and permit conditions. Adjustments to specific reef cell locations were made to comply with water depth requirements prescribed by the Corps and Florida Department of Environmental Protection (DEP) permits.
- Ocean Bay Site 5 was moved to the northeast and only ten cells were constructed at that site due to limited water depths within the limits of the archeological survey. No cells were constructed at Ocean Bay Site 6 due to too shallow water depths. The ten cells that were unable to be constructed at Ocean Bay due to too shallow of water depths were moved to Blind Creek. Five cells were added to the south end of Site 4 at Blind Creek; one cell to the south end of Blind Creek Site 3; four cells to the south end of Site 2.
- In addition, at Blind Creek Site 1 Cell 7 could not be constructed in the permitted location due to insufficient corridor width between cells and the previously constructed reef. This cell was moved to the south end of Site 2.

2. NMFS Recommendation: The final IFR/EA should describe quantitatively the status of the existing 1.1 acres of mitigation reef with regard to the established biological performance standards.

Response: Please see Attachment C, the 2015 Monitoring Report and Attachment D, the Florida Department of Environmental Protection review letter. In addition, ongoing monitoring results, including assessment of permit compliance, will be provided to NMFS upon completion of the associated reports. Natural hardbottom impacts are expected to be concluded in concert with the forthcoming 2016 monitoring report expected by January 2017. Although the 2016 report will assess fulfillment of permit conditions relative to the artificial mitigation reef, continued monitoring of the mitigation reef is expected through 2018 as required by the FDEP permit (Permit No. 0154626-001-JC), including documentation of compliance with “biological performance

standards". All of these pending reports will be provided to NMFS upon completion. Reference to the recently completed monitoring reports describing the status of the existing mitigation reef and the commitment to provide NMFS with future reports to ensure compliance with "biological performance standards" will be documented in the final IFR/EA.

3. NMFS Recommendation: The final IFR/EA should provide the amount of mitigation reef constructed in water depths less than 4.0 meters.

Response: As reflected in the as-built survey, 1.93 acres of mitigation reef were constructed in areas with ambient bottom elevations between -12' and -15' NAVD 88, consistent with the drawings (see Attachment A) approved by the Corps and included in the original Corps permit. At low tide these areas are expected to have ambient water depths between 9.37' and 12.37', less than 13.1' or 4m. In addition, note that the ocean bottom area surrounding the mitigation reef:

- is within the active nearshore littoral system – landward of the "depth of closure",
- was observed to accrete about 2 feet of sand associated with the passage of Hurricane Sandy in 2012, and
- has apparently experienced scouring around the individual reef cells after the reef construction – as is common with such structures in the nearshore region.

This summary related to the amount of mitigation reef constructed in water depths less than 4.0 meters will be documented in the final IFR/EA.

4. NMFS Recommendation: The final IFR/EA should include a synthesis of the available post construction monitoring reports and quantify direct and indirect impact predictions to live/hardbottom habitats seaward of the Equilibrium Toe of Fill.

Response: Construction of the Mitigation Reef was initiated in the summer of 2013, but was not completed until the summer of 2015. As identified in Special Conditions 32 and 33 of the Corps permit, it is anticipated that "success" of the Mitigation Reef will be assessed after 3 years following completion of the construction in 2018. Upon completion of the 2018 monitoring report, NMFS will be provided a copy for review and concurrence that "success" criteria have been met. To date, hardbottom impacts associated with the 2013 non-federal beach fill project appear to be within the "impact predictions". Per Specific Conditions 46 and 47 of the FDEP permit, the forthcoming 2016 Report (expected by January 2017) constitutes the "first (a year after construction)" year monitoring report, a "second and third annual mitigative artificial reef monitoring report shall be provided to NMFS upon completion. These monitoring reports are to address fulfillment of "all permit conditions." A summary of the status of post construction monitoring reports and commitment to provide NMFS with the 2018 monitoring report for review and concurrence that "success" criteria have been met will be integrated into the final IFR/EA.

5. NMFS Recommendation: The final IFR/EA should estimate temporal and direct impacts to nearshore live/hardbottom occurring as a result of project construction during 2013 based on the year 2 monitoring report (and year 3 if that information is available) and evaluate compliance with permit condition 44(i)(6).

Response: See response to NMFS Recommendation 4 cited above. Actual impacts to natural hardbottom are expected to be concluded by the forthcoming 2016 monitoring report – expected by January 2017. The 2016 report constitutes the final natural hardbottom monitoring report as required by Specific Condition 38 of the FDEP permit. A summary of the status of post construction monitoring reports and commitment to provide NMFS with future monitoring reports for review will be integrated into the final IFR/EA.

6. NMFS Recommendation: The year 3 monitoring report should reflect sampling and analysis of 10 reference areas the District agreed in July 2012.

Response: Ongoing monitoring and the year 3 monitoring report do and will reflect FDEP and Corps permit requirements to sample/analyze reference areas. The Scope of Work specifically cites for monitoring of natural hardbottom areas:

A total of twenty (20) monitoring transects will be surveyed: ten (10) within the Project area, two (2) downdrift in Martin County, and eight (8) updrift in St. Lucie County, previously established in 2008/2009 and/or pre-construction monitoring in 2012. Transect positions and lengths are to be permanent.

7. NMFS Recommendation: The final IFR/EA should summarize results from the infaunal monitoring at the borrow site.

Response: In faunal monitoring results will be made available to NMFS upon completion of 2016 monitoring and completion of the associated report. The final IFR/EA will summarize these results.

8. NMFS Recommendation: Dredging at the borrow site should limit dredging to the prevailing downdrift flanks of the shoals, limiting the depths of the dredge cuts to 3 to 6 feet, and limit the dredging to the portions of the shoal expected to fill in most quickly once dredging has stopped.

Response: This recommendation implies that the proposed borrow area located within the St. Lucie shoal complex may recover through active littoral processes following dredging. However, this shoal complex is considered a relic feature and is not connected to the active littoral system. The Corps will continue to collect additional geotechnical and geophysical data within the proposed borrow area during Preconstruction Engineering and Design (PED). These more refined data will inform

the final borrow area design parameters prior to construction. The Corps and BOEM will coordinate with NMFS to develop a refined borrow area design that provides a sufficient volume of compatible sediment to support the project objectives while maintaining overall shoal integrity. The overall goal is to ensure that physical and biological processes following dredging are maintained within the St. Lucie shoal complex to the maximum extent practicable.

Based on the geophysical and geotechnical data that is currently available, the proposed borrow area design includes a dredging template that is oriented with the long axis of the shoal to minimize impacts to the overall shoal complex. Additionally, the Corps and BOEM are currently investigating the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. However, additional analysis will need to be performed during PED to better understand the cumulative volume of sediment within the shoal complex relative to the identified volume of sediment needed to support the federal project. The Corps and BOEM will continue to coordinate with NMFS as additional information becomes available. The final IFR/EA will document a commitment to continue coordination with NMFS during PED as the borrow area design is refined.

9. NMFS Recommendation: A biological monitoring and adaptive management plan that reflects substantive input from NMFS for the nearshore hardbottom impacts is provided prior to the commencement of any new work in the project area.

Response: The DEP/Corps permits for the 2013 non-Federal beach fill project reference the approved Biological and Physical Monitoring Plans. Comparable monitoring (a) should be adequate for the reduced footprint associated with the proposed Federal project, and also (b) will likely be required for monitoring of the federal project per the associated State Water Quality Certification (DEP permit).

ATTACHMENTS TO THE CORPS RESPONSE LETTER DATED DECEMBER 28, 2016 CAN BE FOUND USING THE FOLLOWING LINK. CLICK ON ST. LUCIE COUNTY, THEN SCROLL DOWN TO ST. LUCIE COUNTY CSRM PROJECT AND CLICK ON APPENDIX G (ATTACHMENT 3).

<http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch/EnvironmentalDocuments.aspx>



UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office

263 13th Avenue South

St. Petersburg, Florida 33701-5505

<http://sero.nmfs.noaa.gov>

January 9, 2017

F/SER47:JK/pw

(Sent via Electronic Mail)

Colonel Jason A. Kirk, Commander
U.S. Army Corps of Engineers, Jacksonville District
701 San Marco Boulevard
Jacksonville, Florida 32207-0019

Attention: Paul E. Stodola

Dear Colonel Kirk:

NOAA's National Marine Fisheries Service (NMFS) reviewed the letter dated December 28, 2016, from the Jacksonville District regarding the *St. Lucie County, Florida, Coastal Storm Risk Management Project Draft Integrated Feasibility Report and Environmental Assessment (DIFR/EA)*¹. The Jacksonville District's letter replies to conservation recommendations the NMFS provided by letter dated June 9, 2016, to protect essential fish habitat (EFH).

The NMFS and Jacksonville District have met several times to discuss the beach nourishment project authorized under permit SAJ-2009-03448 (IP-GGL). The DIFR/EA proposes continuing the beach nourishment as a federal civil works project for the next 50 years. By letter dated June 9, 2016, the NMFS provided a detailed consultation history for this project, including the steps taken by the NMFS, Jacksonville District, and St Lucie County to resolve objections the NMFS provided, under Part IV Sections 3(a) and 3(b) of the Clean Water Act Section 404(q) Memorandum of Agreement between the Department of Commerce and the Department of the Army, dated August 11, 1992 (MOA), during evaluation of the permit application. The NMFS removed its objections under the MOA after numerous meetings to develop special conditions for the permit. The comments and recommendations the NMFS provided on the DIFR/EA focused on the status of the actions required by those permit conditions and the continuation of those actions into the federal civil works project. As described below, it appears the permit conditions are not being implemented fully, in particular conditions pertaining to the amount of compensatory mitigation, monitoring of the mitigation, and monitoring of project impacts along the beach. Accordingly, the NMFS cannot conclude at this time that the proposed beach nourishment adequately minimizes impacts to EFH.

The NMFS recommended the Jacksonville District not implement the St. Lucie County, Florida, Coastal Storm Risk Management Project until impacts authorized by permit SAJ-2009-03448 are determined and mitigated fully. Specifically, the NMFS recommended:

¹ The Bureau of Ocean Energy Management is a cooperating agency under the National Environmental and Policy Act for the DIFR/EA because of the proposed use as beach fill of Outer Continental Shelf sand from the St. Lucie Shoal complex. The Jacksonville District proposes to increase beach and shoreline protection in the interest of hurricane protection, storm damage reduction, beach erosion control, and protection of public-trust natural resources for 3.4 miles of Atlantic shoreline from Florida Department of Environmental Protection Monument R-98 (just north of Normandy Beach Access) southward to the Martin County line. The tentatively selected plan would excavate sand from the St. Lucie Shoal complex for three nourishment events with the initial nourishment event requiring 530,400 cubic yards of material and the two subsequent events requiring an average of 380,000 cubic yards of material.



1. The remaining 0.79 acres of mitigation reef should be constructed as described in the federal permit in addition to any mitigation needed to offset the longer temporal lag that has resulted between burial of the live/hardbottom and establishment of the mitigation reefs.
2. The final IFR/EA should describe quantitatively the status of the existing 1.1 acres of mitigation reef with regard to the established biological performance standards.
3. The final IFR/EA should provide the amount of mitigation reef constructed in water depths less than 4.0 meters.
4. The final IFR/EA should include a synthesis of the available post-construction monitoring reports and quantify direct and indirect impact predictions to live/hardbottom habitats seaward of the ETOF.
5. The final IFR/EA should estimate temporal and direct impacts to nearshore live/hardbottom occurring as a result of project construction during 2013 based on the year 2 monitoring report (and year 3 if that information is available) and evaluate compliance with permit condition 44(i)(6).
6. The year 3 monitoring report should reflect sampling and analysis of 10 reference areas the District agreed in July 2012.
7. The final IFR/EA should summarize results from the infaunal monitoring at the borrow site.
8. Dredging at the borrow site should be limited to the prevailing downdrift flanks of the shoals, limiting the depths of the dredge cuts to 3 to 6 feet, and limit the dredging to the portions of the shoal expected to fill in most quickly once dredging has stopped.
9. A biological monitoring and adaptive management plan reflecting substantive input from the NMFS should be developed for the nearshore hardbottom impacts and provided to the NMFS prior to the commencement of future beach nourishment work.

Regarding recommendation 1, contrary to permit requirements, the District is using the sum of the acres defined by the perimeters of the mitigation reefs deployed in 2013 and 2015 at Blind Creek and Ocean Bay as the amount of mitigation reef provided. Special condition 23 of the permit states “The permittee shall create a minimum of 1.89 acres of hardbottom substrate” (page 9 of 27, emphasis added) and special condition 25 states “The perimeter of the mitigation site shall encompass an area of 2.55 [acres] and the actual footprint of the artificial reefs shall cover 1.89 acres of the sea floor” (page 9 of 27, emphasis added). While the perimeters encompass 1.93 acres (page 2 of the District’s letter), this falls short of the perimeter required by special condition 25 and has an unknown relationship to the substrate requirement in special condition 23.

While conservation recommendation 2 requested information from the monitoring of the mitigation reefs deployed in 2013 and 2015, the District’s response focused instead on the monitoring of hardbottom impacts at the fill site. The NMFS has not received information on the status of the monitoring of the mitigation reefs deployed in 2013 or 2015 other than the CSA report titled *The St. Lucie County South County Beach and Dune Restoration Project Immediate Post-Construction Mitigation Reef Monitoring Report* (September 2015). Please note the CSA report focuses on only 1.1 acres of mitigation reef construction², not all the mitigation reefs described in Appendix A.

Regarding recommendation 3, the NMFS appreciates the District providing the bathymetric survey results and analysis. It appears many of the reef placement areas were moved into deeper waters (-14 to -15 feet NAVD 88, maximum elevation) compared to what was proposed initially (-12 to -13 feet NAVD 88, maximum elevation). For example, please see cells 1 through 3 on sheet 8 of 14; cells 8 through 11

² Of the 1.52 acres of mitigation reef (perimeter) deployed, the percent net boulder cover and percent sand cover were 72.4 percent (1.10 acres) and 27.6 percent (0.42 acres), respectively (information from pages 1 and 30 of CSA 2015).

on sheet 10 of 14; cells 1 through 20 on sheet 11 of 14; and cells 1 through 12 on sheet 14 of 14. Despite these changes, the District concludes the reefs were constructed in water depths less than 4 meters, and the NMFS accepts the conclusion.

In response to recommendation 4, the District agrees to provide the NMFS with results from the three-year post-construction mitigation reef monitoring report (final monitoring event expected to be completed in 2018). In the interim, the NMFS requests a status report on each of the mitigation reefs constructed in 2013 and 2015. Please include in the status report any data available gauging performance of the reef with respect to the performance standards the NMFS and Jacksonville District developed as permit conditions 32(c) and 46(c), which specify successful mitigation must include no less than 6.0 percent cover by worm reef.

In response to recommendations 4 and 5, while the District agrees to provide a summary of the status of the post-construction monitoring reports for the direct and indirect impact predictions at the fill sites, the letter is inconsistent regarding this matter. The District's letter states "To date, hardbottom impacts associated with the 2013 non-federal beach fill project appear to be within the impact predictions." However, the District provided correspondence to St Lucie County from the Florida Department of Environmental Protection (FDEP) stating "The review letter for the 2014 biological monitoring report (dated 5/18/2015) noted loss of hardbottom resources due to encroachment of potentially project related sediment into the hardbottom area adjacent to the fill template (R-100 to R-113). Our [FDEP] review of the 2015 monitoring report combined with additional analysis of previous and current survey data suggest these impacts have not receded" (emphasis added). The NMFS requests the District resolve this inconsistency in the post-construction monitoring summary the District said would be provided during January 2017.

The District agrees to implement recommendations 6 and 7.

Regarding recommendation 8, the District and the Bureau of Ocean Energy Management (BOEM) agree to continue investigating the feasibility of maintaining a refuge patch in coordination with the NMFS; however, the other BMPs the NMFS recommended will not be followed because the shoal is a relic feature, rather than actively accreting. The BMPs are meant to minimize the effect of the dredging on localized currents created by water moving across the shoals. These localized currents include eddies and other features that concentrate prey and become feeding grounds for fishery species. The localized currents are not dependent on whether the shoal is accreting sand. Accordingly, the NMFS requests the District and BOEM re-evaluate their response to this conservation recommendation.

Regarding conservation recommendation 9, the District did not supply the monitoring and adaptive management plan the NMFS requested. Rather, the District indicates similar monitoring would occur as previously required under permits from the FDEP and Jacksonville District. Overall, the NMFS agrees the existing biological monitoring protocol is sufficient for the impact assessment. For this plan, the NMFS sees continued value in not reducing the number of reference sites, as reflected in the District's letter. Due to the low number of transects included in the monitoring, the NMFS recommends continued monitoring of permanent transects and quadrats rather than randomly selected transects and quadrats. The NMFS would like to have the opportunity to evaluate any future changes to the monitoring if changes are proposed.

As noted above, much of the information important to minimizing and mitigating impacts to EFH from nourishing the St Lucie County beaches with sand from the shoals is still in development. Accordingly, the need for an adaptive management plan for this project seems critical, especially in the case the year three biological monitoring plan determines hardbottom impacts detected in the 2014 and 2015

monitoring events have not receded and additional mitigation is needed to offset temporary or permanent hardbottom impacts. In addition, the adaptive management plan should address actions that may be required after the year three mitigation monitoring report and supporting data becomes available in order for St Lucie County to comply with special conditions contained in permit SAJ-2009-03448, in particular conditions 23, 25, 32(c), and 46(c), as discussed above.

Closing

In accordance with the intentions of 50 CFR 600.920(k)(2), the NMFS requests continued coordination between the Jacksonville District and the NMFS Habitat Conservation Division on the issues pertaining to the EFH recommendations for the reasons provided above.

Thank you for the opportunity to provide comments. Please direct related correspondence to the attention of Ms. Jocelyn Karazsia at our West Palm Beach office, 400 North Congress Avenue, Suite 110, West Palm Beach, Florida, 33401. She may be reached by telephone at (561) 249-1925, or by e-mail at Jocelyn.Karazsia@noaa.gov.

Sincerely,



/ for

Virginia M. Fay
Assistant Regional Administrator
Habitat Conservation Division

cc: COE, Paul.E.Stodola@usace.army.mil
COE, Gina.P.Ralph@usace.army.mil
BOEM, Douglas.Piatkowski@boem.gov
FWS, Ashleigh_Blackford@fws.gov
EPA, Miedema.Ron@epa.gov
FWCC, Lisa.Gregg@MyFWC.com
FDEP, Brendan.Biggs@dep.state.fl.us
SAFMC, Roger.Pugliese@safmc.net
F/SER4, David.Dale@noaa.gov
F/SER47, Jocelyn.Karazsia@noaa.gov



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

Planning and Policy Division
Environmental Branch

APR 3 2017

Ms. Virginia Fay
NOAA Fisheries Service
Southeast Regional Office
263 13th Avenue South
Saint Petersburg, Florida 33701

Dear Ms. Fay:

The U.S. Army Corps of Engineers, Jacksonville District (Corps) and Bureau of Ocean Energy Management (BOEM), Department of Interior, have jointly reviewed the letter dated January 9, 2017, from the National Marine Fisheries Service (NMFS) regarding the St. Lucie County, Florida, Coastal Storm Risk Management Study. This was the second letter issued by NMFS on the study, and was written in response to our letter dated December 28, 2016. The outstanding recommendations and concerns described by NMFS are primarily directed towards the status of actions taken by St. Lucie County as required by Department of the Army (DA) Permit SAJ-2009-03448. We have since conducted extensive coordination with Corps Regulatory Division (RD) and St. Lucie County in order to compile and thoroughly analyze all relevant documentation required by the permit to further address your recommendations and concerns.

Your primary recommendation is that the Corps should not implement the St. Lucie County, Florida, Coastal Storm Risk Management until impacts associated with St. Lucie County's previously completed shore protection project (DA Permit SAJ-2009-03448) are determined and fully mitigated. Corps RD has reviewed all documentation provided by St. Lucie County and has determined that the beach placement, mitigation, and monitoring have been performed in compliance with the County's permit. We defer to RD's determination that all permit conditions have been satisfied and have revised the Final Integrated Feasibility Report and Environmental Assessment accordingly, including reference to all relevant documentation in support of the determination. Please find the enclosed RD compliance letter dated April 3, 2017.

As stated in our previous letter, the Corps and BOEM will continue to informally coordinate with NMFS as additional data become available during Pre-Construction Engineering and Design (PED) to develop a refined St. Lucie Shoal/borrow area design that provides a sufficient volume of compatible sediment to support the project objectives while maintaining overall shoal integrity. During PED, the Corps and BOEM will continue to investigate the feasibility of maintaining a refuge patch at maximum shoal elevations to promote quicker biological recovery following dredging. Additionally, the Corps and BOEM will coordinate with NMFS and St. Lucie County in the development of any future monitoring plans.

We are aware that NMFS issued a letter dated January 30, 2017, to Corps RD regarding public notice of DA Permit SAJ-2009-03448. The notice pertained to a request from St. Lucie County to modify its permit to perform additional beach nourishment between Florida Department of Environmental Protection monuments R-98 to R-115 plus an additional 1000 feet. It is our understanding that Corps RD is preparing a response to your letter, and will be providing information on the monitoring of the mitigation reefs deployed by St. Lucie County as a component of that response.

We believe that the responses contained in this letter fulfill the EFH consultation requirements pursuant to the Magnuson-Stevens Fishery Conservation and Management Act and 50 CFR 600.920. With the exception of our commitment to continue informal coordination with the NMFS regarding St. Lucie Shoal, this concludes the EFH coordination process.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Gina Paduano Ralph', is written over a circular embossed seal. The signature is fluid and cursive.

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch

Enclosures

cc:

Mr. Pace Wilber, National Marine Fisheries Service, 217 Fort Johnson Road,
Charleston, SC 29412

Ms. Jocelyn Karazzia, National Marine Fisheries Service, 400 North Congress Avenue,
Suite #110, West Palm Beach, FL 33401

Mr. Doug Piatkowski, Bureau of Ocean Energy Management, 45600 Woodland Road,
VAM OEP, Sterling, VA 20166

Ms. Linda Knoeck, U.S. Army Corps of Engineers, 4400 Pga Boulevard, Suite #500,
Palm Beach Gardens, FL 33410



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
PENSACOLA REGULATORY OFFICE
41 NORTH JEFFERSON STREET, SUITE 301
PENSACOLA, FLORIDA 32502

REPLY TO
ATTENTION OF

APRIL 3, 2017

Regulatory Division
South Branch
Enforcement Section
SAJ-2009-03448 (IP-GGL)

St. Lucie County Erosion District
Attn: Richard Bouchard
2300 Virginia Avenue
Ft. Pierce, FL 34982

Dear Mr. Bouchard:

Reference is made to Department of the Army permit SAJ-2009-03448 issued on January 27, 2012. The project was to stabilize and restore approximately 3.4 miles of beach and dune along the South Beach shoreline of St. Lucie County, using approximately 485,900 cubic yards of fill dredged from an offshore borrow area or from upland sources. The beach and dune restoration site is located in St. Lucie County, and extends from Department reference monument R-98 to the St. Lucie / Martin County Line at R-115+1000, Sections 27, 34, 35, Township 36 and 37 South, Range 41 East, Atlantic Ocean. Two mitigation reefs are included in the project and are in the Atlantic Ocean off of St. Lucie County.

Representatives of the U.S. Army Corps of Engineers (Corps) conducted a file review on March 27, 2017. The file review confirmed the work authorized by the permit has been completed. Corps personnel reviewed the file for this project and noted all conditions of the permit are currently in compliance.

Thank you for your cooperation with our regulatory program. If you have any questions or concerns regarding this matter contact Mr. Terry Wells at the letterhead address or via email at Terry.e.wells@usace.army.mil or by telephone at 850-433-8860.

Sincerely,

TRULOCK.SHELLEY.FAY
E.1230638663

Digitally signed by TRULOCK.SHELLEY.FAY.E.1230638663
DN: c=US, o=US Government, ou=DoD, ou=PE, ou=USA,
cn=TRULOCK.SHELLEY.FAY.E.1230638663
Date: 2017.04.03 09:46:45 -0400

Shelley Trulock
Acting Chief, Enforcement Section

ATTACHMENTS TO THE CORPS RESPONSE LETTER DATED DECEMBER 28, 2016 CAN BE FOUND USING THE FOLLOWING LINK. CLICK ON ST. LUCIE COUNTY, THEN SCROLL DOWN TO ST. LUCIE COUNTY CSRM PROJECT AND CLICK ON APPENDIX G (ATTACHMENT 3).

<http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch/EnvironmentalDocuments.aspx>

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX H

Pertinent Correspondence



**US Army Corps
of Engineers**
Jacksonville District



Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Noah Valenstein
Secretary

August 9, 2017

Mr. Jason Spinning
Chief, Coastal Section
Environmental Branch
Planning & Policy Division
USACE, Jacksonville District
701 San Marco Boulevard
Jacksonville, FL 32207-8175

Dear Mr. Spinning,

The Department has concluded that the proposed St. Lucie County Coastal Storm Risk Management Project is consistent with Florida's Coastal Zone Management Program and its associated statutes. It is likely the project would qualify for a Joint Coastal Permit, which would include water quality certification.

If you have any questions, please do not hesitate to contact me at 850-245-7617 or Lainie.edwards@dep.state.fl.us.

Sincerely,

A handwritten signature in cursive script, appearing to read "Lainie Edwards".

Lainie Edwards, Ph.D.
Program Administrator- Beaches, Inlets and Ports Program
Division of Water Resource Management
Dept. of Environmental Protection



United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960



November 21, 2016

Jason A. Kirk
U.S. Army Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

Service Consultation Code: 04EF2000-2016-F-0351
Date Received: May 26, 2016
Consultation Initiation Date: October 20, 2016
Project: St. Lucie County, Coastal Storm
Risk Management Project
County: St. Lucie

Dear Colonel Kirk:

This document transmits the U.S. Fish and Wildlife Service's (Service) decision document to the U.S. Army Corps of Engineers (Corps) for the placement of sand along approximately 3.4 miles (mi) of shoreline along Hutchinson Island, St. Lucie County, Florida (Project). The Corps determined that the Project may affect, and is likely to adversely affect the endangered leatherback sea turtle (*Dermochelys coriacea*), the endangered green sea turtle (*Chelonia mydas*), the endangered hawksbill sea turtle (*Eretmochelys imbricata*), the endangered Kemp's ridley sea turtle (*Lepidochelys kempii*), and the threatened Northwest Atlantic Ocean (NWAO) Distinct Population Segment (DPS) of the loggerhead sea turtle (*Caretta caretta*); and may affect, but is not likely to adversely affect the endangered beach jacquemontia (*Jacquemontia reclinata*), the threatened piping plover (*Charadrius melodus*), the threatened red knot (*Calidris canutus rufa*), the endangered West Indian manatee (*Trichechus manatus*; manatee), and terrestrial loggerhead sea turtle designated critical habitat. For the purposes of this document, the five identified sea turtles will be referred to collectively as sea turtles. This document is provided in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*).

The Service and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) share Federal jurisdiction for sea turtles under the Act. The Service has responsibility for sea turtles on the nesting beach and the NOAA Fisheries has jurisdiction for sea turtles in the marine environment. The NOAA Fisheries will assess and consult with the Corps concerning potential impacts to foraging and swimming sea turtles, critical habitat in the marine environment, and all other marine species under their jurisdiction within the Project area in accordance with the Marine Mammal Protection Act.

Our analysis in this document will only address activities that may impact nesting sea turtles, their nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea. Please note the provisions of this consultation do not apply to sea turtles in the marine environment, such as swimming juvenile and adult sea turtles or loggerhead critical habitat in the marine environment. If applicable, you are required to consult with the NOAA Fisheries on this Project. For further information on Act compliance with the NOAA Fisheries, please contact Rachel Sweeney, Chief of the Interagency Cooperation Branch, by e-mail at rachel.sweeney@noaa.gov or by phone at 727-209-5953.

This analysis is based on information provided in the Corps' May 20, 2016, letter. A complete record of this consultation is on file at the South Florida Ecological Services Office, Vero Beach, Florida.

Consultation History

On May 26, 2016, the Service received a copy of the Corps' letter dated May 20, 2016.

On October 13, 2016, the Service emailed the Corps a request for additional information.

On October 17 and 20, 2016, the Service received emails from the Corps in response to our request for additional information. Following receipt of all the responses, the Service had sufficient information to initiate formal consultation with the Corps concerning the potential effects of the Project on sea turtles, manatees, piping plovers, red knots, beach jacquemontia, and designated terrestrial loggerhead sea turtle critical habitat.

DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to place beach compatible sand on approximately 3.4 mi of shoreline along Hutchinson Island, St. Lucie County, Florida. The proposed Project involves the placement of sand within a fill template which extends between the Florida Department of Environmental Protection reference monuments R-99 and the Martin County line. The Bureau of Ocean Energy Management is a cooperating agency for this Project due to the proposed use of Outer Continental Shelf sand resources located within a portion of the St. Lucie Shoal complex. Using a hopper dredge, approximately 420,000 cubic yards (cy) of sand will be placed within the fill template for the initial construction of the design profile. Two renourishment events averaging 390,000 cy each are expected to occur at 18-year intervals. Once the dredge material has been deposited within the fill template, bulldozers will move and grade the material to produce the authorized beach design which is characterized by a 20-foot (ft) berm extension from the toe of the 2008 dune profile.

All beach corridors, staging areas, and pipeline corridors will be selected to avoid affects to upland habitat. Construction vehicles and equipment must traverse or be stored within these designated areas, corridors, and/or within the pipeline corridor. In addition, all construction pipes will be placed parallel to the shoreline and positioned as far landward as possible up to the

vegetated dune line. Existing vegetated habitat at these sites and corridors shall be protected to the maximum extent possible to minimize disturbance; therefore, impacts associated with the beach access corridors, pipeline corridors, staging areas, and beach fill template are not anticipated. If impacts occur, all impacted areas and vegetation will be restored to preconstruction condition and elevation. In addition, all impacts to nearshore hardbottom habitat and seagrasses will be avoided. All loose debris will be removed and properly disposed of prior to sand placement.

The proposed Project will be conducted during the day and nighttime hours working 24 hours per day, seven days per week. The intent of the Project is to provide shoreline stabilization along the shoreline.

The proposed Project area lies within Coastal Barrier Resources Act (CBRA) Unit FL-P11, Hutchinson Island. This unit is part of the Coastal Barrier Resources System (System) which supports suitable habitat for species listed under the Act. Section 6 of CBRA (16 U.S.C. § 3505) permits certain federal expenditures and financial assistance within the System if it meets one of the exceptions (A-G) and it is also consistent with the three purposes of CBRA, which include: 1) minimize the loss of human life; 2) minimize wasteful expenditure of Federal revenues; and 3) minimize damage to fish, wildlife, and other natural resources. In a letter to the Corps dated November 2, 2016 (Appendix A), the Service determined that the proposed Project meets the section 6 (G) exemption and is consistent with the three purposes of CBRA.

Minimization measures

The Corps will follow and implement the Reasonable and Prudent Measures (RPMs) and the Terms and Conditions identified in the revised Statewide Programmatic Biological Opinion (2015-SPBO; Service 2015), and the Conservation Measures of the Programmatic Piping Plover Biological Opinion (P³BO; Service 2013) that apply to the Project. The P³BO conservation measures will also minimize effects to red knots.

To minimize impacts to manatees from the proposed Project, the Corps has agreed to follow and implement the Florida Fish and Wildlife Conservation Commission's (FWC) Standard Manatee Conditions for In-Water Work (FWC 2011), and the minimization measures outlined for manatees in the 2015-SPBO and the Corps' SBPO biological assessment (Corps 2011).

Action Area

The action area is defined as all areas to be affected directly or indirectly by the action and not merely the immediate area involved in the action. The Service identifies the action area to include the sand fill template, staging areas, beach access and pipeline corridors, and the St. Lucie Shoal complex. The Project is located along the Atlantic Ocean, Hutchinson Island, St. Lucie County, Florida, at latitude 27.2883 and longitude -80.2112.

THREATENED AND ENDANGERED SPECIES

Beach jacquemontia

Although the Service's Geographic Information System (GIS) data does not document any beach jacquemontia in the Project area, it may be present due to suitable habitat. In addition to the minimization measures outlined in the Corps' SPBO biological assessment (Corps 2011), the following minimization measures shall be followed to reduce potential impacts on beach jacquemontia.

1. Surveys shall be performed preconstruction to determine the presence of beach jacquemontia. Surveys must be performed during the growing season (May through November) or, at a minimum, when dormant vegetation is present. Plant locations must be recorded using a Global Position System, photographs, and written descriptions of the location and extent of growth. To preclude intentional or unintentional disturbance or harm, the exact location of plants should not be marked until necessary for construction design, surveys, and implementation. Marking of plant locations must use noninvasive, temporary techniques such as pin flagging. Surveys must be performed by personnel who have training or experience in identification of beach jacquemontia.
2. All construction personnel shall be educated concerning the presence and location of beach jacquemontia and the minimization measures to be implemented to avoid all potential impacts to the plant.
3. A 25-ft buffer shall be created between any existing beach jacquemontia and construction activities, equipment storage, and beach access corridors.
4. Unless otherwise directed by the Service, all plant site markings must be removed post construction.
5. All marked sites shall be reinspected post construction. Any disturbance or other impacts to beach jacquemontia shall be photographed and recorded in a narrative report and immediately shared with the Service's South Florida Ecological Services Office. Based on the Service's review, remedial action may be necessary.

Based on the implementation of minimization measures listed above and those outlined in the Corps' 2011 biological assessment, and the fact that beach jacquemontia has not been documented in the area, the Service concurs that the Project may affect, but is not likely to adversely affect this species.

Piping plover

The Service has determined the Project's impact to non-optimal piping plover habitat is consistent with the analysis in the P³BO. As previously stated, the Corps has agreed to follow and implement the Conservation Measures outlined in the P³BO that apply to the Project. As it relates to survey guidelines defined in P³BO Conservation Measure #2, the Service approves a reduction in the survey effort, and the following revised survey guidelines can be implemented by the Corps:

1. One preconstruction winter shorebird survey will be conducted within a 10-day timeframe beginning the first Friday in February, as outlined in the Florida Shorebird Alliance's Winter Shorebird Survey (<http://flshorebirdalliance.org>). If the February preconstruction survey is not possible, two preconstruction winter shorebird surveys will be conducted as close as possible to the February dates and at least 15 days apart, and reported to the FWC (<https://public.myfwc.com/crossdoi/shorebirds/loginform.aspx>). Preconstruction surveys will not be conducted between May 16 and July 14. If piping plovers are documented during the preconstruction survey, the Service will be contacted for potential implementation of additional conservation measures prior to construction commencement. In addition, a February winter shorebird survey will be conducted as outlined above, for 2 years post-construction. All shorebird survey data will be forwarded to the Service annually upon completion.
2. The person(s) conducting the surveys must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information outlined in the Winter Shorebird Survey.

Because the Project, as proposed, is consistent with the analysis for non-optimal piping plover habitat in P³BO, the Corps has concurrence for the piping plover for this Project through the concurrence contained within P³BO. A report must be submitted by July 31 of each year in which monitoring is completed, as described in Term and Condition 9 of the P³BO.

Red knot

Red knots may use the Project area during winter and migration periods. In Florida, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments, mangrove and brackish lagoons. Red knots forage along sandy beaches during spring and fall migration throughout Florida. To date, critical habitat has not been proposed or designated for the red knot. According to our GIS database and eBird (eBird 2016), no red knots have been documented in the action area. Because suitable habitat for the red knot and piping plover is similar, minimization measures for potential effects to red knots in non-optimal habitat will be incorporated into the Project, through the Corps' implementation of the Conservation Measures to reduce impacts on piping plovers for projects located in non-optimal piping plover habitat as outlined in the P³BO.

Based on the implementation of P³BO's Conservation Measures, the fact that red knots have not been documented in the area, and the Project area is located in non-optimal red knot habitat, the Service concurs that the Project, as proposed, may affect but is not likely to adversely affect this species.

Sea turtles

The Project is located adjacent to sea turtle nesting habitat, and therefore could adversely affect nesting sea turtles, their nests, and hatchlings. The purpose of the proposed Project is to protect the shoreline from ongoing erosion. Without the restorative activities, erosion is expected to

continue, potentially impacting sea turtle nesting. Consequently, the proposed Project could have beneficial effects to nesting sea turtles.

The Service has determined the Project's effects concerning sand placement activities are consistent with those analyzed in the 2015-SPBO. Therefore, it is appropriate to apply the 2015-SPBO to the Project. Based on the Corps' commitment to implement the minimization measures, RPMs, and the Terms and Conditions identified in the 2015-SPBO that apply to the Project, the Project's take coverage for listed sea turtles is henceforth covered under the 2015-SPBO.

Terrestrial loggerhead sea turtle designated critical habitat

As previously stated, the Project will occur along a stretch of beach that is designated terrestrial loggerhead sea turtle critical habitat. The Project may directly or indirectly impact biological and physical features of critical habitat for the NWAOP DPS of the loggerhead sea turtle along approximately 3.4 mi of beach along Hutchinson Island. The 3.4 mi of beach along Hutchinson Island represents 15.5 percent of Critical Habitat Unit LOGG-T-FL-09, and 0.45 percent of all designated critical habitat in the NWAOP DPS. The Service has determined the Project effects on designated terrestrial loggerhead sea turtle critical habitat are consistent with those analyzed in the 2015-SPBO. Consequently the Service concurs that the Project may affect, but is not likely to adversely affect terrestrial loggerhead sea turtle designated Critical Habitat Unit LOGG-T-FL-09.

West Indian manatee

The Project occurs within the geographic range of the manatee and is located in the manatee consultation area. The Corps has agreed to implement the FWC *Standard Manatee Construction Conditions for In-water Work* (FWC 2011), the minimization measures outlined in the 2015-SPBO, and the minimization measures outlined in the Corps' SPBO biological assessment (Corps 2011), to avoid potential impacts on manatees. Based on the proposed protection measures, the Service concurs that the Project, as proposed, may affect, but is not likely to adversely affect this species. The Project is not located within designated critical habitat for the manatee.

REINITIATION NOTICE

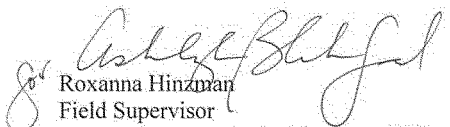
This concludes consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

1. The amount or extent of incidental take outlined in the 2015-SPBO is exceeded. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation;
2. New information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this analysis;

3. The agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this analysis; or
4. A new species is listed or critical habitat designated that may be affected by the action.

Thank you for your cooperation in the effort to conserve fish and wildlife resources. Should you have additional questions or require clarification regarding this letter, please contact Jeff Howe at 772-469-4283.

Sincerely yours,


Roxanna Hinzman
Field Supervisor
South Florida Ecological Services Office

cc: electronic only

Corps, Jacksonville, Florida (Paul Stodola)

DEP, Tallahassee, Florida (Lanie Edwards)

EPA, West Palm Beach, Florida (Ron Miedema)

FWC, Tallahassee, Florida (FWC-CPS, Robbin Trindell)

NOAA Fisheries, Fort Lauderdale, Florida (Audra Livergood)

NOAA Fisheries, West Palm Beach, Florida (Jocelyn Karazsia)

Service, St. Petersburg, Florida (Anne Marie Lauritsen, Peter Plage)

LITERATURE CITED

- eBird.org. 2016. An online database of bird distribution and abundance [Internet]. Cornell Lab of Ornithology; Ithaca, New York [cited November 9, 2016]. Available from: <http://www.ebird.org>.
- Florida Fish and Wildlife Conservation Commission (FWC). 2011. Standard Manatee Conditions for In-Water Work 2011. Tallahassee, Florida [Internet]. [cited November 10, 2016]. Available from: http://myfwc.com/media/415448/Manatee_StdCondln_waterWork.pdf
- U.S. Army Corps of Engineers (Corps). 2011. Statewide Programmatic Biological Assessment. Beach Placement and Shore Protection, Coast of Florida. U.S. Army Corps of Engineers; Jacksonville, Florida.
- U.S. Fish and Wildlife Service (Service). 2013. Programmatic piping plover biological opinion to the U.S. Army Corps of Engineers (Service Log No. 04EF1000-2013-F-0124) for shore protection activities in the geographical region of the north and south Florida Ecological Services Field Offices (May 22, 2013). Jacksonville and Vero Beach Field Offices, Florida.
- U.S. Fish and Wildlife Service (Service). 2015. Statewide programmatic biological opinion to the U.S. Army Corps of Engineers (Service Log No. 41910-2011-F-0170) for shore protection activities along the coast of Florida (March 13, 2015). Jacksonville, Panama City, and Vero Beach Field Offices, Florida.

Appendix A



United States Department of the Interior

FISH AND WILDLIFE SERVICE
 South Florida Ecological Services Office
 1339 20th Street
 Vero Beach, Florida 32960



November 2, 2016

Gina Paduano
 U.S. Army Corps of Engineers
 701 San Marco Boulevard
 Jacksonville, Florida 32207

Service CPA Code: 04EF2000-2016-CPA-0161
 Date Received: May 20, 2016
 Project: St. Lucie County, Coastal Storm
 Risk Management Project
 County: St. Lucie

Dear Ms. Paduano:

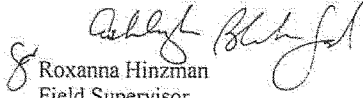
The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) request for a consistency determination under the Coastal Barrier Resources Act (CBRA) for the St. Lucie County, Coastal Storm Risk Management Project's Tentatively Selected Plan (TSP). The Corps specifically requested confirmation that the Corps can award and administer the contract for the TSP beach nourishment project along the privately owned parcels in Unit P11 and remain in compliance with CBRA.

Section 6 of CBRA (16 U.S.C. § 3505) permits certain federal expenditures and financial assistance within the Coastal Barrier Resource System if it meets one of the exceptions (A-G) and it is also consistent with the three purposes of CBRA, which include: 1) minimize the loss of human life; 2) minimize wasteful expenditure of Federal revenues; and 3) minimize damage to fish, wildlife, and other natural resources.

The Service has determined that the TSP meets the section 6 (G) exemption and is consistent with three purposes of CBRA. Expenditure 6 (G) is for nonstructural shoreline stabilization that is designed to mimic, enhance, or restore a natural stabilization system. The Corps has indicated that no Federal funds will be spent within privately owned land in Unit P11 including the work conducted along the beach adjacent to: 1) the approximately 750 feet of private land at the northern boundary of the project area (Department of Environmental Protection monument R-98), 2) the approximately 150 feet of private land north of Dollman Park, and 3) the approximately 2,000 feet of land adjacent to Dollman Park. The Corps will award and administer the contracts for work in these areas; however, all activities including the salaries of individual Corps staff will be paid for with private funds.

Thank you for your cooperation in the effort to protect fish and wildlife resources. If you have any questions regarding this project, please contact Jeff Howe or Ashleigh Blackford at 772-562-3909.

Sincerely yours,


Roxanna Hinzman
Field Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Jacksonville, Florida (Jason Spinning, Paul Stodola)



United States Department of the Interior

FISH AND WILDLIFE SERVICE
 South Florida Ecological Services Office
 1339 20th Street
 Vero Beach, Florida 32960



November 2, 2016

Gina Paduano
 U.S. Army Corps of Engineers
 701 San Marco Boulevard
 Jacksonville, Florida 32207

Service CPA Code: 04EF2000-2016-CPA-0161
 Date Received: May 20, 2016
 Project: St. Lucie County, Coastal Storm
 Risk Management Project
 County: St. Lucie

Dear Ms. Paduano:

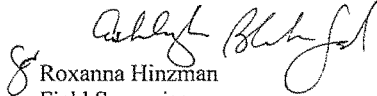
The U.S. Fish and Wildlife Service (Service) has reviewed the U.S. Army Corps of Engineers' (Corps) request for a consistency determination under the Coastal Barrier Resources Act (CBRA) for the St. Lucie County, Coastal Storm Risk Management Project's Tentatively Selected Plan (TSP). The Corps specifically requested confirmation that the Corps can award and administer the contract for the TSP beach nourishment project along the privately owned parcels in Unit P11 and remain in compliance with CBRA.

Section 6 of CBRA (16 U.S.C. § 3505) permits certain federal expenditures and financial assistance within the Coastal Barrier Resource System if it meets one of the exceptions (A-G) and it is also consistent with the three purposes of CBRA, which include: 1) minimize the loss of human life; 2) minimize wasteful expenditure of Federal revenues; and 3) minimize damage to fish, wildlife, and other natural resources.

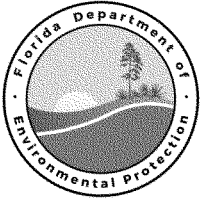
The Service has determined that the TSP meets the section 6 (G) exemption and is consistent with three purposes of CBRA. Expenditure 6 (G) is for nonstructural shoreline stabilization that is designed to mimic, enhance, or restore a natural stabilization system. The Corps has indicated that no Federal funds will be spent within privately owned land in Unit P11 including the work conducted along the beach adjacent to: 1) the approximately 750 feet of private land at the northern boundary of the project area (Department of Environmental Protection monument R-98), 2) the approximately 150 feet of private land north of Dollman Park, and 3) the approximately 2,000 feet of land adjacent to Dollman Park. The Corps will award and administer the contracts for work in these areas; however, all activities including the salaries of individual Corps staff will be paid for with private funds.

Thank you for your cooperation in the effort to protect fish and wildlife resources. If you have any questions regarding this project, please contact Jeff Howe or Ashleigh Blackford at 772-562-3909.

Sincerely yours,


Roxanna Hinzman
Field Supervisor
South Florida Ecological Services Office

cc: electronic only
Corps, Jacksonville, Florida (Jason Spinning, Paul Stodola)



Florida Department of Environmental Protection

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Tallahassee, Florida 32399-3000

Rick Scott
Governor

Carlos Lopez-Cantera
Lt. Governor

Jonathan P. Stevenson
Secretary

July 8, 2016

Paul E. Stodola
U.S. Army Corps of Engineers
Jacksonville District, Planning Division
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Department of the Army - District Corps of Engineers - Integrated Draft
Feasibility Study and Environmental Assessment of a Coastal Storm Risk
Management Study, St. Lucie County, Florida
SAI # FL201605187623C

Dear Paul:

The Florida State Clearinghouse has coordinated a review of the proposed Draft Environmental Assessment (DEA) under the following authorities: Presidential Executive Order 12372; § 403.061(42), *Florida Statutes*; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

Based on the information contained in the submittal, the state finds that the proposed DEA consistent with the Florida Coastal Management Program (FCMP). The state's continued concurrence will be based on the activities' compliance with FCMP authorities, including federal and state monitoring of the activities to ensure their continued conformance, and the adequate resolution of issues identified during this and subsequent regulatory reviews. The state's final concurrence of the project's consistency with the FCMP will continue to be determined during the ongoing state's environmental permitting process, in accordance with Section 373.428, *Florida Statutes*.

Should you have any questions or require additional information, please don't hesitate to contact me at 850/717-9076 or Chris.Stahl@dep.state.fl.us.

Paul E. Stodola
FL201605187623C
Page 2 of 2
July 8, 2016

Yours sincerely,

Chris Stahl

Chris Stahl, Coordinator
Florida State Clearinghouse
Office of Intergovernmental Programs



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

2017 - CPA - 0002

REPLY TO:
ATTENTION OF:

CESAJ-PD-EC (ER 200-2-2)

MAY 20 2016

Bundled
with:

2016-TA-0351
MEMORANDUM FOR THE RECORD

SUBJECT: Coordination Act Report for the St. Lucie County, Florida, Coastal Storm Risk Management Study (CSRM).

PURPOSE: To document an informal understanding between the U.S. Army Corps of Engineers (Corps), Jacksonville District, and the U.S. Fish and Wildlife Service (Service), South Florida Ecological Services Field Office.

Background. The St. Lucie County CSRM study was authorized by Resolution Dockets 2634 and 2757 dated April 11, 2000 and July 23, 1998, respectively. Funding was added by Congress in the appropriations for Fiscal Year 2003 to begin the reconnaissance study; the feasibility study proceeded under that authorization. The purpose of this study is to investigate the feasibility of providing coastal storm risk management within the study area of the St. Lucie County, Florida coastline. St. Lucie County's barrier Islands can be eroded by frequent winter storms (northeasters) as well as tropical storms and hurricanes. The Corps is developing and evaluating alternative plans that address coastal storm risk management, as well as incidental opportunities for preservation of environmental resources and recreation for the southern portion of Hutchinson Island. The Bureau of Ocean Energy Management, Department of Interior, is a cooperating agency under the National Environmental Policy Act for this project due to the proposed use of Outer Continental Shelf sand resources located within a portion of the St. Lucie Shoal complex.

Tentatively Selected Plan (TSP). The study's TSP consists of beach nourishment/renourishment along approximately 3.4 miles of shoreline between Florida Department of Environmental Protection monuments R-96 (just north of Normandy Beach Access) and the Martin County line. The design beach fill template is characterized by a 20 foot berm extension from the toe of the 2008 dune profile. Beach fill material required includes an average of 530,400 cubic yards for initial construction of the design beach profile and approximately 2 renourishment events averaging 380,000 cubic yards each. This project proposes to use sand from St. Lucie Shoal, which contains material compatible with the native sand within the study area, and has a sufficient quantity for a 50-year planning horizon.

CESAJ-PD-EC (ER 200-2-2)

SUBJECT: Coordination Act Report for the St. Lucie County, Florida, Coastal Storm Risk Management Study (CSRM).

Coordination. The Fish and Wildlife Coordination Act (FWCA; 16 U.S.C. 661 et seq., March 10, 1934, as amended 1946, 1958, 1978, and 1995) requires Federal agencies to consult with the Service regarding the impacts to fish and wildlife resources and the proposed measures to mitigate these impacts. Additional coordination authorities exist through the review process of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321-4347, January 1, 1970, as amended 1975 and 1982) and the consultations required under the Endangered Species Act of 1973 (ESA; 7 U.S.C. 136, 16 U.S.C. 1531 et seq. December 28, 1973). The Service continues to coordinate and consult with the Corps through NEPA and the ESA in which impacts to fish and wildlife resources are adequately addressed via these two authorities. The Service will include comments relevant to FWCA in the Services response to the Corps' ESA coordination letter.

Agreement. The undersigned, Corps and the Service, agree to utilize the St. Lucie CSRM Study NEPA review and ESA consultation processes to complete coordination responsibilities under the FWCA. This agreement will avoid duplicate analysis and documentation as authorized under 40 CFR section 1500.4 (k), 1502.25, 1506.4, and is consistent with Presidential Executive Order for Improving Regulation and Regulatory Review, released January 18, 2011.



Ashleigh Blackford
Chief, Planning and Resource Conservation

Roxanna Hinzman, Field Supervisor
South Florida Ecological Services Office



Jason Spinning
Chief, Coastal Section



FLORIDA DEPARTMENT of STATE

RICK SCOTT
Governor

KEN DETZNER
Secretary of State

Mr. Jason Spinning
Environmental Branch, Jacksonville USACE
701 San Marco Boulevard
Jacksonville, Florida 32207-8175

May 3, 2016

RE: DHR Project File No.: 2016-1278/ Received by DHR: March 28, 2016
Project: St. Lucie County Coastal Storm Risk Management Feasibility Study
Tentatively Selected Plan (TSP) South Hutchinson Island Reach from
FDEP Range Monument R98 to R115+10000 Feet,
Near Shore Sand Placement from North and South St. Lucie Shoals
St. Lucie County

Mr. Spinning:

The Florida State Historic Preservation Officer reviewed the referenced project for possible effects on historic properties listed, or eligible for listing, on the *National Register of Historic Places*. The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended, and its implementing regulations in *36 CFR Part 800: Protection of Historic Properties*.

We have reviewed the above referenced TSP from the Feasibility Study. This office concurs that there will likely be no effect on historic properties conditioned upon the maintenance of 500 foot buffers around shipwrecks and anomaly clusters located in the borrow areas.

For questions, please contact Robin Jackson, Historic Preservationist, Compliance and Review at Robin.Jackson@dos.myflorida.com, or by telephone at 850.245.6333 or 800.847.7278.

Sincerely

Timothy A. Parsons, Ph.D.,
Director, Division of Historical Resources, and
State Historic Preservation Officer

Division of Historical Resources
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850.245.6300 • 850.245.6436 (Fax) FLHeritage.com





REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

Planning and Policy Division
Environmental Branch

MAY 02 2016

TO WHOM IT MAY CONCERN:

Pursuant to the National Environmental Policy Act and U.S. Army Corps of Engineers (Corps) Regulation (33 CFR 230.11), this letter constitutes the Notice of Availability of the Draft Integrated Feasibility Report and Environmental Assessment (report) for the St. Lucie County, Florida, Coastal Storm Risk Management (CSRM) Study. A discussion of the study background and Tentatively Selected Plan is included as Enclosure 1.

In addition, this letter serves as an invitation to a public meeting scheduled for June 2, 2016 to provide stakeholders an opportunity to further discuss the proposed work with Corps and St. Lucie County staff. Information about the meeting is included as Enclosure 2.

A copy of the draft report is available for your review at the St. Lucie County Library-Fort Pierce Branch located at 101 Melody Lane, Fort Pierce, Florida 34950. It is also available online at the following website. Click on St. Lucie County, then scroll down to St. Lucie County CSRM Project and click on the draft report or appendices.

<http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch/EnvironmentalDocuments.aspx>

Please submit questions or comments on the draft report in writing to the letterhead address above or by email (Paul.E.Stodola@usace.army.mil) by June 17, 2016.

Sincerely,

Gina Paduano Ralph, Ph.D.
Chief, Environmental Branch

Enclosure

Enclosure 1: St. Lucie County CSRM Study**Project Background**

The St. Lucie County CSRM study was authorized by Resolution Dockets 2634 and 2757 dated April 11, 2000 and July 23, 1998, respectively. Funding was added by Congress in the appropriations for Fiscal Year 2003 to begin the reconnaissance study; the feasibility study proceeded under that authorization. The purpose of this study is to investigate the feasibility of providing coastal storm risk management within the study area of the St. Lucie County, Florida coastline. St. Lucie County's barrier Islands can be eroded by frequent winter storms (northeasters) as well as tropical storms and hurricanes. The Corps is developing and evaluating alternative plans that address coastal storm risk management, as well as incidental opportunities for preservation of environmental resources and recreation for the southern portion of Hutchinson Island.

Tentatively Selected Plan (TSP)

The TSP consists of beach nourishment/renourishment along approximately 3.4 miles of shoreline between Florida Department of Environmental Protection monuments R-98 (just north of Normandy Beach Access) and the Martin County line. The design beach fill template is characterized by a 20 foot berm extension from the toe of the 2008 dune profile. Beach fill material required includes an average of 530,400 cubic yards for initial construction of the design beach profile and approximately 2 renourishment events averaging 380,000 cubic yards each. This project proposes to use sand from St. Lucie Shoal, which contains material compatible with the native sand within the study area, and has a sufficient quantity for a 50-year planning horizon.

Enclosure 2: Public Meeting for St. Lucie County CSRM Study**DATE: June 2, 2016****TIME: 6:30 PM to 9:00 PM****PLACE: Regency Island Dunes, 8650 So. Ocean Drive, Jensen Beach, FL 34957**

The public meeting will feature an open house from 6:30 to 7:00 PM where you will be able to informally discuss the project with Corps and St. Lucie County staff. Following the open house, you will be invited to stay for a brief presentation on the proposed project from 7:00 – 7:15 PM, including: summary of the Tentatively Selected Plan; environmental impacts; and project schedule. A formal comment period will be held after the presentation. Federal and State natural resource agencies are also being invited to attend.

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HONORABLE LARRY LEE
100 NORTH US HWY 1
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HONORABLE JOE NEGRON
3500 SOUTHWEST CORPORATE PARKWAY
SUITE 204
PALM CITY, FL 34990

SURFRIDER FOUNDATION
PO BOX 6010
SAN CLEMENTE, CA 92674-6010


UNITED STATES DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
 Southeast Regional Office
 263 13th Avenue South
 St. Petersburg, Florida 33701-5505
<http://sero.nmfs.noaa.gov>

FEB 2 2 2016
F/SER47/PW

Colonel Jason A. Kirk, Commander
 U.S. Army Corps of Engineers, Jacksonville District
 701 San Marco Boulevard
 Jacksonville, Florida 32207-8175

Dear Colonel Kirk:

NOAA's National Marine Fisheries Service (NMFS) has received the letter dated January 21, 2016, requesting participation as a cooperating agency in the preparation of the draft environmental assessment (EA) for the Coastal Storm Risk Management Study, St. Lucie County, Florida.

On June 23, 2015, the NMFS participated in a U.S. Army Corps of Engineers briefing on the project. Given the information provided, impacts to NOAA-trust resources may result from the proposed placement on the beach of sand dredged from offshore shoals. Therefore, the NMFS agrees to serve as a cooperating agency in the preparation of the EA. Due to staffing and travel constraints, our participation in the preparation of the EA for this project may be limited to our review and comment on draft National Environmental Policy Act documents, teleconferences, and occasional travel to meetings.

We appreciate your invitation to serve as a cooperating agency on the EA for the study. Please direct related correspondence to Ms. Jocelyn Karaszia at our West Palm Beach office, 400 North Congress Avenue, Suite 110, West Palm Beach, Florida, 33401. She may be reached by telephone at (561) 249-1925, or by e-mail at Jocelyn.Karaszia@noaa.gov.

Sincerely,

Roy E. Crabtree, Ph.D.
 Regional Administrator

cc: F. Leathery
 F/SER, Strelcheck, Silverman, Blough
 F/SER3, Bernhart, Sweeney
 F/SER4, Fay, Dale
 F/SER47, Wilber
 Files





United States Department of the Interior

BUREAU OF OCEAN ENERGY MANAGEMENT

WASHINGTON, DC 20240-0001

FEB 09 2016

Mr. Jason Spinning
U.S. Army Corps of Engineers- Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Spinning:

Thank you for your January 21, 2016, letter requesting that the Bureau of Ocean Energy Management (BOEM) become a cooperating agency during preparation of an Environmental Assessment (EA) for the Coastal Storm Risk Management Study in St. Lucie County, Florida. The U.S. Army Corp of Engineers Jacksonville District (Corps) has evaluated several alternatives, consisting of an array of various structural and non-structural measures, to accomplish the identified project planning goals and objectives. Beach nourishment and dune construction were included among the structural measures carried forward within the final array of alternative plans being evaluated. The structural measures may require use of federal sand resources located approximately 3.5 miles offshore within the Outer Continental Shelf (OCS) at St. Lucie Shoals. Section 8(k) of the Outer Continental Shelf Lands Act (OCSLA) grants BOEM the authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration, or for use in construction projects funded in whole or part or authorized by the federal government.

BOEM welcomes the opportunity to participate in this National Environmental Policy Act (NEPA) effort and agrees to serve as a cooperating agency since BOEM has sole jurisdiction over mineral leasing on the OCS. As a cooperating agency, BOEM expects to: participate and provide input in the NEPA process at the earliest possible time; assume, on the request of the Corps, responsibility for developing information and preparing environmental analyses for which BOEM has special expertise; make available staff support, at the lead agency's request, to enhance the interdisciplinary capability of the Corps; provide comment on draft versions of the EA when requested; and use our own funds to accomplish these responsibilities. Several NEPA documents have been previously prepared by the Corps and/or BOEM considering the potential environmental effects of dredging offshore sand resources within the vicinity of the project area. BOEM expects to collaborate with the Corps to identify the existing NEPA analyses that can be used to ensure the most efficient and effective treatment of potential effects, while also considering and incorporating new information and science when appropriate.

BOEM recognizes the importance of initiating and agrees to participate in the required Endangered Species Act (ESA) Section 7 consultation; the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat consultation (Section 305); the National Historic Preservation Act Section (NHPA) Section 106 process; and the Coastal Zone Management Act (CZMA) Section 307 consistency process. The lead agency in ESA Section 7 consultation for potential impacts on protected species will be designated by jurisdiction and in

accordance with 50 CFR §402.07. BOEM is a joint consulting agency with the Corps in the ongoing re-initiated consultation for the South Atlantic Regional Biological Opinion, for which this project would be included as a component of the proposed action. BOEM anticipates that this consultation will be concluded prior to any planned construction date for this project and will serve as the consultation mechanism for the in-water dredging and placement activities of both agencies. The Corps would be the lead agency and consult with the U.S. Fish and Wildlife Service (FWS) concerning use of the Florida Statewide Programmatic Biological Opinion as the appropriate consultation mechanism for addressing effects from placement activities to listed species under FWS purview. Additionally, the Corps will notify FWS of BOEM's interconnected action and cooperating role. BOEM and the Corps will consult jointly with NMFS Habitat Conservation Division on essential fish habitat. BOEM anticipates that the Corps will be the lead federal agency for ensuring NHPA Section 106 compliance. BOEM expects to act in a consulting role, especially when coordinating with the Florida State Historic Preservation Officer (SHPO) concerning the use of OCS sand resources and all related cultural resource survey activities. BOEM requests that the Corps involve BOEM in all deliberations with the SHPO or Tribal Historic Preservation Officers so that BOEM's involvement in the undertaking is understood. The Corps will be following Subpart C procedures to obtain a consistency concurrence from the Florida Department of Environmental Protection through the Joint Coastal Permit process in compliance with Section 307 of the CZMA.

BOEM looks forward to working with the Corps during this process. We would greatly appreciate it if the Corps would include us on all public notices and correspondence to other federal and state agencies concerning this project. If you would like to discuss any of these items further, please contact Doug Piatkowski at (703) 787-1833 or by e-mail at douglas.piatkowski@boem.gov.

Sincerely,



Geoffrey Wikel
Chief, Branch of Environmental Coordination
Division of Environmental Assessment

cc: Jeffrey Reidenauer, Leasing Division
Bureau of Ocean Energy Management

bc: Official File
Chief, DEA
Chief, Branch of Environmental Coordination
Piatkowski, DEA



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
P.O. BOX 4970
JACKSONVILLE, FLORIDA 32232-0019

REPLY TO
ATTENTION OF

Planning Division
Environmental Branch

MAY 31 2006

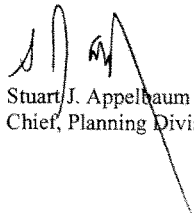
TO THE ADDRESSEES ON THE ENCLOSED LIST:

The U.S. Army Corps of Engineers, Jacksonville District, is gathering information to prepare an Environmental Impact Statement for evaluation of the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of St. Lucie County, Florida. A reconnaissance report has been completed and resulted in the recommendation to continue the study into the feasibility phase. The most immediate and critical needs of the local communities are to address beach and dune erosion and protect State Highway A1A and environmental attributes. This study will determine the Federal interest in participating in a locally supported, cost-shared shore protection project to address St. Lucie County's coastal issues.

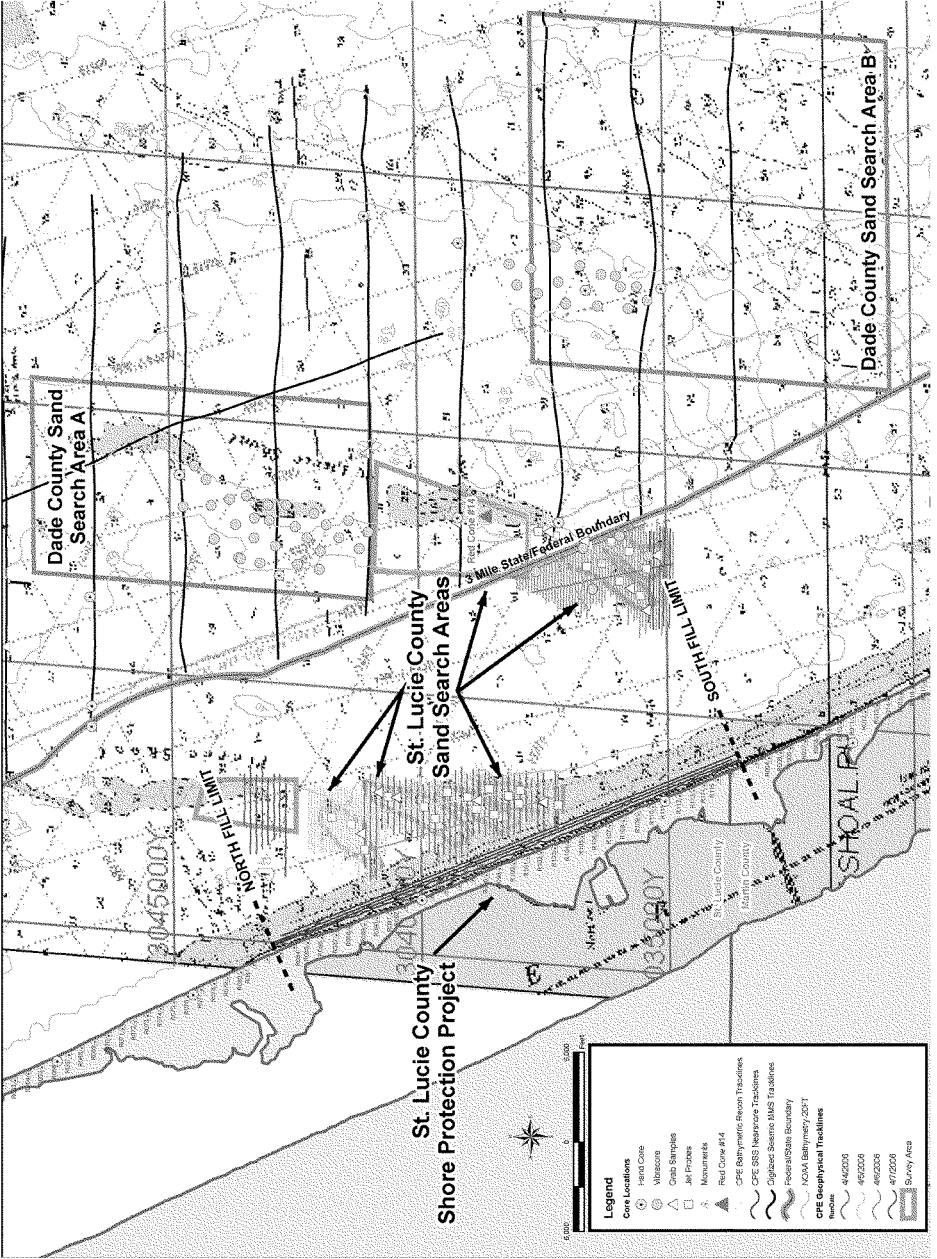
The study area, enclosed, covers about 5 miles of shoreline from the Sand Dollar Shores development (R-88) south to the county line (R-115). The entire coast of St. Lucie County is subject to storm damage and shoreline erosion. One of the most critically eroding areas, located at Ft. Pierce Beach, was addressed under a previously authorized Shore Protection Project and is not included in this study. Potential sand borrow areas to be investigated are also shown on the enclosure but other sources may be developed.

We welcome your views, comments and information about Environmental and Cultural resources, study objectives and important features within the described project area, as well as any suggested improvements. Letters of comment or inquiry should be addressed to the letterhead address to the attention of Mr. Paul DeMarco at telephone number 904-232-1897, Planning Division, Environmental Branch and received by this office within 30 days of the date of this letter.

Sincerely,


Stuart J. Appelbaum
Chief, Planning Division

Enclosure



ERICKA D'AVANZO
FLORIDA REGIONAL MANAGER
SURFRIDER FOUNDATION
P.O. BOX 683
JENSEN BEACH, FL 34958

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PAUL SOUZA
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MR. DAVID BERNHART
NATIONAL MARINE FISHERIES SERVICE
CHIEF, PROTECTED SPECIES BRANCH
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MILES CROOM
ASSISTANT REGIONAL ADMINISTRATOR
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FLORIDA STATE CLEARINGHOUSE
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MS. LYNN GRIFFIN
FLORIDA COASTAL MANAGEMENT PROGRAM
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THE OCEAN CONSERVANCY
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ST. LUCIE COUNTY COMMISSIONER
PAULA LEWIS
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COMMISSIONER DOUG COWARD
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ST. LUCIE COUNTY COMMISSIONER
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FT. PIERCE, FLORIDA 34982-5652

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CITY OF FT. PIERCE
CITY HALL
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FORT PIERCE, FL 34954

MS. PATTI PACITTI
CHAIR, PRESIDENT'S COUNCIL OF SOUTH
HUTCHINSON ISLAND
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OCEAN DUNES CONDOMINIUM
10980 SOUTH OCEAN DRIVE APARTMENT 612
JENSEN BEACH, FLORIDA 34957-2693

OCEAN TOWERS CONDOMINIUM ASSOCIATES
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PRINCESS CONDOMINIUM
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REGENCY ISLAND DUNES
8650 SOUTH OCEAN DRIVE
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OCEANA CONDOMINIUM I & II
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JENSEN BEACH, FLORIDA 34957-2499

OCEANA SOUTH II CONDOMINIUM
10600 SOUTH OCEAN DRIVE OFFICE
JENSEN BEACH, FLORIDA 34957-2647

SAND DOLLAR SHORES CONDOMINIUM ASSOCIATION
7420 SOUTH OCEAN DRIVE
JENSEN BEACH, FLORIDA 34957-2036

VENTURE THREE INC
10701 SOUTH OCEAN DRIVE
JENSEN BEACH, FLORIDA 34957-2683



UNITED STATES DEPARTMENT OF COMMERCE
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 NATIONAL MARINE FISHERIES SERVICE

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June 29, 2006

F/SER4:JK/pw

Colonel Robert M. Carpenter
 District Engineer, Jacksonville District
 Department of the Army Corps of Engineers
 Jacksonville Regulatory Office, South Permits Branch
 PO Box 4970
 Jacksonville, Florida 32232

Dear Colonel Carpenter:

NOAA's National Marine Fisheries Service (NOAA Fisheries) reviewed the May 31, 2006, letter requesting our views, comments and information regarding your efforts to prepare an Environmental Impact Statement in connection with evaluating the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of St. Lucie County, Florida. Specifically, the Jacksonville District Corps of Engineers (COE) is gathering comments and information pertinent to the renourishment of Sand Dollar Shores development (R-88) south to the county line (R-115). A map of potential nearshore and offshore sand borrow areas was provided in your letter. The following comments are provided in response to COE's National Environmental Policy Act scoping actions.

NOAA Fisheries is concerned that excavation of the offshore shoals could have significant adverse consequences to the shoreline and living marine resources. Although these particular offshore shoals have not been thoroughly studied with respect to fish utilization, NOAA Fisheries believes the shoals serve as a benthic nursery area, refuge, and feeding ground for a variety of fishery resources. The South Atlantic Fishery Management Council (SAFMC) identifies sandy shoals as essential fish habitat (EFH) for migratory pelagic fish, including king mackerel, Spanish mackerel, cobia, and dolphin. Further, anecdotal evidence suggests that this shoal area is biologically unique and diverse, supporting fisheries that are economically and recreationally important, such as the migratory species listed above, sailfish, and prey species consumed by these fishery species. Clarke *et al.* (1988) and Michel *et al.* (2001) note the geomorphology of offshore shoals provide a unique assembly of micro-habitats that facilitate high biological productivity.

NOAA Fisheries also is concerned that mining the shoal for sand may alter the local wave climate bringing about erosion that could affect EFH. Through an evaluation of the potential impacts from dredging linear shoals in the U.S. Gulf and Atlantic continental shelves, Hayes and Naim (2004) concluded that the deflation of a shoal feature could change wave patterns between the shoal and the shoreline. In turn, such dredging could change longshore and cross-shore sand-transport patterns and erosion and accretion rates along the shore. Kelley *et al.* (2004) verified this conclusion in their examination of a borrow site offshore Martin County (depths were approximately 8 to 10 m), and recommend application of wave transformation numerical modeling tools that recognize the random nature of incident waves as they propagate onshore when examining incremental and cumulative changes



from sand dredging on the continental shelf.

Lastly, NOAA Fisheries is concerned that excavation of nearshore borrow areas in addition to the placement of fill in nearshore areas could adversely affect hardbottom habitat, which includes corals and worm reefs colonized by *Phragmatopoma lapidosa*. Nearshore hardbottom and worm reefs are also identified by the SAFMC as EFH and as habitat areas of particular concern (HAPC). These reefs reduce wave energy and stabilize shorelines (Kirtley 1967; Kirtley and Tanner 1968) and provide structural habitat for fishery organisms (Gore *et al.* 1977; Nelson 1989; Lindeman and Snyder 1999). Based on a recent conversation with the COE Project Manager, Paul DeMarco, we were advised efforts are underway to map and characterize the nearshore hardbottom within the project impact area. Avoidance and minimization of impacts to hardbottom resources will be important as the project moves forward through planning, design, and construction.

NOAA Fisheries recommends that the COE continue to coordinate closely with the Habitat Conservation Division to ensure the EFH assessment and NEPA documents contain sufficient detail. The consultation requirements in the Magnuson-Stevens Fishery Conservation and Management Act direct federal agencies to consult with NOAA Fisheries when the agency's activities may have an adverse affect on EFH. Please see 50 CFR 600.10 to 600.920 for details on EFH definitions and EFH assessments. In addition, NOAA Fisheries recommends that the EFH assessment include the results of an on-site inspection, the views of recognized experts on the habitat or species affects, a literature review, an analysis of alternatives to the proposed action, and analyses of the borrow site analyses using methods similar to those recommended in Kelley *et al.* (2004).

Thank you for the opportunity to provide comments. Related questions or comments should be directed to the attention of Ms. Jocelyn Karazsia at 11420 North Kendall Drive, Suite 103, Miami, Florida, 33176. She may be reached by telephone at (786) 263-0028 or by e-mail at Jocelyn.Karazsia@noaa.gov.

Sincerely,



/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc: (via electronic mail)

EPA, West Palm Beach
FWS, Vero Beach
FWC, Tallahassee
FDEP, WPB
SAFMC
NMFS, PRD
MMS
F/SER47, Karazsia

Literature Cited:

- Clarke, D.; Fredette, T.J.; Imsand, D. 1988. Creation of Offshore Topographic Features with Dredged Material. Environmental Effects of Dredging, Information Exchange Bulletin, Vol. D 88 5. Prepared by US Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.
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- Michel, J., J.R. Nairn, J. Johnson, and D. Hardin. 2001. Development and Design of Biological and Physical Monitoring Protocols to Evaluate the Long-term Impacts of Offshore Dredging Operations on the Marine Environment. Herndon, Virginia: Minerals Management Service OCS Report MMS 2001-089, 116 pp. 1 appendix.
- Nelson, W. 1989. Beach renourishment and hardbottom habitats: the case for caution. In S. Tait (ed.), *Proceedings of the 1989 National Conference on Beach Preservation Technology*, p. 109-116. Florida Shore and Beach Preservation Association, Tallahassee, Florida.



Jeb Bush
Governor

Department of Environmental Protection

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Colleen M. Castille
Secretary

August 11, 2006

Mr. Paul M. DeMarco
Planning Division, Jacksonville District
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

RE: Department of the Army, Jacksonville District Corps of Engineers – Scoping Notice –
St. Lucie County Shore Protection Project Feasibility Study – St. Lucie County, Florida.
SAI # FL200606052397C

Dear Mr. DeMarco:

The enclosed comments provided by the Florida Department of State (DOS) were received after our previous letter, dated July 14, 2006, was mailed. Please be advised that these comments do not change our finding that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program. Please continue to coordinate with the DOS Division of Historical Resources to ensure protection of historic properties within the proposed project area.

If you have any questions or need further assistance, please don't hesitate to contact me at (850) 245-2170.

Sincerely,

Lauren P. Milligan
Environmental Consultant
Office of Intergovernmental Programs

LPM/vh
Enclosure

cc: Laura Kammerer, DOS

"More Protection, Less Process"

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FLORIDA DEPARTMENT OF STATE

Sue M. Cobb

Secretary of State

DIVISION OF HISTORICAL RESOURCES

RECEIVED

AUG 11 2006

OIP / OLGA

August 7, 2006

Ms. Lauren Milligan
 Director, Florida State Clearinghouse
 Florida Department of Environmental Protection
 3900 Commonwealth Boulevard, Mail Station 47
 Tallahassee, Florida 32399-3000

RE: DHR No.: 2006-4931/ Date Received by DHR: June 6, 2006
 Jacksonville District Corps of Engineers/ SAI #: FL200606052397C
*Scoping Notice – St. Lucie County Shore Protection Project Feasibility
 Study - St. Lucie County, Florida*

Dear Ms. Milligan:

Our office received and reviewed the above referenced project in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended and *36 CFR Part 800: Protection of Historic Properties* and the *National Environmental Policy Act of 1969, as amended*. The State Historic Preservation Officer is to advise Federal agencies as they identify historic properties (archaeological, architectural, and historical) listed, or eligible for listing, in the *National Register of Historic Places*, assess effects upon them, and consider alternatives to avoid or minimize adverse effects.

We reviewed the Florida Master Site File and our records for information to be addressed in an Environmental Impact Statement for evaluation of the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of St. Lucie County. This office recommends first of all that project activities avoid the known shipwrecks and the prehistoric burial site located within the designated study area. Therefore, the Florida Master Site File should be contacted at (850) 245-6440, in order to obtain information about shipwrecks and the burial mound recorded within the proposed five-mile of shoreline.

In our prior review of a proposal to identify potential sand sources for beach renourishment in St. Lucie County, we received information that magnetometer and side scan sonar data had been compiled for the proposed offshore borrow areas. These sites appear to correlate with two of the potential sand borrow areas located within State waters on the Jacksonville District's map of the referenced project area. Therefore, it is the opinion of this office that the special conditions outlined in our letter to Florida Department of Environmental Regulation (DHR No. 2006-2460-B) dated April 19, 2006 must be followed if these sand search areas are developed (see enclosure).

This office previously reviewed a proposal to prospect for mineral resources within a Geophysical Survey (GS) area, recommended that a systematic remote sensing archaeological

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☐ Director's Office (850) 245-6300 • FAX: 245-6436	☐ Archaeological Research (850) 245-6444 • FAX: 245-6452	☒ Historic Preservation (850) 245-6333 • FAX: 245-6437	☐ Historical Museums (850) 245-6400 • FAX: 245-6433
☐ Southeast Regional Office (954) 467-4990 • FAX: 467-4991	☐ Northeast Regional Office (904) 825-5045 • FAX: 825-5044	☐ Central Florida Regional Office (813) 272-3843 • FAX: 272-2340	

Ms. Milligan, Tallahassee
August 7, 2006
Page 2

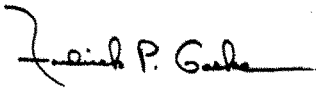
survey be performed within this area (DHR No. 2006-193). According to the Jacksonville District's map of the referenced project area, part of the GS area appears to correlate with the sand source area located within State waters immediately south of the sand source area identified as "Red Cone #14," and the remainder appears to correlate with the Red Cone #14 area itself. According to our records, the resultant report has not been received for review by this office. Therefore, we reiterate our prior opinion that these areas should be investigated, and the resultant report coordinated with this office.

Our search further indicates that we previously reviewed a proposal to use the borrow sites identified on the Jacksonville District's map as the "Dade County Sand Search Area A" and the "Dade County Sand Search Area B" for the renourishment of Miami Beach (DHR No. 2006-3203). Our prior opinion was that a systematic remote sensing investigation be conducted within both borrow areas, and that recorded shipwreck sites within Area A—the America Wreck Site (8SL28) and the Halsey Wreck Site (1942)-UW44 (8SL30)—be relocated during this investigation. We additionally noted that a 500-foot buffer zone, or dredge exclusion area, is required around each shipwreck site. If avoidance were not possible, we advised that additional archaeological investigation would be required, including diver investigation by a marine archaeologist, or other professional experienced in underwater archaeology, to determine their significance. Our records indicate that the resultant survey report for Areas A and B has not been received in this office. Therefore, we reiterate our opinion that they be investigated, and the resultant report coordinated with this office, and that buffering must be performed, if Area A is developed as a sand source area.

In the event that other sand sources that have not been subjected to investigation are proposed as potential sand borrow areas, it is the opinion of this office that a standard systematic remote sensing survey be performed for the offshore borrow areas in order to avoid potential adverse effect to unrecorded shipwrecks. Should potential borrow areas that have not been investigated be developed on land, it is our opinion that that they be subjected to the standard professional cultural resource survey to avoid possible impact to unrecorded sites. This office looks forward to coordinating with the Jacksonville District Corps of Engineers in the management and protection of historic properties associated with this project.

If you have any questions concerning our comments, please contact Janice Maddox, Historic Sites Specialist, by electronic mail at jmaddox@dos.state.fl.us, or by telephone at 850/245-6333. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,



Frederick P. Gaske, Director, and
State Historic Preservation Office

Enclosure



Jeb Bush
Governor

Department of Environmental Protection

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

RECEIVED

17 July 2006

Colleen M. Castille
Secretary

July 14, 2006

Mr. Paul M. DeMarco
Planning Division, Jacksonville District
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

RE: Department of the Army, Jacksonville District Corps of Engineers – Scoping Notice –
St. Lucie County Shore Protection Project Feasibility Study – St. Lucie County, Florida.
SAI # FL200606052397C

Dear Mr. DeMarco:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the referenced scoping notice.

Based on the information contained in the public notice and the enclosed state agency comments, the state has determined that, at this stage, the proposed activity is consistent with the Florida Coastal Management Program (FCMP). The applicant must, however, address the concerns identified by our reviewing agencies prior to project implementation. All subsequent environmental documents must be reviewed to determine the project's continued consistency with the FCMP. The state's continued concurrence with the project will be based, in part, on the adequate resolution of issues identified during this and subsequent reviews. The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting stage.

Thank you for the opportunity to review the proposed project. If you have any questions regarding this letter, please contact Ms. Jacqueline Larson at (850) 245-2182.

Sincerely,

Sally B. Mann, Director
Office of Intergovernmental Programs

SBM/jl
Enclosure

"More Protection, Less Process"

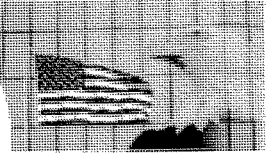
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Florida

Department of Environmental Protection

"More Protection. Less Pressure"



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Project Information	
Project:	FL200606052397C
Comments Due:	07/03/2006
Letter Due:	07/14/2006
Description:	DEPARTMENT OF THE ARMY, JACKSONVILLE DISTRICT CORPS OF ENGINEERS - SCOPING NOTICE - ST. LUCIE COUNTY SHORE PROTECTION PROJECT FEASIBILITY STUDY - ST. LUCIE COUNTY, FLORIDA.
Keywords:	ACOE - ST. LUCIE COUNTY SHORE PROTECTION PROJECT FEASIBILITY STUDY
CFDA #:	12.101
Agency Comments:	
TREASURE COAST RPC - TREASURE COAST REGIONAL PLANNING COUNCIL	
No Final Comments Received	
ST. LUCIE - ST. LUCIE COUNTY	
No Final Comments Received	
FISH and WILDLIFE COMMISSION - FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION	
No Final Comments Received	
STATE - FLORIDA DEPARTMENT OF STATE	
No Final Comments Received	
ENVIRONMENTAL PROTECTION - FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION	
No comments.	

For more information please contact the Clearinghouse Office at:

3900 COMMONWEALTH BOULEVARD MS-47
TALLAHASSEE, FLORIDA 32399-3000
TELEPHONE: (850) 245-2161
FAX: (850) 245-2190

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**BOARD OF
COUNTY
COMMISSIONERS**



**FRANNIE
HUTCHINSON**
COMMISSIONER

June 30, 2006

Mr. Paul DeMarco
Planning Division, Environmental Branch
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

**RE: ST. LUCIE COUNTY, FLORIDA FEASIBILITY STUDY
ENVIRONMENTAL AND CULTURAL RESOURCES**

Dear Mr. DeMarco:

As the local sponsor for the St. Lucie County Feasibility project, we look forward to working closely with the U.S. Army Corps of Engineers and other agencies as we evaluate our shoreline protection needs through the federal process.

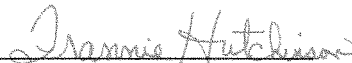
Beach erosion along the Atlantic coastline continues to be exacerbated by high frequency storms and hurricane activity. These storm events have inflicted severe damage to the beach and dune system of St. Lucie County, especially to the 5-mile feasibility study area. Several emergency dune restoration projects have been recently completed in this area to provide short-term storm damage reduction measures. We look forward to moving forward with the Corps in an expeditious manner to address this critically eroding shoreline.

We also recognize the importance of the cultural and environmental resources that exist within the study area and the St. Lucie Shoal. These resources are very important to the coastal environment as well as to the citizens of the Treasure Coast. It is very important that this process provides for a delicate balance between these resources and the shore protection project.

Should you have any questions or if you need further information, please contact Mr. Richard Bouchard, St. Lucie County Erosion District Manager, at (772) 462-1710.

Sincerely,


Doug Coward, Chairman
St. Lucie Board of County Commissioners


Frannie Hutchinson, Chair
St. Lucie County Erosion District

DC:FH

Cc: Board of County Commissioners
Doug Anderson, County Administrator
Dan McIntyre, County Attorney

Ray Wazny, Assistant County Administrator
Don West, Public Works Director
Richard Bouchard, Erosion District Manager

JOSEPH E. SMITH, District No. 1 • DOUG COWARD, District No. 2 • PAULA A. LEWIS, District No. 3 • FRANNIE HUTCHINSON, District No. 4 • CHRIS CRAFT, District No. 5
County Administrator - Douglas M. Anderson

2300 Virginia Avenue • Fort Pierce, FL 34982-5652 • (772) 462-1451

FAX (772) 462-2131 • TDD (772) 462-1428

www.co.st-lucie.fl.us



**Surfrider
Foundation®**

www.surfrider.org

Surfrider Foundation Treasure Coast Chapter

Conservation • Activism • Research • Education

P.O. Box 683
Jensen Beach, FL 34958
772-834-5858
tcsurfrider@yahoo.com

Mr. Paul DeMarco
Planning Division, Environmental Branch
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

June 30, 2006

Dear Mr. DeMarco,

The Treasure Coast Chapter of the National Surfrider Foundation (TC Surfrider) recently received a copy of the "request for comments" letter from Stuart Appelbaum, addressing the shoreline protection project proposed for St. Lucie County beaches, from Sand Dollar Shores south to the Martin County line. We have also studied the Army Corps' map of potential "sand search areas" for this project.

Although we were not a direct recipient of Mr. Appelbaum's letter, as one of the Treasure Coast's most highly regarded environmental organizations addressing coastal issues, we are compelled to respond.

First, we would like to commend the Corps in their recent decision to take the St. Lucie Shoal off the potential "borrow" sites for a planned Miami Beach restoration project. This shoal, along with the other nearby shoals located off the coast of St. Lucie and Martin counties, not only serve as vital marine habitats, but may also provide shoreline protection from storm-generated wave action. TC Surfrider, teaming up with incoming Florida Senate President Ken Pruitt, gathered over 3,000 signatures in opposition to the proposed dredging of St. Lucie Shoal. (A copy of the petition is attached.) The public sentiment against this project was overwhelming.

While the St. Lucie Shoal and "Dade County Search Area B" appear not to be included in the upcoming feasibility plan for the "Sand Dollar" project, we are highly concerned with the wording in the letter: "Potential sand borrow areas to be investigated are also shown on the enclosure *but other sources may be developed.*" This language could suggest that St. Lucie Shoal may once again be targeted as a "borrow" site, despite tremendous community opposition.

Although we continue to be steadfastly opposed to the use of the St. Lucie Shoal as a sand source, any consideration of the Shoal or "Area B," as a sand source would require the same amount of research that was suggested for the Miami-Dade project, including further review of the wave impact modeling on the barrier island and a year-long monitoring of marine life. A programmatic EIS would be required, including a baseline population study to measure the number of mole crabs and other invertebrates that make their homes there. Sediment compatibility should also be reviewed thoroughly by an independent agency.

In 1998, the Corps wanted to "borrow" sand from Capron Shoal, 3 miles off Fort Pierce, to replenish beaches south of the Fort Pierce Inlet. But the shoal was home to a rare species called bryozoans, animals so tiny that a whole colony can live in the space between grains of sand. The Conservation Alliance of St. Lucie County and other groups fought the corps, because scientists thought that the tiny creatures were found nowhere else in the world. A corps study found that the microscopic animals live on several shoals off St. Lucie County but some species were found on Capron Shoal and nowhere else.

Our other concerns are focused on the proposed "St. Lucie County Sand Search Areas." Many of these areas are also important marine habitats, with living reef systems adjacent. As with the shoal areas, all of the above-stated studies should be taken. While TC Surfrider recognizes the importance of shoreline erosion management, it must not come at the expense of the natural marine resources that make Florida's Treasure Coast one of the few stretches of native coastline left in the state.

Another viable alternative is to re-nourish these beaches with sand from a compatible inland source. You are probably aware of the history surrounding St. Lucie County's emergency dune restoration project in the wake of Hurricanes Francis and Jeanne. TC Surfrider Foundation played a large role in holding all parties accountable for this poorly conceived dune restoration project, and we helped force the county to remove 3.7 miles of incompatible "road bed material" that had been mined and trucked in. It was replaced with compatible sand from a local source.

While an unfortunate example, the St. Lucie dune project and other similarly and properly constructed projects proved that it is possible to re-nourish local beaches by bringing in sand from an inland source.

Regrettably, whether sand is used from an inland or offshore source, the present beach restoration technology offers only a "band-aid" solution at best. The Surfrider Foundation welcomes the opportunity to work together to develop better and more socially and environmentally responsible management approaches to local coastal erosion. With over 60,000 members worldwide, Surfrider has biologists and engineers studying every aspect of coastal preservation technology.

TC Surfrider requests that our organization be copied on all correspondence from the Corps Planning Division Environmental Branch regarding beach re-nourishment projects affecting St. Lucie and Martin counties. Please forward correspondence to: Treasure Coast Surfrider, P.O. Box 683, Jensen Beach, FL 34858. We also request that the Corps conduct properly-recorded public hearings on all proposed shoreline protection projects before proceeding with environmental impact studies. These hearings should be advertised well in advance in local newspapers so that taxpaying citizens have fair notice to respond and voice their thoughts and concerns.

Respectfully yours,

Andy Brady, Co-Chair, St. Lucie County
Chris Shultz, Co-Chair, Martin County

CC: Senator Ken Pruitt
St. Lucie County Commission
Martin County Commission



We, the undersigned, supporters of the Surfrider Foundation Treasure Coast Chapter, are petitioning the US Army Corp of Engineers (Corps) to reject the so-called "borrowing" of sand from the St. Lucie shoal. The taxpayers' cost of Miami-Dade's "re-nourishment" project would be astronomical. This shoal is designated Essential Fish Habitat (EFH) under National Marine Fisheries Service protection; a barrier shoal providing protection to Hutchinson Island and our nuclear power plant; and important charter, commercial, and recreational fishing location, providing crucial economics and recreation for our communities. As the keepers of the Treasure Coast, we are vehemently against the Corps from allowing Miami-Dade and other Florida counties from stealing this shoal and our shoreline protection.

<u>Name</u>	<u>Hometown</u>
1. _____	_____
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20. _____	_____

Please return completed petitions to the next meeting or mail to:
 Treasure Coast Surfrider Foundation P.O. Box 683 Jensen Beach, FL 34958
 Email tsurfrider@yahoo.com to find out next time/location of the Treasure Coast Surfrider meeting
 For additional information, call 772-834-5858



**Surfrider
Foundation.**

June 30, 2006

Mr. Paul DeMarco
Planning Division, Environmental Branch
Department of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. DeMarco,

The Surfrider Foundation is submitting this comment letter regarding the shoreline protection project proposed for St. Lucie County beaches, from Sand Dollar Shores south to the Martin County line. The Surfrider Foundation is an international non-profit grassroots organization dedicated to the protection and preservation of our world's oceans, waves and beaches. The Surfrider Foundation now maintains over 50,000 members (4,000 in Florida alone) and 64 chapters across the United States and Puerto Rico, with international affiliates in Australia, Europe, Japan and Brazil (www.surfrider.org).

After studying the reconnaissance report and the 'map of potential "sand search areas" for this project, our organization is highly concerned with the wording in the letter: "Potential sand borrow areas to be investigated are also shown on the enclosure *but other sources may be developed.*" This language would suggest that St. Lucie Shoal may once again be targeted as a "borrow" site, despite overwhelming community opposition. The St. Lucie Shoal as a potential "borrow" site, along with the other nearby shoals located off the coast of St. Lucie and Martin counties, not only serve as vital marine habitats, but could like provide necessary shoreline protection from storm-generated wave action. After speaking with Dr. Mark Byrnes of Applied Coastal Tech, he confirmed my concerns about the use of this shoal and the potential barrier island erosion hot spots that would result from storm wave action, if this shoal was to be used. As suggested in the Miami-Dade Project additional wave modeling from the proposed use of the shoal would need to be done. In addition, any sediment compatibility testing should be done by an independent geologist.

While our organization recognizes the importance of beach management, projects must not come at the expense of the natural marine resources that make Florida's Treasure Coast one of the few stretches of native coastline left in the state. Florida's coastal management policies to protect all recreation, tourism and economic development; therefore, the corps focus should be the same. To take away the protection and recreation from the community to benefit only a 5-mile stretch would be in direct conflict.

We are also concerned that excavation of the nearshore borrow areas in addition to the placement of fill in nearshore areas could adversely affect hardbottom habitat, which includes corals and worm reefs. Nearshore hardbottom and worm reefs are identified by SAFMC and NOAA as EFH and as habitat areas of particular concern (HAPC). These reefs currently reduce wave energy and stabilize shorelines (Kirtley 1967; Kirtley and Tanner 1968) and provide structural habitat for fishery organisms (Gore *et al.* 1977;

Nelson 1989; Lindeman and Snyder 1999). Any mitigation would require kind-for-kind mitigation, which includes the design to be in the same amount of water-depth.

We hope that in the feasibility that there may be better alternatives to the “bandaid” 50-year massive dredge and fill projects. It has been well discussed for years (including a recent conference in Ft. Lauderdale in May) among Florida coastal engineers, geologists, county erosion administrators and other organizations that the opportunity for better inlet management and sand bypass could better serve Florida taxpayers. Other counties, such as Palm Beach and now Broward are using or are looking to use of sand bypass systems at major inlets. This alternative could create an environmentally, recreationally, and long-term cost-friendly solution, especially since we all know that 80% of our sand budget is interrupted by these inlets.

Please copy our organization on all correspondence including Notice of Intents. We didn’t receive the 30 day comment letter, only a letter from Mr. Applebaum. We also request that at the release of the feasibility study that an adequate public comment period be advertised in local newspapers before proceeding with a future environmental impact study, so that residents of this community can provide local insight and knowledge for the area in which they live and work.

We welcome the opportunity to work together to develop better and more locally-designed and environmentally responsible management approaches to coastal erosion. Surfrider has available independent scientists and engineers across the US studying every aspect of coastal preservation technology.

Thank you for this opportunity,

Ericka D’Avanzo
Surfrider Foundation
Florida Regional Manager
Jensen Beach, FL

CC: Senator Pruitt
Martin County Commissioners
St. Lucie County Commissioners
Rep. Harrell



OCEANA SOUTH II

RECEIVED

JUL 05 2006

June 27, 2006

Att: Planning Division Environmental Branch:

Dear Mr. Paul DeMarco

Thank you for the opportunity to comment on the proposed feasibility study. With the effects of recent storms fresh on many of our minds your request for comments and concerns are timely.

We have reviewed the attached information you have provided and we have a few concerns that we feel must be addressed. The location of the proposed borrow areas, could be problematic for both the Dade county efforts as well as the current effort being considered for the St Lucie County. Given the limitations of scale presented in your charts it appears that the sand search are proposed for St Lucie County are fairly close to the shore yielding the possibility of wave reflection and refraction issues. It therefore requested that a wave refraction analysis be performed and the results be independently reviewed, to insure no impact to adjoining shoreline areas. We would also like to understand the correlation of economic life with the availability of sand to maintain the project throughout its entire life. This is critical to understand the full costs associated with the project and to avoid cost increases during proposed renourishment.

The Dade County sand search area raises some interesting questions. We understand that the location for this search area is located in Federal waters controlled by the Mineral Management Agency. We are very curious why you are searching for sand in the waters off Martin and St Lucie Counties for a project over a hundred miles away and what effect if any

2.

will result should more fill be needed for our area beaches.

Additionally, we have been following with great care the efforts associated with the Corps Shoreline Performance Assessment effort formally called S3P21. We hope that you will be using information gathered from this effort and it's associated economic and plan information analysis with the evaluation of affects from the recent hurricanes on Martin and St Lucie Counties.

In closing we would like to thank the Corps of Engineers for the opportunity to comment and we look forward to working with you as the study continues.

Nick Macchia, President
Oceana South II Condo Association

Re: Darlene Anderson

DAIMLERCHRYSLER

DaimlerChrysler Corporation

Paul G. Smuts

Vice President
Human Resources Operations
and Facilities Management

June 19, 2006

Mr. Paul DeMarco,

I have owned a condo on Hutchinson Island for the past 22+ years, and along with many others, am very concerned about the beach erosion.

As I hope we all realize, the sun & the beaches are the main reason people choose to live & vacation in Florida - so the continued viability of the Florida economy is tightly linked to the preservation of its beaches.

I strongly support the continuation of the feasibility study to protect the beaches & shore line in St. Lucie County. I trust we can count on your support for this vital project.

Sincerely,

Paul G. Smuts

4656 Oakhurst Ridge Rd.
Clarkston, Michigan 48348

Mr. Paul DeMarco
Planning Division, Environmental Branch
Dept of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Fl. 32232-0019

Dear Mr. DeMarco,

We support the continuation to the next phase of the feasibility study for gathering information to prepare an Environmental Impact Statement for evaluation of the feasibility of providing erosion protection, hurricane and storm damage reduction and related purposes to the shores of St Lucie County.

Sincerely,

David O. Miner
Association Board of the Island Beach Club (60 unit Association)

Arden Peck

1707 Rio Vista Dr. Ft. Pierce, FL 34949

Mr. Paul DeMarco
Planning Division, Environmental Branch
Dept of the Army
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

June 13, 2006

Dear Mr. DeMarco;

I want to thank you for your recent action recommending the continuation of the study regarding St. Lucie County's shore protection assessment.

Your proactive thinking was greatly appreciated by all of us who are working to protect our shrinking shoreline.

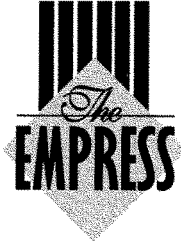
We look forward to your continued support and, of course, will assist you in any way we can.

Thank you again.

Sincerely,

A handwritten signature in black ink, appearing to read "Arden Peck", with a large, stylized loop at the end.

Arden Peck, Director
St. Lucie County Chapter
Florida Shore & Beach Preservation Association



June 11, 2006

Mr. Paul DeMarco
Jacksonville District Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0010

Dear Mr. DeMarco:

This letter is written on behalf of the 117 unit owners in the Empress Condominium on the southeast coast of St. Lucie County and responds to the May 31st letter from Mr. Applebaum asking that input be sent to you. Our homes are currently very vulnerable to any high waves especially those caused by a hurricane. Because of this, we support all efforts that could lead to shoreline protection and a reduction in our current vulnerability to hurricanes.

A review of the aerial photographs you have of this area will easily show our current vulnerability. Photographs you have of our area before Hurricane Francis show our homes were protected by a dune about 89 feet wide vegetated with mature saw palmettos and a very wide beach. After hurricanes Francis and Jeanne, our dune was reduced to about 23 feet at its widest point with no dune in some places. Since that time, at our expense, we rebuilt the portions of the 23 feet wide dune that were washed away and vegetated the entire dune. As you know, the recent state and St. Lucie County effort added about 19 feet to our dune width in what was called an emergency dune restoration project. In their correspondence this was called a band-aid effort. That is not very comforting if your home is on the beach. The resultant dune that protects our homes is about 42 feet wide. We are in the process of vegetating the new portion of our dune. Our beach is very narrow. In fact, we had some minor wash over of our dune this last spring during the normal spring high tides. It is for this reason, as we said earlier, that we support efforts to improve the protection provided by our dune.

Since your study is to determine the federal interest in participating in this effort, we would like to know the steps we can take to increase the federal interest. If there is anything we can do in this regard, please contact me at the above address.

Sincerely,

Steed Johnson, President
Empress Board of Directors

cc: Chuck Shelton
Bob Fedak

Florida Sportsman Communications Network
2700 S. Kanner Hwy.
Stuart, FL 34994
Phone: (772) 219-7400
Fax: (772) 219-6916

Mr. Paul DeMarco
Department of the Army
Corps of Engineers Jacksonville Regulatory Office,
South Permits Branch
PO Box 4970 Jacksonville, Florida 32232

Cc
St. Lucie County Commission
Richard Bouchard
St. Lucie County Erosion Administrator

Dear Mr. DeMarco;

This letter contains our comments on and questions about the proposed south St. Lucie County “beach nourishment” project.

Although it is not clear exactly what the project would entail, a dredge-and-fill project in this area has considerable potential to cause a variety of very serious environmental damage—damage that would also have significant social repercussions. The *Florida Sportsman Communications Network* is based in Stuart, Florida, and we are intimately familiar with the marine resources both in the project area and related to or near the potential “borrow areas.” We look forward to helping the Corps, the Florida Department of Environmental Protection, the National Marine Fisheries Service, the U.S. Environmental Protection Agency, the Florida Fish & Wildlife Conservation Commission and St. Lucie County to identify and quantify known resources.

The information we’ve received does not make the project details clear, except that a dredge-and-fill project is proposed for South St. Lucie beaches with several potential “borrow areas” under consideration. We have a number of questions, and we would appreciate a quick and complete response to the following questions organized by subhead.

Sand Compatibility

Primary complaints among anglers and divers about “beach nourishment” are a., impacts to forage such as beach invertebrates; b. degraded water clarity; and c. direct burial, dredging of, or indirect siltation of nearshore, shallow and offshore reefs. Some of these impacts can be minimized or avoided by carefully choosing high-quality fill material that is genuinely compatible with native beach sediments.

--In microns, what is the range in size, stratified by percentage, of native beach sediments and their character, e.g. quartz/carbonate ratio?

--In microns what are the ranges in sizes, stratified by percentage, of the materials sampled in each borrow areas. And, please describe fully their character. Are they quartz grains, skeletal carbonate grains (mollusks), or are they non-skeletal ooid grains, or come combination? What is the percentage of fine sediment (less than 30 microns) in the material examined from each borrow site?

--We would appreciate an opportunity to examine the samplings ourselves.

Project Scope

--Roughly how many yards of fill would be necessary?

--How far out into the ocean would the berm extend?

--Is fixed sand bypassing at the Fort Pierce Inlet being considered by the state and/or the Corps as a compliment or alternative to this project?

--Have breakwaters or similar structures been considered for the purposes of extending the life of the projects?

--Are alternative, more turtle-friendly templates being considered?

--Is a long-term strategy being developed, that takes into account anticipated sea-level rise and possibly finite sand resources?

Nearshore Hardbottom

--Chronic turbidity in the surf zone has been a reality since the botched St. Lucie Dune Restoration Project and the Martin Federal project were implemented. The number of days with visibility to conduct transect surveys are very limited. To what extent have the nearshore hardbottom resources been mapped and quantified? If so, what were the methods and materials and who was the contractor?

We want to make it clear that the proposed project area is blessed with abundant nearshore reef resources, including reefs built by the gregarious polychaete worm, *P. lapidosa*, which provide forage and cover for more then 530 marine species, including sea turtles. This beach is also a famous surf fishing destination (or you can fish toward

the beach from a boat) because species such as pompano, snook, tarpon, bluefish, Spanish mackerel, gray snapper and myriad other gamefish utilize the reefs as ambush points and for other reasons. Several of these species are federally managed, and the reefs are designated Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC). But most importantly, these reefs provide habitat for newly settled reef fish, such as grunts and snappers. Dr. Grant Gilmore, the scientist who has described virtually every fish on the Treasure Coast, has ample data showing that survival ratios are much lower among demersal fish on deeper reefs. Presently, we are unaware of any technology that successfully creates kind-for-kind habitat mitigation for nearshore hardbottom and **we will request that NMFS elevate this project should the project would impact these habitats or fish or fishing are impacted in any unreasonable way.**

Dredge Sites

While we realize that a number of borrow areas are identified on the map, we are concerned that the St. Lucie Shoal may still be considered as a potential dredging site. Recent community outcry against using the St. Lucie Shoal as a “borrow site” for a Dade County project was loud and universal. Allowing St. Lucie County to utilize that potential sand resource would presumably make the shoal fair game to every other coastal county. Our comments on that proposal are attached so you can reference our concerns.

Further, very valuable hard bottom resources are located in close proximity to several of the investigated sites. Some of these reefs are our best bottom fishing “numbers.” Both Martin and St. Lucie counties have a highly successful artificial reef program, and it makes no sense to damage or even endanger existing natural or man-made reef resources when the community clearly values them so highly. Both recreational and commercial fishing are huge industries in this area, and both have suffered severely from the St. Lucie canal discharges, the St. Lucie dune project and the Martin County federal project.

Cumulative Impacts

Dozens of “beach nourishment” projects have taken place in Southeast Florida, yet no adequate assessment of the cumulative impacts exists. The need for such studies has been recognized. FDEP’s Southeast Coral Reef Initiative (SEACRI) is presently working on such an assessment. The project is not only limited to impacts from beach dredge-and-fill operations, and recognizes that multiple stressors on interconnected ecosystems (e.g. seagrass beds and coral reefs) can have cascading impacts on many trophic levels. But the assessment is incomplete and does not involve St. Lucie County.

Given the biological abundance and diversity in the proposed borrow areas and project areas, and their close proximity to North America’s most biologically diverse estuary, the Indian River Lagoon, the Corps needs to take a hard look at the cumulative impacts and multiple stressors that have degraded these interconnected ecosystems. These stressors include, a. the 500-plus-billion gallons of nutrient-laden runoff that

fouled the St. Lucie River and parts of the IRL while causing a massive, persistent and toxic blue/green algae bloom; b. approximately 50 percent of the Martin County beach fill material was either fine sediment or materials that are abraded into carbonate muds—a press disturbance persists in terms of water clarity and scouring particles; c. the St. Lucie County dune restoration project put more than 100,000 yards of mud into the system, resulting in a similar press disturbance; d. the Taylor Creek canal discharges; and e. the armoring of the IRL's western shoreline in St. Lucie County and the impacts to seagrass beds.

As part of the feasibility study, the Corps should attempt to quantify the combined and cumulative impacts of all these stressors. We suggest that the ecosystems perhaps should not be stressed further at this time by a massive dredge-and-fill project.

The Taxpayer's Rights

At minimum, the Corps can reduce impacts to nearshore hardbottom by starting the project farther south. It is completely inappropriate to dredge-and-fill one of two remaining native beaches on the island to protect property that hasn't been constructed yet. No one should be allowed to live in the area on the north end of the project, known as "The Narrows." But the Tesoro and other developments are planned or underway.

Like so many Corps projects, so-called "beach nourishment" simply encourages people to live in floodplains. Even worse, the Narrows is frequently the site of an ephemeral inlet, and was being considered for inclusion in the Hobe Sound National Wildlife Refuge. The project will only encourage further development in unsustainable locations. Since protecting A1A is also a goal, then perhaps the Corps should recommend elevating the roadway on pilings.

Furthermore, it should be noted that yesterday Citizens Property Insurance Corp., Florida's insurer of last resort, announced that it will stop providing builders risk coverage for new buildings under construction in coastal areas. Already, in our opinion, the public is unfairly forced to subsidize beachfront interests with tax dollars for "beach nourishment," and often a second time in terms of impacts to public trust resources, such as reefs. It makes no sense to make the public pay for a land reclamation project with tax dollars and natural resources, to give ground-floor protection to a few buildings that will never get insured. The project will likely fail, as will the buildings, and the public will be stuck with the tab, again.

Conclusion

While we realize that St. Lucie County is the sponsor, we are concerned that, to our knowledge, neither the County nor the Corps has engaged in any scoping or outreach to beach users and boaters or any other public interest. Since there is little community awareness about this proposed project, we insist that you extend the public comment period and immediately plan scoping and outreach meetings.

A feasibility study must proceed with a design template in mind, which means that the study is biased toward one approach despite the fact that the community would likely prefer to pursue alternatives to big, square beaches. The Corps has modified template designs both in Florida and in New Jersey to protect local resources. We would appreciate it if the Jacksonville District would demonstrate similar flexibility and work with the many community stakeholders.

Again, to insure that this project reflects the will of the community, and not just the will of beachfront interests, there is a dire need for outreach and scoping. We look forward to a quick response from your agency.

Thank you;

Terry Gibson
Managing Editor
For Staff



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240



In Reply Refer To:
FWS/DHRC/BRMS/040270

Mr. Joseph Smith
Chair, Board of Commissioners
St. Lucie County
2300 Virginia Avenue
Fort Pierce, Florida 34982

APR 17 2009

Dear Mr. Smith:

Enclosed for your review and comment is the U.S. Fish and Wildlife Service's (Service) *Report to Congress: John H. Chafee Coastal Barrier Resources System Digital Mapping Pilot Project*. The report describes the results of the Service's digital mapping pilot project and a framework for modernizing the remainder of the John H. Chafee Coastal Barrier Resources System (CBRS) maps. The pilot project was conducted pursuant to the Coastal Barrier Resources Reauthorization Act of 2000 (P.L. 106-514). Also enclosed are large-scale copies of the draft pilot project maps for the areas under your jurisdiction.

The Coastal Barrier Resources Act (CBRA, P.L. 97-348) of 1982 established the CBRS, a defined set of geographic units located along the Atlantic, Gulf of Mexico, Great Lakes, Puerto Rico, and U.S. Virgin Island coasts. These units are delineated on a set of maps enacted by Congress and maintained by the Service. Most new Federal expenditures and financial assistance that have the effect of encouraging development are prohibited within the CBRS. The CBRA does not prevent development, and it imposes no restrictions on development conducted with non-Federal funds. Congress enacted CBRA to minimize the loss of human life, reduce wasteful Federal expenditures, and minimize the damage to natural resources associated with coastal barriers.

The maps that currently depict the 3.1 million acres of the CBRS were created almost two decades ago and are outdated, difficult to use, and sometimes contain errors that affect private property owners. Congress directed the Service to modernize the CBRS maps using digital technology. Modernizing the CBRS maps will correct mistakes that affect private property owners; improve customer service and government efficiency; make CBRS information available in digital format for use in coastal planning and restoration efforts, including decisions related to sea level rise; and help secure the long-term integrity of the CBRS by limiting the need for future legislative changes. The Service has taken the first major step forward towards map modernization by completing the enclosed report to Congress that contains draft revised maps of 70 CBRS units (approximately 10% of the entire CBRS) and describes the feasibility, data needs, and costs of completing digital maps for the entire CBRS. The pilot project units are located in Delaware, North Carolina, South Carolina, Florida, and Louisiana.

RECEIVED

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IN AMERICA** 

MAY 6 2009

Board of County Commission
District 3

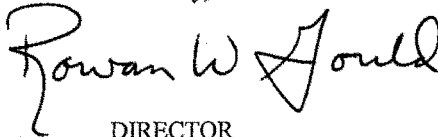
Mr. Joseph Smith

2

The Coastal Barrier Resources Reauthorization Act of 2005 (P.L. 109-226) requires the Service to finalize the pilot project and prepare a second report to Congress, in consultation with the Governors of the States in which any CBRS units are located, and after providing an opportunity for the submission and consideration of public comments. The second report to Congress will contain the final recommended maps created under the pilot project and a summary of the comments received from the Governors of the States, other government officials, and the public regarding the pilot project maps. The Service announced the availability of the pilot project report and draft maps for public review and comment in a notice published in the *Federal Register* on April 7, 2009. We invite you to review the pilot project report and maps and provide input to the Service during the public comment period which closes on July 6, 2009. Additional information concerning CBRA and the pilot project can be found at the Service's Internet site: http://www.fws.gov/habitatconservation/coastal_barrier.html.

We look forward to your input and involvement in this important process to finalize the CBRS digital mapping pilot project. If you have any questions concerning this matter, please contact Mr. Gary Frazer, Assistant Director, Fisheries and Habitat Conservation, at (202) 208-6394.

Sincerely,

A handwritten signature in black ink, reading "Rowan W. Gould". The signature is fluid and cursive, with the first name "Rowan" and last name "Gould" being more prominent than the middle initial "W".

DIRECTOR

Enclosure



United States Department of the Interior

FISH AND WILDLIFE SERVICE
 South Florida Ecological Services Office
 1339 20th Street
 Vero Beach, Florida 32960



May 27, 2009

Eric P. Summa
 U.S. Army Corps of Engineers
 Planning Division
 P.O. Box 4970
 Jacksonville, Florida 32232-0019

Service Log No.: 41420-2009-FA-0389
 Date Received: February 9, 2009
 Applicant: U.S. Army Corps of Engineers
 Project: Beach Renourishment in
 CBRA Unit P11
 County: St. Lucie

Dear Mr. Summa:

The Fish and Wildlife Service (Service) has reviewed the maps and other information submitted by the U.S. Army Corps of Engineers (Corps) for the project listed above. This letter is submitted in accordance with Section 6 of the Coastal Barrier Resources System Act (CBRA). CBRA requires that the appropriate Federal officer consult with the Secretary of the Interior before making Federal expenditures or financial assistance available within the System.

PROJECT DESCRIPTION

The Corps is requesting a consistency determination for an action affecting CBRA Unit P11 Hutchinson Island, located in St. Lucie County, Florida. Specifically, the Corps would like to evaluate the feasibility of providing shoreline erosion protection, hurricane and storm damage reduction, and related purposes to the shores of St. Lucie County, Florida. In the original letter dated February 6, 2009, the Corps proposes to renourish 5 miles of shoreline from the Sand Dollar Shores Development (R-88) south to the county line (R-115). The Corps also requested information regarding any restrictions under CBRA for structural and nonstructural shore protection measures.

A second letter from the Corps was submitted on March 12, 2009, and provided further clarification to the original letter of request. The Corps identified two possible project alternatives, the first of which is to renourish 7.2 miles of shoreline from the Sand Dollar Shores development (R-88) south to the county line (R-115). The second alternative is to renourish approximately 3.6 miles of beach within three CBRA Unit P11 excluded areas which are located



approximately between monuments R-81 to R-84, R-89 to R-90, and R-100 to R-101, plus the remaining southern 2.4 miles of St. Lucie County beach outside the CBRA Unit P11. Additionally, the Corps is requesting a consistency determination with regard to measures to reduce “end losses” under this alternative such as terminal groins, groin fields, and breakwaters.

CBRA CONSISTENCY DETERMINATION

Portions of the project area described in the first alternative are within Unit P11 Hutchinson Island. Unit P11 is part of the System, located east of Port St. Lucie, Florida. This area supports suitable habitat for species listed under the Endangered Species Act of 1973, as amended (87 Stat. 884; 16 U.S.C. 1531 *et seq.*), including the threatened piping plover (*Charadrius melodus*), threatened loggerhead sea turtle (*Caretta caretta*), endangered green sea turtle (*Chelonia mydas*), endangered leatherback sea turtle (*Dermochelys coriacea*), and endangered hawksbill sea turtle (*Eretmochelys imbricata*). The beaches of St. Lucie County support the fifth highest nesting density of sea turtles in Florida. The purposes of CBRA are to minimize the loss of human life, wasteful expenditure of Federal revenues, and damage to fish, wildlife, and other natural resources associated with units of the System.

Section 6 of the CBRA provides an exception to Section 5, *Limitations on Federal Expenditures Affecting the System*, if the expenditure is for nonstructural shoreline stabilization projects that are designed to mimic, enhance, or restore a natural stabilization system.

Upon review of the St. Lucie County property appraisal maps, the primary ownership of land outside the excluded parcels of Unit P11 are privately owned and not under any perpetual conservation designation. Without permanent protection of the environmental attributes of these privately owned parcels, it is anticipated that renourishment of the beaches may encourage development of the privately owned parcels. Therefore, it is our conclusion that the proposed action as described in the first alternative does not meet the exception definition under Section 6 of CBRA.

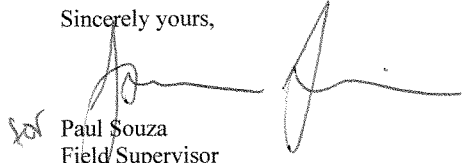
We have no comment on the renourishment activities under the second alternative since they would occur within excluded areas that are outside the boundary of Unit P11. However, the placement of end structures such as groins or jetties within the excluded areas to maintain renourished sand in these areas is not consistent with CBRA. These structures would impede natural sediment transport and may accelerate erosion throughout the entire CBRA unit. This would cause indirect adverse effects to the natural environment for which this unit was designed to protect.

Eric Summa

Page 3

Thank you for your cooperation and effort in protecting federally listed species. If you have any questions regarding this project, please contact Debbie DeVore at 772-562-3909, extension 324.

Sincerely yours,



Paul Souza
Field Supervisor
South Florida Ecological Services Office

cc:

Service, Arlington, Virginia (Katie Niemi)

Service, Atlanta, Georgia (Cindy Bohn)

**BOARD OF
COUNTY
COMMISSIONERS**



PAULA A. LEWIS
COMMISSIONER

July 24, 2009

Mr. Gary Frazer
Assistant Director, Fisheries and Habitat Conservation
United States Department of the Interior
Fish and Wildlife Service
Washington, D.C. 20240

RE: CBRA System Digital Mapping Pilot Project for St. Lucie County, Florida

Dear Mr. Frazer:

On behalf of St. Lucie County Board of County Commissioners, we appreciate the opportunity to review the *Report to Congress: John H. Chafee Coastal Barrier Resources System Digital Mapping Pilot Project* which includes St. Lucie County, Florida. We have completed a comprehensive review of the proposed CBRA zone maps and have attached a list of our comments and a mapping inventory of County lands such as parks and preserves. The Board would like to emphasize two important issues which may negatively impact St. Lucie County as a result of this digital mapping effort

1. The reclassification of the port and inlet area into a CBRA Zone, as depicted on digital map 17 in Unit P10A, is a serious concern. The aquatic preserve area stops at North Bridge and does not continue south into the port and inlet area as depicted on the map. In recognition of this mapping error and maintaining consistency with the area excluded from the CBRA Zone immediately to the south, we respectfully request the port and inlet area also remain excluded from the CBRA Zone.
2. We request that all County parks and preserves, as correctly identified in our attached mapping inventory, be classified as Otherwise Protected Areas (OPAs). This includes allowing those properties proposed to be removed from an OPA to remain and designating any parks and preserves which are identified in a CBRA zone to be designated as an OPA.

Our port, inlet, parks and preserves were often purchased and/or improved with state and federal funds. They are important assets to the community and designating them in CBRA zones appears to be in direct conflict with other state and federal programs in which the County regularly participates.

We appreciate the opportunity to coordinate this mapping effort with and request that you keep the County updated as this process moves forward. Should you have any further questions, please contact Mr. Richard Bouchard, the County's Erosion District Manager at 772-462-1710.

Mr. Gary Frazer
July 24, 2009
Page 2

Sincerely,



Paula A. Lewis, Chair
Board of County Commissioners

PAL:rb

Encl: 1) Bullet list of concerns and errors
 2) 3 pg. County owned parcel list
 3) 3 pg. Ariel maps

cc: Senator Bill Nelson w/attachment 1
 Senator Mel Martinez w/attachment 1
 U.S. Representative Alcee Hastings w/attachment 1
 U.S. Representative Tom Rooney w/attachment 1
 Board of County Commissioners w/attachment 1
 Faye W. Outlaw, MPA, County Administrator w/attachment 1
 Lee Ann Lowery, Assistant County Administrator w/attachment 1, 2, 3
 Christopher Steers, Assistant County Administrators w/attachment 1
 Department Directors of St. Lucie County w/attachment 1
 Richard Bouchard, Erosion District Manager w/attachment 1, 2, 3
 Marc Meyers, Building Official, City of Fort Pierce w/attachment 1

John H. Chafee Coastal Barrier Resources System Digital Mapping Pilot Project:
St. Lucie County - Addendum

Priority Concerns:

- The Fort Pierce Inlet and Port of Fort Pierce areas are parts of a Federally-maintained Deep-water Port (established in 1935) that is maintenance-dredged by the ACE using federal funds; improvements may potentially be planned for the area, such as shoreline stabilization and a sand-transfer plant, therefore, inclusion of the Port into the project area would not be sought at this time; the County requests no change in the Port area designation at this time.
- The County requests that all Parks and Preserves be converted to and/or remain in OPA status in order to allow Park amenities to be maintained and protected that do not contribute to additional development in these areas; updated shape-files of all Parks and Preserves on Barrier Island were transmitted, as requested, to update FWS files beyond the 2005 status depicted in the photo; Coastal Park and Preserve maps are being provided to clarify their locations, in support our request for retention of Park OPA status/reclassification.

Other Concerns/Mapping Errors Found:

- Labeling error: showing "Pepper Beach State Park" on Jack Island, which is actually "Fort Pierce Inlet State Recreation Area".
- Pepper Park Addition is actually entirely publicly-owned and can be included in the project in its entirety as an OPA; currently it has a section cut out, which was purchased July 31, 2006 (Park shape-files e-mailed as requested to support this item).
- Labeling error: the section of the Aquatic Preserve which is contiguous to the Port of Fort Pierce does not enter the Fort Pierce Port and Turning Basin Area; the north AP's southern limit is the north causeway island known as "Little Jim Island", as well as, the north causeway bridges.
- The boundary line lying along Blue Heron Blvd could be straightened at the point it reaches the dunes along the Atlantic Ocean; currently it is drawn with an angle to the north, which covers a strip of beachfront dune property in front of a completed development and no longer serves a restrictive purpose.
- Labeling error: "Frederick Davis Memorial Park" is actually "Frederick Douglass Memorial Park".
- The exclusion boundary adjacent/on the South Hutchinson Island Fire Station No. 8 (site acquired June 1, 1982), could be extended to exclude their facility from the project, since the project was required for public safety, not to encourage additional development.
- The exclusion boundary adjacent to the South Hutchinson Island Wastewater Treatment Plant (site acquired January 10, 1994), could be extended to exclude their facility due to the environmental benefits gained from the plant (removal of failing private package plants).
- In the comments for Unit P10A, Blue Hole; it is stated that the Queens Island Preserve (and the Indrio Blueway Buffer) are managed by St. Luce County Public Works. Queen's Island Preserve is actually managed by St. Lucie County

Mosquito Control District, and Indrio Blueway is co-managed by the St. Lucie County Mosquito Control District and the St. Lucie County Environmental Resources Dept.

- In the comments for Unit FL-14P, Pepper Beach; it is stated that Kings Island is managed by St. Lucie County Environmental Resources Dept. King's Island Park is actually managed by the St. Lucie County Mosquito Control District.
- Six, 400 foot tall wind turbines, are being proposed by FPL for the construction in the conservation area outside of the FPL Hutchinson Island Nuclear Power Plant; does this require a consistency consultation for the CBRA Unit?

**BOARD OF
COUNTY
COMMISSIONERS**



CHRIS CRAFT
COMMISSIONER

October 6, 2009

Dave Stout
Chief, Division of Habitat and Resource Conservation
U.S. Fish & Wildlife Service
Fisheries and Habitat Conservation
4401 N. Fairfax Drive, Room 830A
Arlington, VA 22203

RE: Coastal Barrier Resources System Digital Mapping Pilot Project

Dear Mr. Stout:

Thank you for your time last week to meet with me regarding the U.S. Fish & Wildlife Service's Coastal Barrier Resources System Digital Mapping Pilot Project. As we discussed, we are most concerned with the proposed addition of the Fort Pierce Inlet and associated Port area into a Coastal Barrier Resources Area (CBRA) in St. Lucie County, Florida.

As one example, we are concerned that port and inlet activities of the Federally-maintained inlet, turning basin, and associated jetties by the U.S. Army Corps of Engineers, with a local entity as the local sponsor, may somehow be impacted in the future by inclusion in a CBRA zone. Please confirm that CBRA contains an exception for maintenance or new improvements to existing Federal navigation channels and related structures, including rock jetties.

We are also concerned about the potential future Federal construction of a sand bypassing facility located within the Inlet that would pass sand from either the north side of the Fort Pierce Inlet, currently an Otherwise Protected Area (OPA), or from the Inlet itself, to the south side of the Inlet. As we discussed, the south side of the Inlet, which is not currently in, nor proposed to be added to a CBRA zone, is a Federally-authorized beach nourishment project. The beach must be nourished routinely by the Corps of Engineers because of the impacts of the Fort Pierce jetty system on littoral sand transfer. Will you please comment on the future feasibility of a sand transfer facility in that area and the removal of sand from the Inlet or an OPA zone?

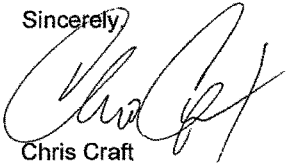
Mr. David Stout
October 6, 2009
Page 2

We remain concerned about the impacts a new CBRA designation may have on public and private upland development of areas near the port, particularly those on the east-facing side of the Indian River Lagoon. Will you please confirm that these areas have been designated as developed shorelines on the new maps and therefore have a 50 foot boundary from the shoreline to the CBRA zone? Also, will you please confirm that a shoreline stabilization structure in this area, such as a seawall, would be permitted to receive Federal funding for construction because it would not extend 50 feet into the water?

Finally, will you please confirm that any construction-related activities associated with port development beyond the 50-foot shoreline boundary would not be eligible for Federal funding?

Thank you again for meeting with me on this important issue. I appreciate the time you have taken to better educate me on CBRA zones and look forward to hearing from you on these specific concerns.

Sincerely,



Chris Craft
Board of County Commissioners

CC:rb

cc: Senator Bill Nelson
Senator George LeMieux
U.S. Representative Alcee Hastings
U.S. Representative Tom Rooney
Board of County Commissioners
Faye W. Outlaw, MPA, County Administrator
Lee Ann Lowery, Assistant County Administrator
Department Directors of St. Lucie County
Richard Bouchard, Erosion District Manager
Marc Meyers, Building Official, City of Fort Pierce



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240



In Reply Refer To:
FWS/DHRC-BRMS/044276

MAR 15 2010

Mr. Chris Craft
Board of County Commissioners
St. Lucie County
2300 Virginia Avenue
Fort Pierce, Florida 34982

Dear Mr. Craft:

Thank you for your letter of October 6, 2009, regarding the John H. Chafee Coastal Barrier Resources System (CBRS) Digital Mapping Pilot Project, and thank you for meeting with the Service on September 17, 2009, concerning this matter. Your letter outlines your concerns with the proposed addition of the Fort Pierce Inlet and associated port area to CBRS Unit P10A. The other unit in the vicinity of the Fort Pierce Inlet is otherwise protected area (OPA) FL-14P.

The Coastal Barrier Resources Act (CBRA, P.L. 97-348) of 1982 established the CBRS, a defined set of geographic units along the Atlantic, Gulf of Mexico, Great Lakes, Puerto Rico, and U.S. Virgin Island coasts. Most new Federal expenditures and financial assistance, including Federal flood insurance, are prohibited within the CBRS. CBRA does not prevent development, and it imposes no restrictions on development conducted with non-Federal funds. Congress enacted CBRA to minimize the loss of human life, reduce wasteful Federal expenditures, and minimize the damage to natural resources associated with coastal barriers. Unit P10A was designated with the passage of CBRA in 1982.

In 1990, Congress enacted the Coastal Barrier Improvement Act (CBIA, P.L. 101-591) which expanded the CBRS by adding new units, enlarging some previously designated units, and adding OPAs as a new category of lands. An OPA is defined as an undeveloped coastal barrier within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes. The only Federal spending prohibition within OPAs is the prohibition on Federal flood insurance. Unit FL-14P was designated as an OPA with the passage of the CBIA in 1990.

Recognizing the limitations and challenges associated with the existing set of CBRS maps, the Coastal Barrier Resources Reauthorization Act of 2000 (P.L. 106-514) directed the Secretary of the Interior to complete a Digital Mapping Pilot Project which includes draft digital maps for 50-75 units in the CBRS and a report to Congress that describes the results of the pilot project and the feasibility, data needs, and costs of completing digital maps for the entire CBRS.

**TAKE PRIDE
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On April 7, 2009, the Service released its *Report to Congress: John H. Chafee Coastal Barrier Resources System Digital Mapping Pilot Project* for a 120-day public review and comment period, which closed on August 5, 2009. Units P10A and FL-14P are two of the 70 total units under review as part of the pilot project. The Service plans to review all comments received during the comment period and make adjustments to the pilot project maps, as appropriate, based on CBRA's criteria and objective mapping protocols. The Service will create a set of final recommended maps to address the comments made during the public comment period and to update the underlying base maps with newer aerial imagery. As part of this process, the Service may further modify the boundaries of Units P10A and FL-14P. The Service's official response to the public comments and final recommended maps will be included in a report to Congress, per the directives of the Coastal Barrier Resources Reauthorization Act of 2005 (P.L. 109-226). The pilot project maps will only become effective if they are enacted by Congress through new legislation.

The pilot project recommends adjusting the southern boundary of Unit P10A to include additional associated aquatic habitat surrounding and within OPA Unit FL-14P. CBRA defines a coastal barrier to include all associated aquatic habitats, including the adjacent wetlands, marshes, estuaries, inlets, and near-shore waters; however in carrying out the pilot project, the Service noted that the associated aquatic habitat had not been delineated consistently throughout the CBRS. In particular, channels are not mapped consistently throughout the CBRS. In some cases, the entire width of the channel is included; in other cases none of the channel is included; and often, about half of the channel is included within the CBRS. In the pilot project, the Service adopted a consistent approach for the placement of CBRS boundaries within channels. Because channels are part of a coastal barrier's associated aquatic habitat, we proposed to include the entire width of channels within pilot project System unit boundaries, including for Unit P10A.

Your letter expressed concern that potential future activities by the U.S. Army Corps of Engineers within the Federally-maintained Fort Pierce inlet, turning basin, and associated jetties may be affected in the future if the inlet is included within the CBRS. We note that Section 6(a)(2) of the CBIA contains an exception for the "maintenance or construction of improvements of existing Federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the disposal of dredge materials related to such maintenance or construction." This exception allows for maintenance as well as widening and deepening of existing Federal navigation channels and the disposal of related dredge materials within or outside of the unit.

Your letter also expressed concern about the potential future Federal construction of a sand bypassing facility located within the Fort Pierce Inlet that would pass sand from either the north side of the inlet, currently an OPA, or from the inlet itself, to the south side of the inlet. If the proposed pilot project map for Unit P10A is enacted, the Fort Pierce Inlet would be included within Unit P10A. Section 6(a)(6)(G) of the CBIA contains an exception for "nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system" and that are also consistent with the purposes of CBRA (i.e., minimize the

loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barrier). The Department of the Interior's Office of the Solicitor reviewed similar cases in the past and advised us that Section 6(a)(6)(G) applies only to projects to stabilize the shoreline of a unit of the CBRS; the exception does not apply to projects to stabilize a shoreline outside of the CBRS, regardless of whether the project might be consistent with the purposes of CBRA. Therefore, in general, a proposed Federal action designed to nourish beaches located outside the CBRS using beach material taken from within the CBRS does not meet the criteria for a Section 6(a)(6)(G) exception and is not consistent with CBRA. However, in order to comment on whether the potential sand bypassing facility you refer to would be consistent with CBRA, we would need specific information regarding the sand bypassing process and the location of the proposed project (e.g., whether infrastructure would be constructed in the inlet to transport sand). Such an information exchange normally happens as part of a CBRA consistency consultation between the Service and the Federal agency proposing to fund or conduct the activity.

Your letter also raised the issue of the impacts that a new CBRS designation may have on public and private upland development of areas near the port, particularly those on the east-facing side of the Indian River Lagoon. The proposed landward boundary of Unit P10A was adjusted to follow the wetland/upland interface along the Indian River and contains a 50 foot buffer along the developed shoreline to avoid the inadvertent inclusion within the CBRS of developed property on the mainland. This buffer, and the application of shoreline buffering, is being reviewed by the Service and will be addressed in the final recommended pilot project maps and the accompanying report to Congress. We note that the construction of shoreline stabilization structures, and any other construction-related activities associated with port development, are subject to CBRA's prohibition on Federal expenditures and financial assistance for activities within the CBRS.

The information provided in this letter is intended to assist you in understanding the proposed pilot project maps and the potential implications for Federal financial assistance if the proposed pilot project maps for Units P10A and FL-14P are enacted into law. Please note that the information contained in this letter in no way replaces CBRA's consultation requirements for Federal agencies that propose spending funds within the CBRS.

If you have any additional questions, please contact Martin Kodis, Chief, Branch of Resource and Mapping Support, at (703) 358-2161.

Sincerely,

A handwritten signature in dark ink, appearing to read "David J. Stout". The signature is fluid and cursive, with the first name "David" and last name "Stout" clearly distinguishable.

David J. Stout
Chief, Division of Habitat and Resource Conservation



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

JAN 21 2016

Ms. Roxanna Hinzman
U.S. Fish and Wildlife Service
1339 20th Street
Vero Beach, Florida 32960-3559

Dear Ms. Hinzman:

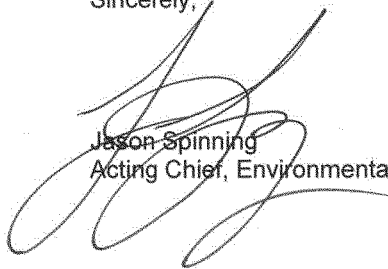
In accordance with regulations pertaining to the National Environmental Policy Act (Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency on the Coastal Storm Risk Management Study, St. Lucie County, Florida. Please note that cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. Your agency is being specifically requested to provide input on the Environmental Assessment that we are preparing which will evaluate impacts to resources under the jurisdiction of the U.S. Fish and Wildlife Service. We look forward to your cooperation and advice as our agencies coordinate on these issues.

The formulation of the project, alternatives, and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic, and social factors. As a cooperating agency, you must fully consider the views, needs, and benefits of competing interests.

No cooperating agency will have "veto" over the selection of the project plan, alternatives, or mitigation measures. Under your status as a commenting agency, you may recommend actions not ultimately adopted or implemented by the lead agency. You may also impose requirements to the extent allowed under your legal authority as a permitting agency. Conflict with the lead agency may be resolved through mediation, placing a dissenting opinion in the EA, withdrawing your cooperating agency status, or the Lead agency pursuing an EA without you as a cooperating agency. For additional information see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981).

Please indicate whether you accept this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Mr. Paul Stodola at 904 232-3271.

Sincerely,



Jason Spinning
Acting Chief, Environmental Branch

Enclosure



DEPARTMENT OF THE ARMY
 JACKSONVILLE DISTRICT CORPS OF ENGINEERS
 701 San Marco Boulevard
 JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
 ATTENTION OF

JAN 21 2016

Planning and Policy Division
 Environmental Branch

Dr. Roy Crabtree
 National Marine Fisheries Service
 263 13th Avenue, South
 St. Petersburg, FL 33701

Dear Dr. Crabtree:

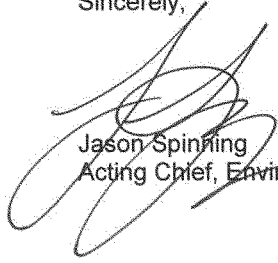
In accordance with regulations pertaining to the National Environmental Policy Act (Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency on the Coastal Storm Risk Management Study, St. Lucie County, Florida. Please note that cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. Your agency is being specifically requested to provide input on the Environmental Assessment that we are preparing which will evaluate impacts to resources under the jurisdiction of the National Marine Fisheries Service. We look forward to your cooperation and advice as our agencies coordinate on these issues.

The formulation of the project, alternatives, and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic, and social factors. As a cooperating agency, you must fully consider the views, needs, and benefits of competing interests.

No cooperating agency will have "veto" over the selection of the project plan, alternatives, or mitigation measures. Under your status as a commenting agency, you may recommend actions not ultimately adopted or implemented by the lead agency. You may also impose requirements to the extent allowed under your legal authority as a permitting agency. Conflict with the lead agency may be resolved through mediation, placing a dissenting opinion in the EA, withdrawing your cooperating agency status, or the Lead agency pursuing an EA without you as a cooperating agency. For additional information see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981).

Please indicate whether you accept this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Mr. Paul Stodola at 904 232-3271

Sincerely,

A handwritten signature in black ink, appearing to read 'J. Spinning', is written over the typed name and title.

Jason Spinning
Acting Chief, Environmental Branch

Enclosure



DEPARTMENT OF THE ARMY
 JACKSONVILLE DISTRICT CORPS OF ENGINEERS
 701 San Marco Boulevard
 JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
 ATTENTION OF

Planning and Policy Division
 Environmental Branch

JAN 21 2016

Mr. Geoffrey Wikel, Chief
 Branch of Environmental Coordination
 Division of Environmental Assessment
 Bureau of Ocean Energy Management
 45600 Woodland Road, VAM OEP
 Sterling, VA 20166

Dear Mr. Wikel:

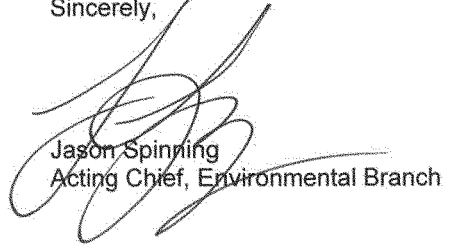
In accordance with regulations pertaining to the National Environmental Policy Act (Title 40 of the Code of Federal Regulations, part 1501.6), I am formally inviting your agency to become a cooperating agency on the Coastal Storm Risk Management Study, St. Lucie County, Florida. Please note that cooperating agency status involves actions and responsibilities beyond that normally associated with a commenting or permitting agency. Your agency is being specifically requested to provide input on the Environmental Assessment (EA) that we are preparing as part of this study. We look forward to your cooperation and advice as our agencies coordinate on the preparation of this document.

The formulation of the project, alternatives, and mitigation will be in accordance with Engineer Regulation ER 1105-2-100 and will fully consider a range of environmental, economic, and social factors. As a cooperating agency, you must fully consider the views, needs, and benefits of competing interests.

No cooperating agency will have "veto" over the selection of the project plan, alternatives, or mitigation measures. Under your status as a commenting agency, you may recommend actions not ultimately adopted or implemented by the lead agency. You may also impose requirements to the extent allowed under your legal authority as a permitting agency. Conflict with the lead agency may be resolved through mediation, placing a dissenting opinion in the EA, withdrawing your cooperating agency status, or the Lead agency pursuing an EA without you as a cooperating agency. For additional information see the enclosed "Rights and Responsibilities of Lead and Cooperating Agencies" (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, Council on Environmental Quality, 1981).

Please indicate whether you accept this invitation to become a cooperating agency (as described above) within 30 days of the date of this letter. If you have any questions, please contact Mr. Paul Stodola at 904 232-3271.

Sincerely,

A handwritten signature in black ink, appearing to read "Jason Spinning", is written over the typed name and title. The signature is stylized with loops and a long horizontal stroke extending to the right.

Jason Spinning
Acting Chief, Environmental Branch

Enclosure



United States Department of the Interior

BUREAU OF OCEAN ENERGY MANAGEMENT

WASHINGTON, DC 20240-0001

FEB 09 2016

Mr. Jason Spinning
U.S. Army Corps of Engineers- Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Spinning:

Thank you for your January 21, 2016, letter requesting that the Bureau of Ocean Energy Management (BOEM) become a cooperating agency during preparation of an Environmental Assessment (EA) for the Coastal Storm Risk Management Study in St. Lucie County, Florida. The U.S. Army Corp of Engineers Jacksonville District (Corps) has evaluated several alternatives, consisting of an array of various structural and non-structural measures, to accomplish the identified project planning goals and objectives. Beach nourishment and dune construction were included among the structural measures carried forward within the final array of alternative plans being evaluated. The structural measures may require use of federal sand resources located approximately 3.5 miles offshore within the Outer Continental Shelf (OCS) at St. Lucie Shoals. Section 8(k) of the Outer Continental Shelf Lands Act (OCSLA) grants BOEM the authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration, or for use in construction projects funded in whole or part or authorized by the federal government.

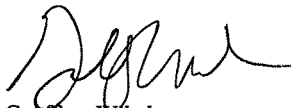
BOEM welcomes the opportunity to participate in this National Environmental Policy Act (NEPA) effort and agrees to serve as a cooperating agency since BOEM has sole jurisdiction over mineral leasing on the OCS. As a cooperating agency, BOEM expects to: participate and provide input in the NEPA process at the earliest possible time; assume, on the request of the Corps, responsibility for developing information and preparing environmental analyses for which BOEM has special expertise; make available staff support, at the lead agency's request, to enhance the interdisciplinary capability of the Corps; provide comment on draft versions of the EA when requested; and use our own funds to accomplish these responsibilities. Several NEPA documents have been previously prepared by the Corps and/or BOEM considering the potential environmental effects of dredging offshore sand resources within the vicinity of the project area. BOEM expects to collaborate with the Corps to identify the existing NEPA analyses that can be used to ensure the most efficient and effective treatment of potential effects, while also considering and incorporating new information and science when appropriate.

BOEM recognizes the importance of initiating and agrees to participate in the required Endangered Species Act (ESA) Section 7 consultation; the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat consultation (Section 305); the National Historic Preservation Act Section (NHPA) Section 106 process; and the Coastal Zone Management Act (CZMA) Section 307 consistency process. The lead agency in ESA Section 7 consultation for potential impacts on protected species will be designated by jurisdiction and in

accordance with 50 CFR §402.07. BOEM is a joint consulting agency with the Corps in the ongoing re-initiated consultation for the South Atlantic Regional Biological Opinion, for which this project would be included as a component of the proposed action. BOEM anticipates that this consultation will be concluded prior to any planned construction date for this project and will serve as the consultation mechanism for the in-water dredging and placement activities of both agencies. The Corps would be the lead agency and consult with the U.S. Fish and Wildlife Service (FWS) concerning use of the Florida Statewide Programmatic Biological Opinion as the appropriate consultation mechanism for addressing effects from placement activities to listed species under FWS purview. Additionally, the Corps will notify FWS of BOEM's interconnected action and cooperating role. BOEM and the Corps will consult jointly with NMFS Habitat Conservation Division on essential fish habitat. BOEM anticipates that the Corps will be the lead federal agency for ensuring NHPA Section 106 compliance. BOEM expects to act in a consulting role, especially when coordinating with the Florida State Historic Preservation Officer (SHPO) concerning the use of OCS sand resources and all related cultural resource survey activities. BOEM requests that the Corps involve BOEM in all deliberations with the SHPO or Tribal Historic Preservation Officers so that BOEM's involvement in the undertaking is understood. The Corps will be following Subpart C procedures to obtain a consistency concurrence from the Florida Department of Environmental Protection through the Joint Coastal Permit process in compliance with Section 307 of the CZMA.

BOEM looks forward to working with the Corps during this process. We would greatly appreciate it if the Corps would include us on all public notices and correspondence to other federal and state agencies concerning this project. If you would like to discuss any of these items further, please contact Doug Piatkowski at (703) 787-1833 or by e-mail at douglas.piatkowski@boem.gov.

Sincerely,



Geoffrey Wikel
Chief, Branch of Environmental Coordination
Division of Environmental Assessment

cc: Jeffrey Reidenauer, Leasing Division
Bureau of Ocean Energy Management

bc: Official File
Chief, DEA
Chief, Branch of Environmental Coordination
Piatkowski, DEA



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

MAR 25 2016

Mr. Fred Dayhoff, Tribal Representative
NAGPRA, Section 106
Miccosukee Tribe of Indians of Florida
Post Office Box 440021
Tamiami Station
Miami, Florida 33144

Re: St. Lucie County Coastal Storm Risk Management Feasibility Study

Dear Mr. Dayhoff,

The U.S. Army Corps of Engineers, Jacksonville District (Corps), is studying the feasibility of providing coastal storm risk management within St. Lucie County, Florida. The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island. Hutchinson Island is split by Fort Pierce Inlet into North Hutchinson Island and South Hutchinson Island. The current study area includes only the South Hutchinson Island reach, measuring approximately 3.4 miles. The study area includes the shoreline from Florida Department of Environmental Protection range monument R98 to R115+1000 feet.

The purpose of this project is to develop an implementable and acceptable plan to address specific problems and opportunities for coastal storm damage reduction in the study area. The primary problem within the study area consists of storm-induced erosion which endangers natural beach habitat, limits recreational and tourism opportunities, and threatens coastal infrastructure. By implementing a federal beach renourishment and dune creation/remediation project, the Corps believes there is an opportunity to reduce storm damage, restore natural dune function, conserve natural habitat, protect the current hurricane evacuation route along Hutchinson Island, and maintain existing recreation and tourism levels.

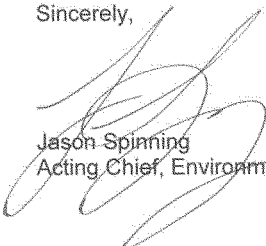
As a result of the feasibility study, a Tentatively Selected Plan (TSP) for the project was chosen which includes placing sand in the nearshore to maintain and extend the existing beach berm. The TSP will provide a protective berm that extends the project shoreline profile (R98 to R115+1000 feet) 20 feet seaward from the existing dune. A hydraulic dredge will be utilized to fill the template with compatible sand from the North and South St. Lucie Shoals.

All portions of the proposed project area, including the offshore borrow area and the sand placement template have been subject to cultural resource surveys (see Attachment). New South Associates conducted a Phase I cultural resources survey of the sand placement area in October 2007 (DHR Manuscript #17559). No cultural resources were identified as a result of the survey; however, the study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. As a result of this report, the Corps determined that beach nourishment would have no effect on cultural resources listed or eligible for listing in the National Register of Historic Properties (NRHP). The State Historic Preservation Office (SHPO) concurred with the determination in a letter to the Corps dated July 27, 2010 (DHR File No. 2008-02141-B).

A remote sensing survey of the proposed offshore borrow location was conducted by SEARCH between October 2007 and June 2008 (DHR Manuscript #17990). Based on this survey, one cluster of magnetic anomalies was identified in the southern borrow area and two historic shipwreck sites (8SL28 and 8SL30) are located adjacent to the northern borrow area. No diver evaluations were performed on the magnetic targets, and a buffer of 200 feet was recommended to avoid effects on the potentially significant resource. In a letter dated July 31, 2008 the Corps determined that a 500-foot buffer of the anomalies would be utilized during dredging to avoid impacts. This letter also noted that the two previously recorded historic shipwrecks are located outside of the project area and determined that, contingent upon the preservation of the anomaly cluster with a 500-foot buffer zone, no historic properties would be affected by dredging. The SHPO concurred with the determination of effects in letters dated September 4, 2008 and January 20, 2011 (DHR File Nos. 2008-05091 and 2011-00231).

During implementation of the St. Lucie County Coastal Storm Risk Management Feasibility Study TSP, the Corps will continue to protect these cultural resources by maintaining the 500-foot buffer previously utilized during dredging (see Attachment). Contingent upon maintaining the buffer, the Corps has determined that the TSP will have no effect on historic properties listed or eligible for listing in the NRHP. I request your comments on the determination of no effect. If there are any questions, please contact Ms. Meredith Moreno at 904-232-1577 or e-mail at Meredith.a.moreno@usace.army.mil.

Sincerely,


Jason Spinning
Acting Chief, Environmental Branch

3/25/16

Enclosure



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

MAR 25 2016

Dr. Paul Backhouse, THPO
Seminole Tribe of Florida
Tribe Historic Preservation Office
30290 Josie Billie Highway
PMP 1004
Clewiston, FL 33440

Re: St. Lucie County Coastal Storm Risk Management Feasibility Study

Dear Dr. Backhouse:

The U.S. Army Corps of Engineers, Jacksonville District (Corps), is studying the feasibility of providing coastal storm risk management within St. Lucie County, Florida. The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island. Hutchinson Island is split by Fort Pierce Inlet into North Hutchinson Island and South Hutchinson Island. The current study area includes only the South Hutchinson Island reach, measuring approximately 3.4 miles. The study area includes the shoreline from Florida Department of Environmental Protection range monument R98 to R115+1000 feet.

The purpose of this project is to develop an implementable and acceptable plan to address specific problems and opportunities for coastal storm damage reduction in the study area. The primary problem within the study area consists of storm-induced erosion which endangers natural beach habitat, limits recreational and tourism opportunities, and threatens coastal infrastructure. By implementing a federal beach renourishment and dune creation/remediation project, the Corps believes there is an opportunity to reduce storm damage, restore natural dune function, conserve natural habitat, protect the current hurricane evacuation route along Hutchinson Island, and maintain existing recreation and tourism levels.

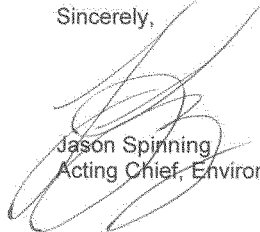
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Sincerely,



Jason Spinning
Acting Chief, Environmental Branch

3/25/16

Enclosure



DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT CORPS OF ENGINEERS
701 San Marco Boulevard
JACKSONVILLE, FLORIDA 32207-8175

REPLY TO
ATTENTION OF

Planning and Policy Division
Environmental Branch

MAR 25 2016

Tim Parsons, Ph.D., SHPO
Division of Historical Resources
State Historic Preservation Officer
500 South Bronough Street
Tallahassee, Florida 32399-0250

Re: St. Lucie County Coastal Storm Risk Management Feasibility Study

Dear Dr. Parsons,

The U.S. Army Corps of Engineers, Jacksonville District (Corps), is studying the feasibility of providing coastal storm risk management within St. Lucie County, Florida. The St. Lucie County, Florida shoreline consists of a 25-mile-long narrow barrier island named Hutchinson Island. Hutchinson Island is split by Fort Pierce Inlet into North Hutchinson Island and South Hutchinson Island. The current study area includes only the South Hutchinson Island reach, measuring approximately 3.4 miles. The study area includes the shoreline from Florida Department of Environmental Protection range monument R98 to R115+1000 feet.

The purpose of this project is to develop an implementable and acceptable plan to address specific problems and opportunities for coastal storm damage reduction in the study area. The primary problem within the study area consists of storm-induced erosion which endangers natural beach habitat, limits recreational and tourism opportunities, and threatens coastal infrastructure. By implementing a federal beach renourishment and dune creation/remediation project, the Corps believes there is an opportunity to reduce storm damage, restore natural dune function, conserve natural habitat, protect the current hurricane evacuation route along Hutchinson Island, and maintain existing recreation and tourism levels.

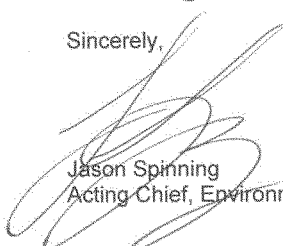
As a result of the feasibility study, a Tentatively Selected Plan (TSP) for the project was chosen which includes placing sand in the nearshore to maintain and extend the existing beach berm. The TSP will provide a protective berm that extends the project shoreline profile (R98 to R115+1000 feet) 20 feet seaward from the existing dune. A hydraulic dredge will be utilized to fill the template with compatible sand from the North and South St. Lucie Shoals.

All portions of the proposed project area, including the offshore borrow area and the sand placement template have been subject to cultural resource surveys (see Attachment). New South Associates conducted a Phase I cultural resources survey of the sand placement area in October 2007 (DHR Manuscript #17559). No cultural resources were identified as a result of the survey; however, the study recommended that the project avoid areas near previously recorded underwater sites and undisturbed areas of back dune where previously recorded sites are located. As a result of this report, the Corps determined that beach nourishment would have no effect on cultural resources listed or eligible for listing in the National Register of Historic Properties (NRHP). The State Historic Preservation Office (SHPO) concurred with the determination in a letter to the Corps dated July 27, 2010 (DHR File No. 2008-02141-B).

A remote sensing survey of the proposed offshore borrow location was conducted by SEARCH between October 2007 and June 2008 (DHR Manuscript #17990). Based on this survey, one cluster of magnetic anomalies was identified in the southern borrow area and two historic shipwreck sites (8SL28 and 8SL30) are located adjacent to the northern borrow area. No diver evaluations were performed on the magnetic targets, and a buffer of 200 feet was recommended to avoid effects on the potentially significant resource. In a letter dated July 31, 2008 the Corps determined that a 500-foot buffer of the anomalies would be utilized during dredging to avoid impacts. This letter also noted that the two previously recorded historic shipwrecks are located outside of the project area and determined that, contingent upon the preservation of the anomaly cluster with a 500-foot buffer zone, no historic properties would be affected by dredging. The SHPO concurred with the determination of effects in letters dated September 4, 2008 and January 20, 2011 (DHR File Nos. 2008-05091 and 2011-00231).

During implementation of the St. Lucie County Coastal Storm Risk Management Feasibility Study TSP, the Corps will continue to protect these cultural resources by maintaining the 500-foot buffer previously utilized during dredging (see Attachment). Contingent upon maintaining the buffer, the Corps has determined that the TSP will have no effect on historic properties listed or eligible for listing in the NRHP. I request your comments on the determination of no effect. If there are any questions, please contact Ms. Meredith Moreno at 904-232-1577 or e-mail at Meredith.a.moreno@usace.army.mil.

Sincerely,



3/25/16
Jason Spinning
Acting Chief, Environmental Branch

Enclosure

17990



FLORIDA DEPARTMENT OF STATE
Kurt S. Browning
 Secretary of State
 DIVISION OF HISTORICAL RESOURCES

Mr. Ivan Acosta
 Department of the Army
 Jacksonville District Corps of Engineers
 P.O. Box 4970
 Jacksonville, Florida 32232-0019

January 20, 2011

Re: DHR Project File No.: 2011-00231 (2008-05091, 2007-4714) / 1A-32 Permit No.: 0708.16
 Received by DHR: January 14, 2011
 Final Report: *Historic Assessment and Submerged Cultural Resources Remote Sensing Survey of Four Borrow Areas for Martin and St. Lucie Counties Shore Protection Projects, Florida*

Dear Mr. Acosta:

Our office received and reviewed the above referenced draft survey report in accordance with Section 106 of the *National Historic Preservation Act of 1966* (Public Law 89-665), as amended in 1992, and 36 *C.F.R., Part 800: Protection of Historic Properties*, and Chapter 267, *Florida Statutes*, for assessment of possible adverse impact to cultural resources (any prehistoric or historic district, site, building, structure, or object) listed, or eligible for listing, in the National Register of Historic Places (NRHP).

Between September 2007 and June 2008, Southeastern Archaeological Research, Inc. (SEARCH) conducted an underwater remote sensing survey of four proposed sand borrow areas associated with shore protection projects. The survey was conducted on behalf of the U.S. Army Corps of Engineers. SEARCH identified twenty-one magnetic anomalies within the surveyed areas during the investigation.

SEARCH determined that a cluster of four magnetic anomalies in Borrow Area C (M3 – M6) may represent a significant cultural resource and should be avoided by dredging. The U.S. Army Corps of Engineers recommends that the cluster be avoided with a 500-foot buffer zone.

SEARCH also located two previously recorded historic shipwrecks (8SL29 and 8SL30) outside of the project area. SEARCH did not locate the previously recorded America Wreck (8SL28) but determined that it does not exist in project area.

The U.S. Army Corps of Engineers determined that, contingent upon the preservation of the anomaly cluster with the 500-foot buffer zone, no historic properties will be affected by the proposed dredging project.

Based on the information provided, our office concurs with the determinations of the U.S. Army Corps of Engineers and finds the submitted report complete and sufficient in accordance with Chapter 1A-46, *Florida Administrative Code*.

500 S. Bronough Street • Tallahassee, FL 32399-0250 • <http://www.flheritage.com>

☐ Director's Office
 (850) 245-6300 • FAX: 245-6436

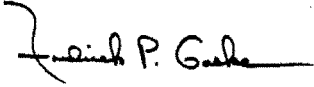
☐ Archaeological Research
 (850) 245-6444 • FAX: 245-6452

☒ Historic Preservation
 (850) 245-6333 • FAX: 245-6437

Mr. Acosta
January 20, 2011
Page 2

For any questions concerning our comments, please contact Rudy Westerman, Historic Preservationist, by electronic mail at rjwesterman@dos.state.fl.us, or by phone at (850) 245-6333. We appreciate your continued interest in protecting Florida's historic properties.

Sincerely,

A handwritten signature in black ink, appearing to read "Frederick P. Gaske". The signature is written in a cursive style with a long horizontal line extending to the right.

Frederick P. Gaske, Director, and
State Historic Preservation Officer

Xc: Louis Tesar, Interoffice Mail Station 8B

17984



FLORIDA DEPARTMENT OF STATE
Kurt S. Browning
 Secretary of State
 DIVISION OF HISTORICAL RESOURCES

Mr. Michael Krivor
 Southeastern Archaeological Research, Inc.
 315 NW 138th Terrace
 Newberry, Florida 32669

January 20, 2011

Re: DHR Project File No.: 2011-00114 / 1A-32 Permit No.: 1011.026
 Received by DHR: January 4, 2011
*Submerged Cultural Resources Remote Sensing Survey of Proposed Offshore Sand
 Source Area 5, St. Lucie County, Florida*

Dear Mr. Krivor:

Our office received and reviewed the above referenced survey report in accordance with Section 106 of the *National Historic Preservation Act of 1966* (Public Law 89-665), as amended in 1992, and 36 C.F.R., *Part 800: Protection of Historic Properties*, and Chapter 267, *Florida Statutes*, for assessment of possible adverse impact to cultural resources (any prehistoric or historic district, site, building, structure, or object) listed, or eligible for listing, in the National Register of Historic Places (NRHP).

In December 2010, Southeastern Archaeological Research, Inc. (SEARCH) conducted an underwater remote sensing survey of the portion of Offshore Sand Source Area 5 that was not previously investigated. The survey was conducted on behalf of Coastal Technology Corporation. SEARCH identified one side-scan sonar target but no magnetic anomalies or subbottom profiler features within the project area during the investigation.

SEARCH determined that the side-scan sonar target appears to represent isolated modern debris and is also outside of the proposed project area.

SEARCH determined that the proposed activities within the portion of Area 5 surveyed in this investigation will have no effect on cultural resources listed, or eligible for listing, on the NRHP. SEARCH recommends no further investigation of the area.

Based on the information provided, our office concurs with these determinations and finds the submitted report complete and sufficient in accordance with Chapter 1A-46, *Florida Administrative Code*.

500 S. Bronough Street • Tallahassee, FL 32399-0250 • <http://www.flheritage.com>

☐ Director's Office
 850.245.6300 • FAX: 245.6436

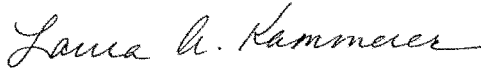
☐ Archaeological Research
 850.245.6444 • FAX: 245.6452

☒ Historic Preservation
 850.245.6333 • FAX: 245.6437

Mr. Krivor
January 20, 2011
Page 2

For any questions concerning our comments, please contact Rudy Westerman, Historic Preservationist, by electronic mail at rjwesterman@dos.state.fl.us, or by phone at 850.245.6333. We appreciate your continued interest in protecting Florida's historic properties.

Sincerely,

A handwritten signature in cursive script that reads "Laura A. Kammerer". The signature is written in dark ink and is positioned above the printed name and title.

Laura A. Kammerer
Deputy State Historic Preservation Officer
For Review and Compliance

Pc: Louis Tesar, Interoffice Mail Station 8B

#17559



FLORIDA DEPARTMENT OF STATE

Dawn K. Roberts

Interim Secretary of State

DIVISION OF HISTORICAL RESOURCES

Mr. Daniel Hughes
 Department of the Army
 Jacksonville District Corps of Engineers
 P.O. Box 4970
 Jacksonville, Florida 32232-0019

July 27, 2010

Re: DHR Project File No.: 2008-02141-B / Received by DHR: April 14, 2008
 Additional Information Received: July 26, 2010
 Final Report: *Cultural Resource Survey St. Lucie County Shoreline Protection Project, St. Lucie County, Florida*

Dear Mr. Hughes:

Our office received and reviewed the above referenced draft survey report in accordance with Section 106 of the *National Historic Preservation Act of 1966* (Public Law 89-665), as amended in 1992, and 36 *C.F.R., Part 800: Protection of Historic Properties*, for assessment of possible adverse impact to cultural resources (any prehistoric or historic district, site, building, structure, or object) listed, or eligible for listing, in the National Register of Historic Places (NRHP).

In October 2007, New South Associates (NSA) conducted an archaeological and historical Phase I survey of the St. Lucie County Shoreline Restoration project area on behalf of the U.S. Army Corps of Engineers. NSA identified no cultural resources within the project area during the investigation.

NSA determined that the proposed beach nourishment project will have no effect on cultural resources listed, or eligible for listing, in the NRHP, or otherwise of historical, archaeological, or architectural value. NSA recommends no further investigation of the subject parcel.

Based on the information provided, our office concurs with these determinations and finds the submitted report complete and sufficient in accordance with Chapter 1A-46, *Florida Administrative Code*.

For any questions concerning our comments, please contact Rudy Westerman, Historic Preservationist, by electronic mail at rjwesterman@dos.state.fl.us, or by phone at 850.245.6333. We appreciate your continued interest in protecting Florida's historic properties.

Sincerely,

Laura A. Kammerer
 Deputy State Historic Preservation Officer
 For Review and Compliance

Pc: Cindy Thomas, New South Associates, Inc. – St. Augustine

500 S. Bronough Street • Tallahassee, FL 32399-0250 • <http://www.flheritage.com>

☐ Director's Office
 850.245.6300 • FAX: 245.6436

☐ Archaeological Research
 850.245.6444 • FAX: 245.6452

☒ Historic Preservation
 850.245.6333 • FAX: 245.6437



FLORIDA DEPARTMENT OF STATE

Kurt S. Browning

Secretary of State

DIVISION OF HISTORICAL RESOURCES

Mr. James J. McAdams
 Acting Chief, Environmental Branch
 Department of the Army
 Jacksonville District Corps of Engineers
 P.O. Box 4970
 Jacksonville, Florida 32232-0019

April 15, 2008

Re: DHR Project File No.: 2008-02141 / Received by DHR: March 14, 2008
 Draft Report: *Cultural Resource Survey St. Lucie County Shoreline Protection Project,
 St. Lucie County, Florida*

Dear Mr. McAdams:

Our office received and reviewed the above referenced draft survey report in accordance with Section 106 of the *National Historic Preservation Act of 1966* (Public Law 89-665), as amended in 1992, and *36 C.F.R., Part 800: Protection of Historic Properties*, for assessment of possible adverse impact to cultural resources (any prehistoric or historic district, site, building, structure, or object) listed, or eligible for listing, in the National Register of Historic Places (NRHP).

In October 2007, New South Associates (NSA) conducted an archaeological and historical Phase I survey of the St. Lucie County Shoreline Restoration project area on behalf of the U.S. Army Corps of Engineers. NSA identified no cultural resources within the project area during the investigation.

NSA determined that the proposed beach nourishment project will have no effect on cultural resources listed, or eligible for listing, in the NRHP, or otherwise of historical, archaeological, or architectural value. NSA recommends no further investigation of the subject parcel.

Based on the information provided, our office concurs with these determinations.

However, we recommend that the final report include the following revision for completeness and sufficiency in accordance with Chapter 1A-46, *Florida Administrative Code*:

- **Curation:** Provide the location where project records will be curated.

500 S. Bronough Street • Tallahassee, FL 32399-0250 • <http://www.flheritage.com>

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 (850) 245-6300 • FAX: 245-6436

☐ Archaeological Research
 (850) 245-6444 • FAX: 245-6452

☐ Historic Preservation
 (850) 245-6333 • FAX: 245-6437

☐ Historical Museums
 (850) 245-6400 • FAX: 245-6433

☐ South Florida Regional Office
 (561) 416-2115 • FAX: 416-2149

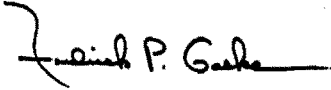
☐ North Florida Regional Office
 (850) 245-6445 • FAX: 245-6435

☐ Central Florida Regional Office
 (813) 272-3843 • FAX: 272-2340

Mr. McAdams
April 15, 2008
Page 2

For any questions concerning our comments, please contact April Westerman, Historic Preservationist, by electronic mail at amwesterman@dos.state.fl.us, or by phone at (850) 245-6333. We appreciate your continued interest in protecting Florida's historic properties.

Sincerely,

A handwritten signature in black ink, appearing to read "Frederick P. Gaske". The signature is written in a cursive style with a long horizontal line extending to the right.

Frederick P. Gaske, Director, and
State Historic Preservation Officer



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
 WASHINGTON, D.C. 20314-1000

REPLY TO
 ATTENTION OF:

OCT 12 2006

South Atlantic Division
 Regional Integration Team

Mr. Doug Coward
 Chairman
 St. Lucie Board of County Commissioners
 2300 Virginia Avenue
 Fort Pierce, Florida 34982-5652

Dear Mr. Coward:

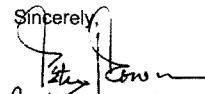
Thank you for your letter of September 7, 2006, regarding the joint efforts of St. Lucie County and the U.S. Army Corps of Engineers (Corps) to restore and protect the beach system of St. Lucie County, Florida. I hope that our meeting on September 28, 2006 at Corps Headquarters was valuable to you.

As you know, the Jacksonville District is in the process of preparing a Feasibility Study to address the critical storm damage prevention needs of the southern 5.0 miles of St. Lucie County. The realistic schedule for completion of the Final Feasibility Report is January 2010 with initial construction after 2012. However, St. Lucie County and the State of Florida have agreed to move forward with emergency renourishment of this area due to the impacts of the 2004 and 2005 hurricane seasons. To insure that this emergency effort will not jeopardize the viability of the Federal project, this emergency renourishment should be clearly identified as a one-time emergency action. The sponsor could also elect to pay 100% of the initial construction (i.e. the emergency renourishment project) and then ask the Federal government to cost share with St. Lucie County in future renourishments of this project.

A survey of the study area shoreline was taken in the summer of 2006; this will define the "without project" condition for the Feasibility study and establish the long-term erosion rate at the pre-hurricane condition. Should the "without project" condition change as a result of the emergency renourishment by St. Lucie County, there are other options that can be explored with the Jacksonville District during and after completion of the Feasibility Report.

The Corps is committed to serving the storm damage reduction and environmental needs of Florida. If you have any further questions, please contact Mr. Michael J. Klosterman, Civil Works Deputy, South Atlantic Division Regional Integration Team, Washington, DC at (202) 761-4106.

Sincerely,


 For Peter J. Rowan, COL, EN
 Steven L. Stockton, P.E.
 Deputy Director of Civil Works



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
 ATTENTION OF:

OCT 12 2006

South Atlantic Division
 Regional Integration Team

Ms. Frannie Hutchinson
 Chair
 St. Lucie County Erosion District
 2300 Virginia Avenue
 Fort Pierce, Florida 34982-5652

Dear Ms. Hutchinson:

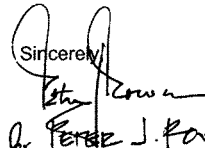
Thank you for your letter of September 7, 2006, regarding the joint efforts of St. Lucie County and the U.S. Army Corps of Engineers to restore and protect the beach system of St. Lucie County, Florida. I hope that our meeting on September 28, 2006 at Corps Headquarters was valuable to you.

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Sincerely,


 Dr. Steven L. Stockton COL, EN
 Steven L. Stockton, P.E.
 Deputy Director of Civil Works

ST. LUCIE COUNTY, FLORIDA

COASTAL STORM RISK MANAGEMENT PROJECT
FINAL INTEGRATED FEASIBILITY STUDY AND ENVIRONMENTAL
ASSESSMENT

APPENDIX I

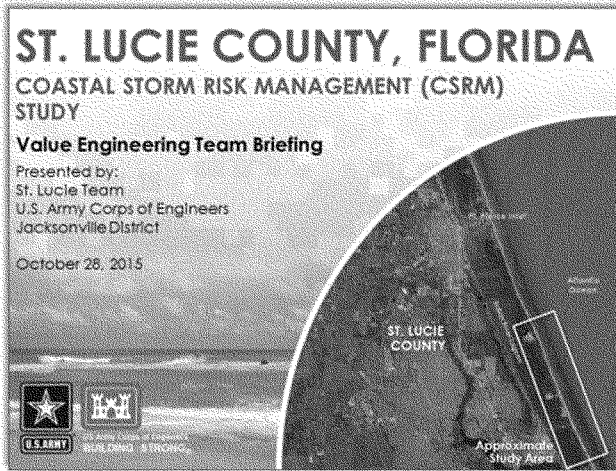
Value Engineering



**US Army Corps
of Engineers**
Jacksonville District



U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT



112339 ST. LUCIE COUNTY, FL
COASTAL STORM RISK MANAGEMENT PROJECT
DECISION DOCUMENT
VALUE ENGINEERING REPORT
31 December 2015

DOD SERVICE: USACE

VALUE ENGINEERING OFFICER: Autumn N. Ziegler, PE, AVS

CONTROL NO: SAJ-VE-2016-002C

REPORT INFORMATION

VALUE ENGINEERING FIRM: U. S. Army Corps of Engineers
Jacksonville District
701 San Marco Blvd
Jacksonville, FL 32207

VALUE ENGINEERING WORKSHOP CONDUCTED: 28-30 October 2015, Subsequent Job Plan Phases conducted during additional team meetings and sub-team work times.

VALUE ENGINEERING STUDY TEAM LEADER: Jimmy Matthews, PE, CVS

VALUE ENGINEERING STUDY TEAM MEMBERS: Team member names and contact information are in Appendix B.

POINTS OF CONTACT: Autumn N. Ziegler, PE, AVS
Value Engineering Officer
Jacksonville District
701 San Marco Blvd
Jacksonville, FL 32207
(904) 232-1956

STUDY RESULTS:

Evidence of Creativity: 27 ideas generated; several ideas combined into single proposals or comments

Number of Recommendations: 13

Number of Recommendations Accepted: 5 adopted or partially adopted for future consideration

Cost Avoidance Potential: \$1,609,450

Cost of VE Study: \$30,000

Return on VE Study Investment: $\text{Cost Avoidance} / \text{Cost of VE Study} = \53 for each \$1 invested

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INTRODUCTION

This Value Engineering (VE) Report documents the completion of the St. Lucie County Coastal Storm Risk Management Study, St. Lucie County, Florida Value Analysis. The current phase of the decision document is between the Alternatives Milestone and the Tentatively Selected Plan (TSP) milestone. The feasibility study is being conducted in accordance with the USACE SMART Planning Process. This VE study scope is for this point in time for the project and is being conducted with the schedule constraint that the authorization timeline is not flexible. The VE Study team was comprised of USACE employees from the Jacksonville District and other USACE attendees on an as-needed basis.

PROJECT DESCRIPTION ON DATE OF VE STUDY

The purpose of the decision document is to study the feasibility of providing hurricane and storm damage reduction within the southern five miles of the St. Lucie County, Florida, coastline. Alternatives considered will include: no-action, non-structural measures (flood proofing, relocation, retreat, land acquisition, etc.), shore protection with hard structures (seawalls, revetments, groins, etc.), shore protection with soft structures (beach nourishment, geotubes, etc.), combinations of the above, and others.

The scope of this study has been severely limited by the presence of a large Coastal Barrier Resource Act (CBRA) unit within the study area from R77 to R103, with three relatively small gaps, or excluded areas, at approximately R80-84, R88.5-90, and R98-101. Of the approximate 7.2 miles of shoreline within the study area, roughly 3.4 miles of shoreline are in the CBRA zone. The three excluded areas have a total length of about 1.5 miles of shoreline. The non-CBRA affected shoreline is the southernmost part of St. Lucie County and stretches 2.3 miles from approximately R103 to the St. Lucie/Martin County line at R115. All together, the CBRA affected land comprises about 42% of the study area.

The four study reaches are, from north to south:

- North Hutchinson Island: R77 to R80 (0.57 miles)
- Power Plant Area: R80 to R90 (1.9 miles)
- Narrows of Hutchinson Island: R90 to R98 (1.5 miles)
- South Hutchinson Island: R98 to R115 (3.4 miles)

R-monuments refer to Florida Department of Environmental Protection (FDEP) survey monuments used for geographic reference. The boundaries of all of the subject reaches and FDEP R-monuments are illustrated in Figure 1.



Figure 1: Study area map with key boundaries and reference points.

VALUE METHODOLOGY

This report documents the VE workshop conducted 28-30 October 2015 and related follow up value analyses. The workshop was conducted using the six-phase Value Engineering Job Plan as sanctioned by USACE and the Society of American Value Engineers International (SAVE). The VE Workshop culminated in the development phase where ideas were captured and refined into recommendations. Appendix E contains the related documentation.

VE Scope of Work for the Job Plan

The job plan was used to scope the VE and to determine the appropriate team members to address desired outcomes or success. The plan was developed with input from project team members and the project manager. The plan addressed the following objectives.

- Develop the scope and objectives for the Value Study (Define the end product and how it will be used. What is success?) The Value Engineering process can assist with the following items during the workshop:
 - Identify any potential new combinations of solutions which would provide incremental benefits, to possibly include the publicly-owned parks.
 - Investigate Beach-fx files in more depth to understand not just the average damages reported by the model, but to better understand extreme high (and low) damages which may better “tell the story” for formulation choices, or refine choices.
 - Work with plan formulation process to use critical thinking when looking at the Final array of alternatives to choose the Tentatively Selected Plan (TSP).
 - Success will be measured by PDT understanding of the issues, critical thinking to ask all needed questions, a thorough look at all choices, and moving forward with a TSP (with potential refinements).
- Identify and prioritize strategic issues of concern.
 - Low damages in upper area of the reach; high damages in lower area of the reach; ensure a solution is developed that is policy compliant and makes sense for the whole reach, if possible.
 - Use extreme storms and damages from Beach-fx model (rather than just the averages which it reports) and use the information to better understand solutions.
- Identify Value Team members (the following is a list if team members from the Job Plan)
 - Stacey Roth – Planning Technical Lead
 - Shelley Trulock – Project Manager
 - Jim Lagrone – Engineering Technical Lead
 - Lori Hadley – Coastal Modeler
 - Chris Graham – Economist

- Colin Rawls – Economist
- Sophia Bryant – Cost Engineer
- Paul DeMarco/Aubree Hershorin – NEPA specialist
- Tamela Kinsey – Permitting/Compliance

Special Attendees (USACE) (to attend for certain time frames):

- Mark Gravens or other Beach-fx model specialist (4 hrs.)
- Jason Engle – Chief, Coastal Engineering Section (4 hrs.)
- Matt Schrader – Coastal Technical Expert (4 hrs.)
- Rep from National Non-structural flood proofing committee

Six-phase Value Engineering Job Plan

Information Phase. At the beginning of the study, the project team presented current planning and design status of the project. This included a general overview and various project requirements. Report details were presented as appropriate. Discussion with the VE Team enhanced the value team's knowledge and understanding of the project.

Function Analysis Phase. For this study, team members used the NASA Functional Analysis Module Space Systems Engineering, version 1.0, to create the report's functional architecture. The architecture was input into a functional block diagram (Task- Oriented FAST Diagram). This approach developed the top-down definition of feasibility report and project functions. A function list and outline were developed by the team and input into the diagram. The function analysis is located in Appendix C.

Creativity Phase. The Creativity Phase involved identifying and listing creative ideas. During this phase, the team participated in a brainstorming session to identify as many means as possible to provide the necessary project functions. Judgment of the ideas was not permitted in order to generate a broad range of ideas. The creative phase continued through the other phases and often can create other ideas.

Evaluation Phase. The purpose of the Evaluation Phase was to systematically assess the potential impacts of ideas generated during the Creativity Phase relative to their potential for value improvement. Each idea was evaluated in terms of its potential impact to cost and overall project performance. Once each idea was fully evaluated, it was given a rating to identify whether it would be carried forward and/or developed as a recommendation, combined with other ideas, presented as a design suggestion, dismissed from further consideration or that it is already being done by Project Delivery Team. Appendix D lists those ideas with their evaluation disposition. The appendix tables also display the evolution of ideas from creation through their embodiment into recommendations.

Development Phase. During the Development Phase, evaluated ideas were expanded and developed into recommendations. The development process considered such things as the impact to performance,

cost, constructability, and schedule of the alternative concepts relative to the baseline concept. This analysis was prepared as appropriate for each recommendation, and the information includes an initial cost and/or life cycle cost comparisons if applicable. Each recommendation or idea describes the baseline concept and proposed changes and includes a technical discussion. The related documentation is located in Appendix E.

Presentation Phase. The VE Workshop concluded with a preliminary presentation of the value team's assessment of the project and value recommendations and ideas. The presentation provided an opportunity for the owner, project team, and stakeholders to preview the recommendations and develop an understanding of the rationale behind them. The presentation was also used to refine recommendation justification to include the corporate perspective.

STUDY RESULTS AND RECOMMENDATIONS

During the course of the VE study, the value team developed recommendations that warrant more detailed investigation. Appendix E contains the related documentation.

This VE study will be supplied to the PDT at the start of each of the subsequent project phases. The PDT will incorporate the results of this VE Study and determine if additional VE recommendations appropriate. Related cost avoidance will be developed for awarded contract(s) and reported into the Value Engineering Reporting System (VERS). Should ideas/comments result in additional quantifiable cost avoidance, those ideas/comments will be documented as recommendations and appended to this report.

The following recommendations have been evaluated by the PDT and the action noted as adopted, not adopted or partially adopted. Also noted is whether the recommendation will be addressed in the report, the Preconstruction, Engineering and Design Phase (PED) or both.

	RECOMMENDATIONS	PROPOSED SAVINGS	ADOPTED OR NOT ADOPTED	PROJECT PHASE
1	Strategically Place Breakwaters/Groins to Reduce Nourishment Cycle	N/A	Not Adopted	N/A
2	Create Multi-Purpose Breakwater/Nearshore Habitat	N/A	Not Adopted	N/A
3	Apply Erosion Measures Uniformly Across the Project Study Area	N/A	Adopted	Feasibility
4	Use Sheetpile Wall Along High Damage Areas Along Dune Profile	N/A	Not Adopted	N/A
5	Options to Reinforce Dunes	N/A	Not Adopted	N/A
6	Strategic Buyout	N/A	Not Adopted	N/A
7	Apply Adaptive Management for Intermediate and High Sea Level Rise (SLR) Scenarios	N/A	Adopted	Feasibility and PED
8	Contracting Strategies to Reduce Construction Cost for Dredging	\$1,609,450	Adopted	PED
9	Reconsider Beach-Fx Results/Reliability Analysis to Determine If a More Resilient and Cost Effective Plan Can Be Developed Based on More Extreme Event Percentiles	N/A	Not Adopted	N/A
10	Specialized Truck Haul for Narrow Beach and Dune Gaps	N/A	Not Adopted	N/A
11	Withdrawn	N/A	N/A	N/A
12	Coordinate with National Floodproofing Committee	N/A	Adopted	PED
13	Account for National Environmental Restoration Benefits related to Sea Turtle Nesting	N/A	Adopted	Feasibility
14	Coordinate with ERDC Programmatically for Modeling of Artificial Reefs, Groins, etc.	N/A	Not Adopted	N/A

APPENDIX A: WORKSHOP AGENDA

VALUE ENGINEERING WORKSHOP AGENDA HURRICANE AND STORM RISK REDUCTION ST. LUCIE COUNTY, FL 28 & 29 OCT 2015

Meeting Location:

28 Oct – EN Conference Room, 381, 4E

29 Oct – PD Conference Room, 539, 5W

Call-in and Web Meeting Number:

USA Toll-Free: (877)873-8017

Access Code: 4591724

Security Code: 1234

Web Meeting Address:

<https://www.webmeeting.att.com>

* The first time you use the Web Meeting Service, you will need to download the client software. Web Meeting HELP & Software Downloads can be found at: <https://www.webmeeting.att.com>*

28OCT15:

0925-0930	Attendees Call In and Establish Web Meeting Connections
0930-0935	Introductions and Web Meeting Rules
0935-1000	Workshop Purpose and VE Scope and Activities – Jimmy Matthews
1000-1100	Report and Project Overview – PDT
	Break as needed
1100-1200	Function Analysis – Autumn Ziegler & Jimmy Matthews
1200-1245	Lunch
1245-1345	Creativity Phase – VE Team, Autumn Ziegler
1345-1500	Evaluation Phase and Day 1 Wrap-up – VE Team

29OCT15:

0900-0930	Complete Evaluation Phase – Autumn Ziegler
0930-1130	Development Phase (Assignments & Work Session) – VE Team
1130-1215	Lunch
1215-1400	Complete Development Phase – Autumn Ziegler
1400-1500	Workshop Wrap Up and Completion Schedule - J Matthews & Autumn Ziegler
TBS	Complete the Presentation Phase & VE Report – VE Team
	Break as needed

APPENDIX B: WORKSHOP PARTICIPANT ROSTER

Value Engineering Workshop - St. Lucie County, FL, HSRP 28-29 October 2015				Attendance	
Name	Office	Phone	E-mail (@usace.army.mil)	28-Oct-15	29-Oct-15
Jimmy Matthews	CECO-C-RAO	(904)232-2087	Jimmy.D.Matthews@usace.army.mil	X	X
Autumn Ziegler	CESAJ-EN-Q	(904)232-1956	Autumn.N.Ziegler@usace.army.mil	X	X
Sheldon Shuff	CESAJ-OC	(904)232-1635	Sheldon.G.Shuff@usace.army.mil	X	
Shelley Trulock	CESAJ-PM-WN	(904)232-3292	Shelley.F.Trulock@usace.army.mil	X	
Paul Stodola	CESAJ-PD-EC	(904)232-3271	Paul.E.Stodola@usace.army.mil	X	
Paul DeMarco	CESAJ-PD-EC	(904)232-1897	Paul.M.DeMarco@usace.army.mil	X	
Kelly Legault	CESAJ-EN-WC	(904)232-1861	Kelly.R.Legault@usace.army.mil	X	
Gina Ralph	CESAJ-PD-PN	(904)232-2336	Gina.P.Ralph@usace.army.mil	X	X
Meredith Moreno	CESAJ-PD-ES	(904)232-1577	Meredith.A.Moreno@usace.army.mil	X	
James LaGrone	CESAJ-EN-DW	(904)232-2437	James.W.LaGrone@usace.army.mil	X	
Sophia Bryant	CESAJ-EN-TC	(904)232-2919	Sophia.L.Bryant@usace.army.mil	X	X
Stacey Roth	CESAJ-PD-PN	(904)232-1055	Stacey.L.Roth@usace.army.mil	X	X
Troy Mayhew	CESAJ-EN-GG	(904)232-1140	Troy.A.Mayhew@usace.army.mil	X	X
Colin Rawls	CESAJ-PD-D	(904)232-1652	Colin.D.Rawls@usace.army.mil	X	X
Lori Hadley	CESAJ-EN-WC	(904)232-1386	Lori.L.Hadley@usace.army.mil		X

APPENDIX C: FUNCTION ANALYSIS

FUNCTION LIST**Plan Project**

Address Issues

Protect Environment

Understand Issues

Coordinate with Sponsor

Determine Damages

Gather Data

Maintain Consistency

Evaluate Risk

Address Resiliency

Address Sea Level Rise

Provide Protection

Authorize Project

Document Rationale

Ensure Environmental Compliance

Provide Protection

Address Low Nourishment Rate

Engineer and Design Project (PED)

Manage expectations

Obtain Permit

Minimize Impacts

Communicate with PDT

Ensure Compatibility

Address Permit Compliance

Avoid Scope Creep

Avoid Rocks

Maximize Fill Density

Construct Project

Monitor Contractor

Meet Design Intent (ECI)

Respond to Construction

Address Weather

Monitor Environmental Impacts

Communicate with Resource Agencies

Perform OMRR&R

Monitor Beach

Document Lessons Learned

Address outyear monitoring

Implement adaptive management options

Implement after action plan

Update DDR

Capture Lessons Learned

Control Cost Growth

Coordinate cycle with Martin County

Address RSM

Address Acquisition Strategy

Minimize modifications

Encourage Innovation

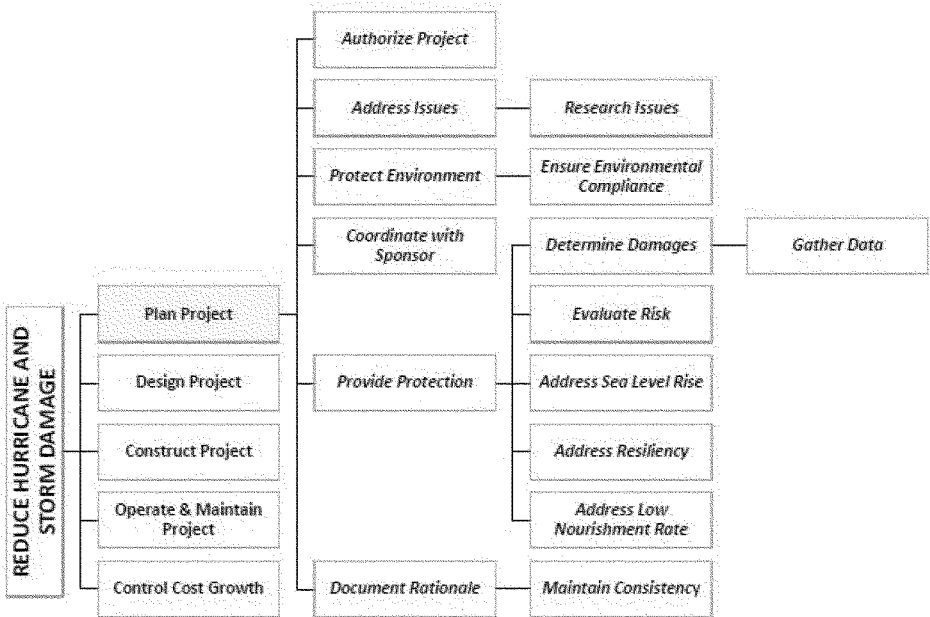
Promote Competition

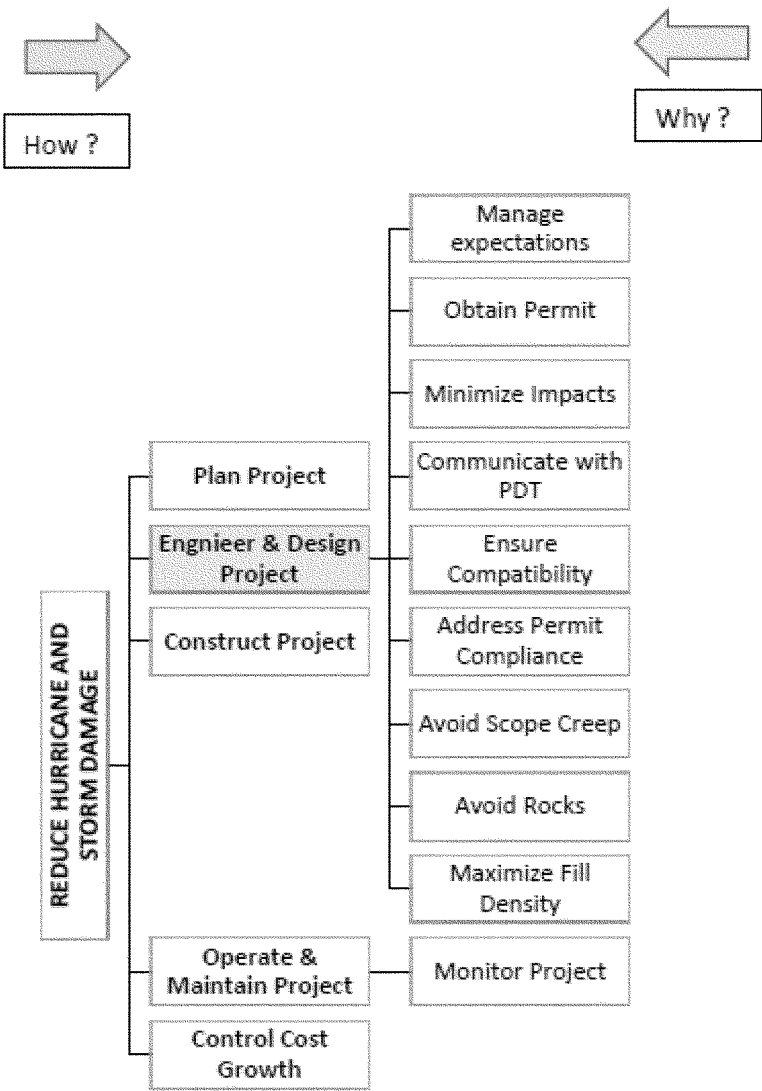
FAST DIAGRAMS

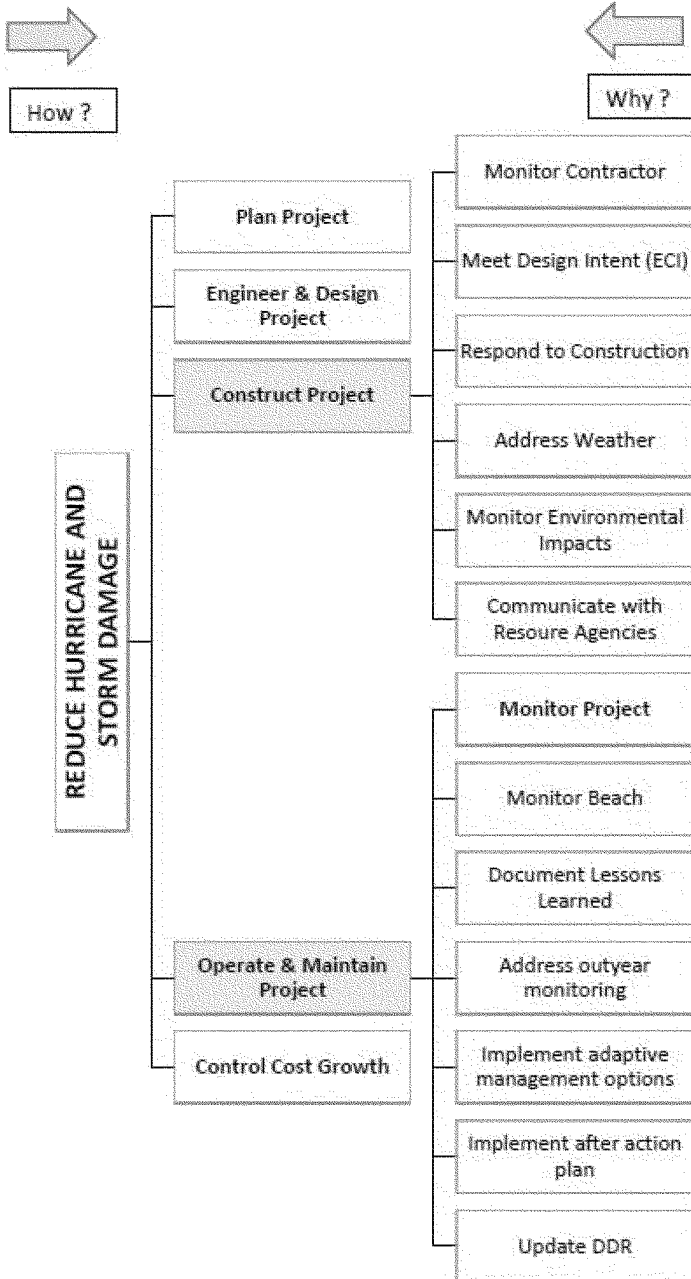
How ?

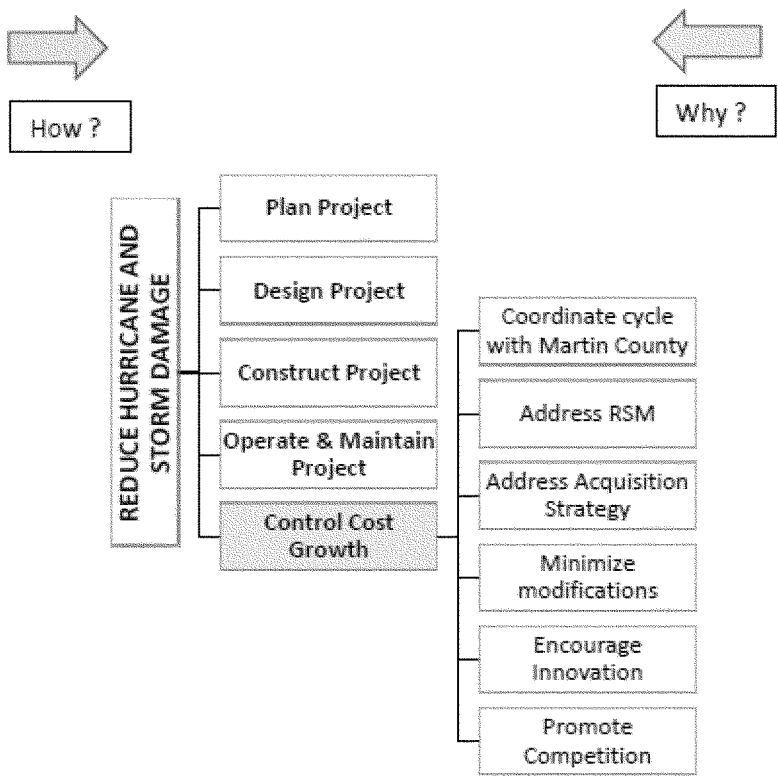


Why ?









APPENDIX D: CREATIVITY AND EVALUATION

St. Lucie Co. VE - Created Ideas			
Idea	Idea Group	Action	Created Ideas
1			Develop NER plan for sea turtle nesting area
2			Use breakwaters along certain reaches to reduce the renourishment cycle
3			Create nearshore low profile habitat/mitigation
4			Use low profile groins
5			Use oblique groins
6			Enhance worm rock
7			Apply erosion measures uniformly across project
8			Use buried geotubes along the fronting dune line
9			Use sheetpile wall along high damage areas along dune profile
10			Build vegetated dune at the natural grade levels
11			Use sand fencing as sand sink/dune stacking
12			Combination of small geotubes and dune stacking
13			Buyout bottom floors of Turtle Reef Club (R-113)
14			Apply adaptive management for intermediate and high SLR
15			Avoid borrow areas with rock
16			Combine mob with Martin Co SPP
17			Combine mob with Ft Pierce SPP
18			Look at Beach-fx results/reliability analysis
19			Maximize the dredging window (Environmental and Operational)
20			Develop a defined acquisition strategy
21			Truck Haul
22			Specialized Truck Haul for narrow beach
23			Use St. Lucie dredged material in 1st nourishment
24			Coordinate with National Floodproofing Committee
25			Strategic Buyout

St. Lucie Co. VE - Evaluated and Grouped Ideas			
Idea	Idea Group	Action	Already Being Done or Eliminate, Idea Group = 0.00; Keep Idea, Idea Group = Number; Combine into another idea, Idea Group = N.ii
1	0.00		Develop NER plan for sea turtle nesting area
15	0.00		Avoid borrow areas with rock
8	0.00		Use buried geotubes along the fronting dune line
21	0.00		Truck Haul
2	2.00		Use breakwaters along certain reaches to reduce the renourishment cycle
4	2.04		Use low profile groins
5	2.05		Use oblique groins
3	3.00		Create nearshore low profile habitat/mitigation
6	3.06		Enhance worm rock
7	7.00		Apply erosion measures uniformly across project
9	9.00		Use sheetpile wall along high damage areas along dune profile
10	10.00		Build vegetated dune at the natural grade levels
11	10.11		Use sand fencing as sand sink/dune stacking
12	10.12		Combination of small buried geotubes and dune stacking
13	13.00		Buyout bottom floors of Turtle Reef Club (R-113)
25	13.25		Strategic Buyout
14	14.00		Apply adaptive management for intermediate and high SLR
16	16.00		Combine mob with Martin Co SPP
17	16.17		Combine mob with Ft Pierce SPP
19	16.19		Maximize the dredging window (Environmental and Operational)
20	16.20		Develop a defined acquisition strategy
18	18.00		Look at Beach-fx results/reliability analysis
22	21.22		Specialized Truck Haul for narrow beach and dune gaps
23	23.00		Use St. Lucie Inlet dredged material in 1st nourishment
24	24.00		Coordinate with National Floodproofing Committee
26	26.00		Account for NER benefits
27	27.00		Coordinate with ERDC on broad measure (e.g. artificial reefs, groins)

St. Lucie Co. VE - Recommendations				
Idea	Idea Group	Recom. No.	Created Ideas	POC
2	2.00	R1	Use breakwaters along certain reaches to reduce the renourishment cycle	Jim/Kelly
4	2.04		Use low profile groins	
5	2.05		Use oblique groins	
3	3.00	R2	Create nearshore low profile habitat/mitigation	Jim/Paul
6	3.06		Enhance worm rock	
7	7.00	R3	Apply erosion measures uniformly across project	Kelly/Lori
9	9.00	R4	Use sheetpile wall along high damage areas along dune profile	Jim
10	10.00	R5	Build vegetated dune at the natural grade levels	Jim/Kelly
11	10.11		Use sand fencing as sand sink/dune stacking	
12	10.12		Combination of small buried geotubes and dune stacking	
13	13.00	R6	Buyout bottom floors of Turtle Reef Club (R-113)	Stacey
25	13.25		Strategic Buyout	
14	14.00	R7	Apply adaptive management for intermediate and high SLR	Paul/Gina
16	16.00	R8	Combine mob with Martin Co SPP	Stacey/CT
17	16.17		Combine mob with Ft Pierce SPP	
19	16.19		Maximize the dredging window (Environmental and Operational)	
20	16.20		Develop a defined acquisition strategy	
18	18.00	R9	Look at Beach-fx results/reliability analysis	Colin/Lori
22	21.22	R10	Specialized Truck Haul for narrow beach and dune gaps	Lori
23	23.00	R11	Use St. Lucie Inlet dredged material in 1st nourishment	Stacey/Troy
24	24.00	R12	Coordinate with National Floodproofing Committee	Stacey/Shelley
26	26.00	R13	Account for NER benefits	Paul
27	27.00	R14	Coordinate with ERDC on broad measures (e.g. artificial reefs, groins)	Stacey

APPENDIX E: RECOMMENDATIONS DOCUMENTATION

RECOMMENDATION NO. 1 (2.0, 2.04, 2.05): Strategically Placed Breakwaters/Groins to Reduce Nourishment Cycle

PROPOSED DESIGN: This idea is to focus on the sub-reaches within the South Hutchinson Island reach which have the most damages (R111-R115, as shown in Figure E-1), in areas and place breakwaters, low-profile groins, or oblique groins to reduce wave energy and also trap sand.

- a. Breakwaters – an offshore structure parallel to the shore
- b. Low-profile groins - perpendicular to the shore
- c. Oblique groins - at an angle to the shore

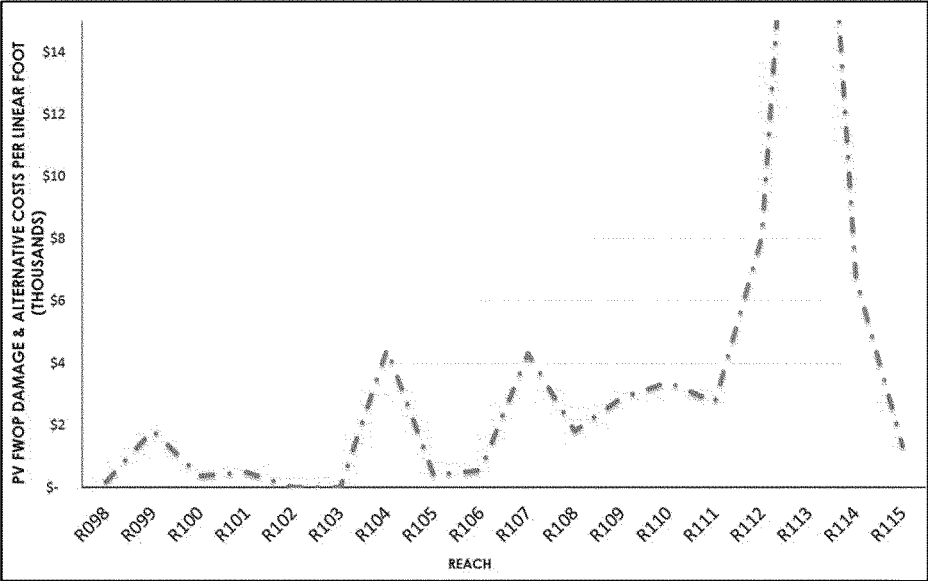


Figure E-1: FWOP damages compared to Reach

ADVANTAGES:

- a. Breakwaters:
 - 1. Would break wave energy in specific areas and may or may not trap sand in specifically desired areas. This could extend the nourishment cycle.
- b. Low-profile groins (perpendicular to shore)
 - 1. Would trap some sand in currently erosional areas. The low-profile nature would allow some sand to be trapped, but still allow transport to down-drift areas. This could extend the nourishment cycle.
- c. Low-profile oblique groins (at an angle to the shore)
 - 1. The slanted nature of these groins would break wave energy and also trap sand. This could extend the nourishment cycle.

DISADVANTAGES:

- a. Breakwaters:
 - 1. A breakwater could be unfavorable to the community, which currently does not have any structures along the beach.
 - 2. The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.
- b. Low-profile groins (perpendicular to shore)
 - 1. Groins could be unfavorable to the community, which currently does not have any structures along the beach, as well as potentially negative impacts to sea turtle habitat.
 - 2. The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.
- c. Low-profile oblique groins (at an angle to the shore)
 - 1. Groins could be unfavorable to the community, which currently does not have any structures along the beach, as well as potentially negative impacts to sea turtle habitat.
 - 2. The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.

ACTIVITIES TO IMPLEMENT:

Discuss more as a team to better understand dynamic physical processes.

DETERMINATION:

This recommendation was not adopted by the PDT. The nourishment cycle could potentially be extended by the ability of these structures to trap sand in strategic areas. However, these structures have disadvantages which could be non-implementable.

RECOMMENDATION NO. 2 (3.00, 3.06): Create Multi-Purpose Breakwater/Nearshore Habitat

PROPOSED RECOMMENDATION: This idea would be to build a structure which could break wave energy (Figure E-2) and provide a hard substrate (hard ground) which would tie into the existing hard ground (worm rock, Figure E-3), for the added benefit of environmental habitat. The structure could be a series of concrete balls, etc and would likely be from R111-R115+1000 feet.



Figure E-2: Proposed Breakwater/Habitat Tie-in to Existing Hardground



Figure E-3: Existing Wormrock in St. Lucie Project Area

ADVANTAGES:

- The breakwater would break wave energy in certain locations, reducing potential for damages caused by wave attack.
- The hard substrate would “extend” existing habitat.

DISADVANTAGES:

- A breakwater could be unfavorable to the community, which currently does not have any structures along the beach.
- The erosion rate in this area is fairly uniform, and applying structures in a specific area could negatively alter the natural forces and erosion rates in adjacent areas.
- This idea could be potentially costly which might not be able to be supported by the benefits (similar to artificial reef idea which was screened out due to high cost during preliminary planning screening).

ACTIVITIES TO IMPLEMENT:

Discuss more as a team to better understand dynamic physical processes.

DETERMINATION:

This recommendation was not adopted by the PDT. It was determined to be too expensive and could lead to additional mitigation requirements.

RECOMMENDATION NO. 3 (7.0): Apply Erosion Measures Uniformly Across the Project Study Area

PROPOSED RECOMMENDATION: This idea is to apply erosion alternatives uniformly across the study area, due to the fact that erosion rates are fairly uniform. Accordingly to Figure E-4, erosion rates only vary by -1.8 to +0.6 feet per year in the entire study reach (R77 to R115 + 1000 feet), which is considered a small fluctuation. While there are areas of erosion and accretion there are no “hot spots” of high erosion that would need to be addressed with a specialized measure over a limited scale. Although the project has been de-scoped at this point to R98 to R115+1000 (the area shown in the green box), it is important to understand the reach as an entire system. Altering the natural forces in one area without a significant need could negatively impact adjacent shorelines.

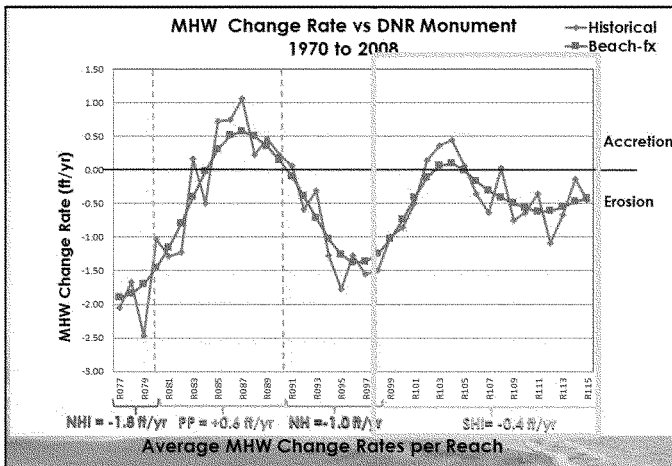


Figure E-4: MHW Change Rate vs. DNR Monument 1970 to 2008

ADVANTAGES:

This idea will ensure that structural measures function across the system, rather than just for a small area which could negatively impact other adjacent areas.

DISADVANTAGES:

There are no known disadvantages to this idea.

ACTIVITIES TO IMPLEMENT:

Discuss more as a team to better understand dynamic physical processes.

DETERMINATION:

This idea is important to convey in the Feasibility Report/Appendices and make the team aware of during continued plan formulation. Therefore, this recommendation was adopted by the PDT and will be presented in the Feasibility Report/Appendices.

RECOMMENDATION NO. 4 (9.0): Use Sheetpile Wall Along High Damage Areas Along Dune Profile**PROPOSED RECOMMENDATION:**

This idea is to install a sheetpile wall as extra stabilization/protection along the toe of the dune along high damage areas, which correlates approximately to R111 to R115+1000 feet.

ADVANTAGES:

This idea could potentially ensure that the dune is not washed out during high energy storm events, and provides protection to the existing condominium and associated structures behind it.

DISADVANTAGES:

This idea would incorporate an additional cost to a dune feature, depending on how long and deep the sheetpile needs to be. This could be difficult to permit in light of recreation and turtle nesting habitat; however, if the sheetpile is buried sufficiently, it might not be a problem.

ACTIVITIES TO IMPLEMENT:

This idea could be modeled, if current modeling of dunes (underway) shows that some damages are still occurring in a particular area.

DETERMINATION:

This recommendation was not adopted by the PDT. St. Lucie County does not allow armoring.

RECOMMENDATION NO. 5 (10.0, 10.11, 10.12): Options to Reinforce Dunes**PROPOSED DESIGN:**

This idea is to consider options that relate to reinforcing dune features. See Figure E-5.

- a. Use sand fencing technique as a sand sink/dune stacking (fore dune/rear dune)
- b. Combination of small buried geotubes and dune stacking

ADVANTAGES:

- a. This would be a relatively easy and inexpensive way to incorporate an additional ability for the dune to “trap sand” while providing protection.
- b. Geotubes would be relatively inexpensive to provide extra stability to dunes, and the dune stacking would be a relatively easy and inexpensive way to incorporate an additional ability for the dune to “trap sand” while providing protection.

DISADVANTAGES:

- a. Construction may need to be more specific and technical in order to create the rear and fore dune.
- b. Geotubes are generally used less for long term projects and used more for temporary projects, as they tend to degrade in the short term and are also more prone to being tampered with. Construction may need to be more specific and technical in order to create the rear and fore dune.

ACTIVITIES TO IMPLEMENT:

The idea of dune stacking, with or without geotubes, could be potentially modeled, if current modeling of dunes (underway) shows that some damages are still occurring in a particular area.

DETERMINATION:

This recommendation was not adopted by the PDT due to the disadvantages cited.

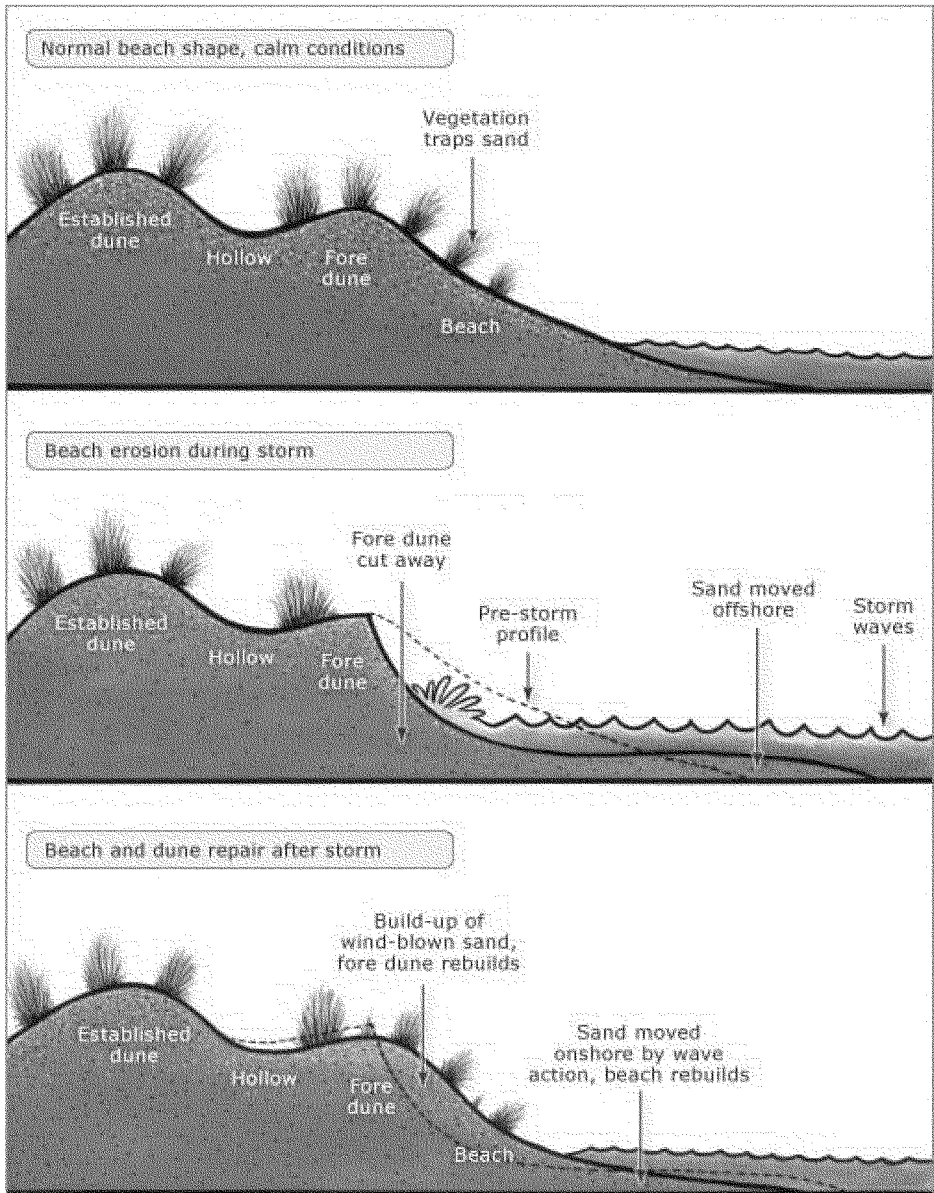


Figure E-5: "Dune Stacking" - Rear and Fore Dune Concept

RECOMMENDATION NO. 6 (13.00, 13.25): *Strategic Buyout***ORIGINAL DESIGN:**

The study area contains condominiums, rather than individual residential homes. Therefore, the buyout option will likely be even more expensive than a typical buyout approach. This idea was screened from the initial project measures.

PROPOSED DESIGN:

A strategic buyout idea would focus on the area “hot spots”, where damages would be most likely. In this case, two condominiums (Turtle Reef Club and Vistana’s Beach Club) are slab on grade construction, and are therefore more vulnerable to flood inundation damage than other condominiums on pile foundations (as currently shown in the future without-project damages in the Beach-fx model). Therefore, a buyout for all or some portion of these condominiums could potentially reduce the risk of flooding to the residents.

- a. One idea could be to buy out one or both condominiums.
- b. Another idea would be to buy out just the first few floors of each condominium, which would then have to be gutted and re-habilitated into empty space with piles, so that any flooding that occurred would not impact residents, residential space, or the structural integrity of the building.

ADVANTAGES:

- a. A buyout of these full condominiums could potentially reduce some of all of the flood damages with a non-structural measure.
- b. A buyout of the first few floors would allow most residents to continue to live in their homes, and could potentially reduce some of all of the flood damages with a non-structural measure.

DISADVANTAGES:

- a. This option is potentially very costly. A cursory buyout analysis performed by SAJ Real Estate showed an estimate of \$18,358,800 for buyout and demolition of Vistana’s Beach Club Resort and \$8,595,000 for buyout and demolition of Turtle Reef Club Resort. This option also has potential to be very unpopular with the owners and residents.
- b. This partial buyout has potential constructability concerns, if the bottom floors would need to be re-habilitated and the foundation replaced with piles. It also has legal implications that would need to be addressed (such as which entity owns the empty space and foundation and who is responsible for maintenance).

ACTIVITIES TO IMPLEMENT:

- a. The real estate estimate for buyout (full condominiums) will be reviewed by the team, and can be compared to the future with-project costs once the Beach-fx model is run with the alternatives. If the buyout option continues to look potentially justified and a contender with the other alternatives, it may be run in the Beach-fx model to assess reduction in damages.

NOTES AND CALCULATIONS:

Estimated cost for buyout of Turtle Reef Club Resort and Vistana's Beach Club Resort = \$26,953,800

**Excerpt from St. Lucie County Beach Restoration, Estimated Buy-out and Relocation Cost of Selected Damage Elements (November 2015).*

Vistana's Beach Club Resort

This facility is part of the Starwood worldwide corporate family of hotels and resorts. The professionally managed resort benefits from the Starwood reservation system. The facility is also required to maintain a higher level of maintenance and quality that is associated with the Starwood brand. Accordingly, this hotel benefits from better occupancy rates and a higher Average Daily Rate (ADR) than independently operated competitors experience. Accordingly, the valuation model associated with this facility is as follows:

Room Nights sold	21,637
ADR	\$155
Estimated room revenue	\$3,353,735
Other income @3.5%	\$ 120,000
Total revenue	\$3,473,735
Operating expenses @70%	\$2,431,614
Net operating income @30%	\$1,042,121
Capitalized at 6% OAR	\$17,368,683
Rounded	\$17,500,000

The indicated capitalized value of \$17,500,000 is equivalent to approximately \$230,000 per unit or \$209 per sq. ft. assuming all units contain 1,100 square feet of living area. This is supported by a pending sale of a unit at The Princess condominium located at 9650 S. Ocean Drive that is under contract for a reported \$267,500 for the 1,346 sq. ft. unit or \$198 psf. A unit at Sand Dollar Shores condominium located at 7400 S. Ocean Drive is currently for sale by owner at a price of \$249,999 for the 1,115 sf. Dwelling or \$224 psf.

Legal fees associated with the Buy-Out of this property are estimated at \$2,500 per unit or \$190,000. Relocation costs do not apply, as there are no permanent residents in the facility. Demolition costs are estimated at approximately \$8.00 per sq. ft or \$668,800.

Based on the forgoing analysis, the total estimated Buy-Out and Relocation cost associated with the Vistana's Beach Club Resort is approximately **\$18,358,800.**

Turtle Reef Club Resort

This facility is not flagged with any national franchise and is managed and operated by an independent company, Defender Resorts, Inc. headquartered in Myrtle Beach, South Carolina. Defender Resorts, per their web page, manages a number of resorts in Florida, the Carolinas, Maryland, Massachusetts, Delaware and the Caribbean. The facility does not benefit from a central reservation system. Rooms are booked directly on the Turtle Reef Club website or with various web based platforms such as Orbitz, Expedia, etc. While professionally managed, the facility is not held to as high a standard such as the Vistana's property next door. cursory research on the internet indicates many customer reviews panning the property as old, outdated and in need of significant repair of deferred maintenance. Accordingly, this hotel does not benefit from improved occupancy rates and a higher Average Daily Rate (ADR) associated with nationally flagged competitors. Accordingly, the valuation model associated with this facility is as follows:

Room Nights sold	12,811
ADR	\$135
Estimated room revenue	\$1,729,485
Other income @3.5%	\$ 60,500
Total revenue	\$1,789,985
Operating expenses @70%	\$1,252,989
Net operating income @30%	\$ 536,996
Capitalized at 7.0% OAR	\$7,671,371
Rounded	\$7,700,000

The indicated capitalized value of \$7,700,000 is equivalent to approximately \$142,592 per unit. This is supported by unit #106 that sold in January 2015 in the Oceana South condominium located at 10600 S. Ocean Drive for \$155,000.

Legal fees associated with the Buy-Out of this property are estimated at \$2,500 per unit or \$135,000. Relocation costs do not apply, as there are no permanent residents in the facility. Demolition costs are estimated at approximately \$8.00 per sq. ft. or \$760,000.

Based on the forgoing analysis, the total estimated Buy-Out and Relocation cost associated with the Turtle Reef Club Resort is: **\$8,595,000**

- a. Turtle Reef Club ~ 6 floors high. Estimate buyout of bottom 2 floors. Using \$8,595,000 and pro-rating it for just two floors = \$2,865,000. This is a very rough number and does not account for any rehabilitation that would need to occur to those 2 floors, or the building(s) for structural stability.

Vistana's Beach Club ~ 9 floors high. Estimate buyout of bottom 2 floors. Using \$18,358,800 and pro-rating it for just two floors = \$4,079,733. This is a very rough number and does not account for any rehabilitation that would need to occur to those 2 floors, or the building(s) for structural stability.

DETERMINATION:

This recommendation was not adopted by the PDT due to the disadvantages cited.

RECOMMENDATION NO. 7(14.00): Apply Adaptive Management for Intermediate and High Sea Level Rise (SLR) Scenarios

PROPOSED RECOMMENDATION:

Implement an Adaptive Management and Monitoring Plan to address coastal resiliency in light of projected sea level rise scenarios. The Adaptive Management Plan provides strategies to address sea level rise uncertainties that will be faced throughout the project's 50-year life cycle. Each strategy follows a scientific approach that uses performance measures, monitoring, triggers and/or thresholds to inform project resiliency and support decisions regarding the need to adjust management measures to improve performance.

Background and Definitions.

Adaptive Management – A scientific process for continually improving management policies and practices by learning from their outcomes; Adaptive Management links science to decision making to improve restoration performance, efficiency, and probability of success.

Uncertainty – A question faced during planning or implementation regarding the best actions to achieve desired goals and objectives within constraints, which cannot be fully answered with available data or modeling.

Management Options – Potential structural, non-structural, and operational alternatives to be undertaken to improve design performance. In the planning process, management actions are grouped into alternative plans. Adaptive management plans contain potential management actions "options" that may be taken to improve performance if project/program goals and objectives are not met.

Strategies – A plan to address one or more uncertainties identified in the adaptive management Plan. The adaptive management strategies fit into the following approaches:

Active Adaptive Management (See Figure E-7) – Multiple pilot projects or design tests are implemented to test designs or operational criteria to achieve desired goals and objectives. Each design or operational action is monitored, assessed, and results are used to inform implementation of the best design for project component or operations. Pilot projects or design tests are usually conducted before implementing the full project component that they are intended to inform.

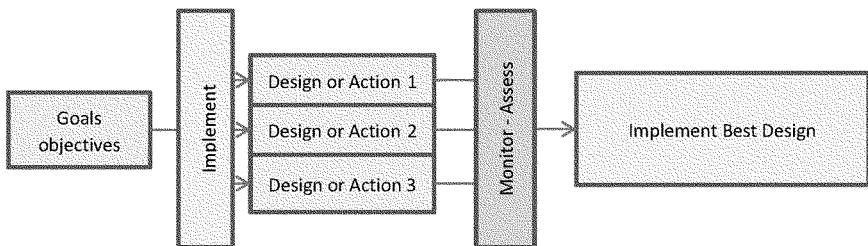


Figure E-7: Active Adaptive Management

Project goals and objectives are evaluated to determine multiple designs or management actions to test by implementing them with associated monitoring, assessing results, and determining the best design of a particular project component to move forward.

Passive Adaptive Management (See Figure E-8) – Most of the proposed St. Lucie County Adaptive Management Plan strategies are considered passive adaptive management approaches. One project component or set of operational criteria is implemented to test its ability to achieve desired goals and objectives. Results are monitored, assessed and communicated to implementing agencies and the appropriate participating agencies to determine how best to adjust project component designs, operations, contingency options, or inform future projects.

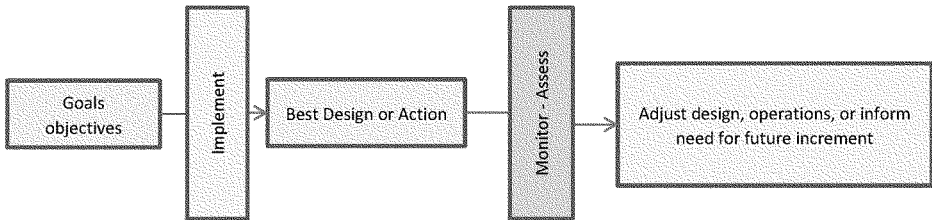


Figure E-8: Passive Adaptive Management

Diagram illustrates that the best design or management action is implemented to achieve project goals and objectives with associated monitoring and results are assessed to adjust other project component designs, adjust operations, and inform the need for a future increment.

ADVANTAGES:

Through inclusion of adaptive management options within the Feasibility Study design it negates the need for future Limited Reevaluation Reports or General Reevaluation Report as uncertainties will be addressed within the Adaptive Management Plan with associated monitoring, options to address the uncertainties and associated costs.

It would comply with guidance to incorporate AM into Project Life Cycles.

It could reduce the need for future Post Authorization Reports and related schedule impacts.

DISADVANTAGES:

There could be report schedule impacts.

ACTIVITIES TO IMPLEMENT:

Related activities will need to be scheduled and funded.

DETERMINATION:

This recommendation was adopted by the PDT and will be presented in the Feasibility Report and further developed during PED phase.

RECOMMENDATION NO. 8 (16.00, 16.17, 16.19, 16.20): Contracting Strategies to Reduce Construction Cost for Dredging

ORIGINAL DESIGN:

The St. Lucie Coastal Storm Risk Management project is nearby two other Federal projects: Ft. Pierce Shore Protection project to the north and Martin County Shore Protection project to the south (See Figure E-9).

PROPOSED DESIGN:

The idea is that these existing Federal projects have existing re-nourishment schedules and that the potential St. Lucie project could share a mobilization and demobilization (mob/demob) cost with either of these projects, assuming the St. Lucie tentatively selected plan includes nourishment. The Fort Pierce project has a 2-year renourishment cycle; the Martin County Shore Protection Project has a 7-year nourishment cycle.

ADVANTAGES:

Mob/demob costs for these types of projects is generally around \$3.2 million. This costs accounts for generally equipment setup and shutdown, but also takes into account where a dredge is traveling from. Therefore, if a dredge is already in a location near to the project to which it is traveling, the mob/demob cost could be smaller. Therefore, planning timing of dredging could be beneficial to both the St. Lucie project sharing the mob/demob cost with another Federal project (cutting the mob/demob potentially in half to \$1.6 million). Additionally, having the dredge at a nearby location prior to the St. Lucie project construction could also potentially decrease mob/demob costs.

DISADVANTAGES:

Timing of the nourishment cycle between projects can be difficult, and the timing of funding streams add complexity.

ACTIVITIES TO IMPLEMENT:

This idea could be investigated further during the PED, when all information about the recommended plan is known and when timing of the initial nourishment could be better estimated in comparison to the Ft. Pierce and Martin County Shore Protection projects and a contract acquisition strategy could be developed with Contracting. Maximizing the dredging window could also be investigated during this time to see if doing so is 1) permitted and 2) allows more efficiency's to be shared among the Federal projects.

DETERMINATION:

If the difficulties of funding stream and project nourishment timing could be overcome, this proposal could potentially reduce the project construction cost. Therefore, this recommendation was adopted by the PDT and will be further developed during PED phase.

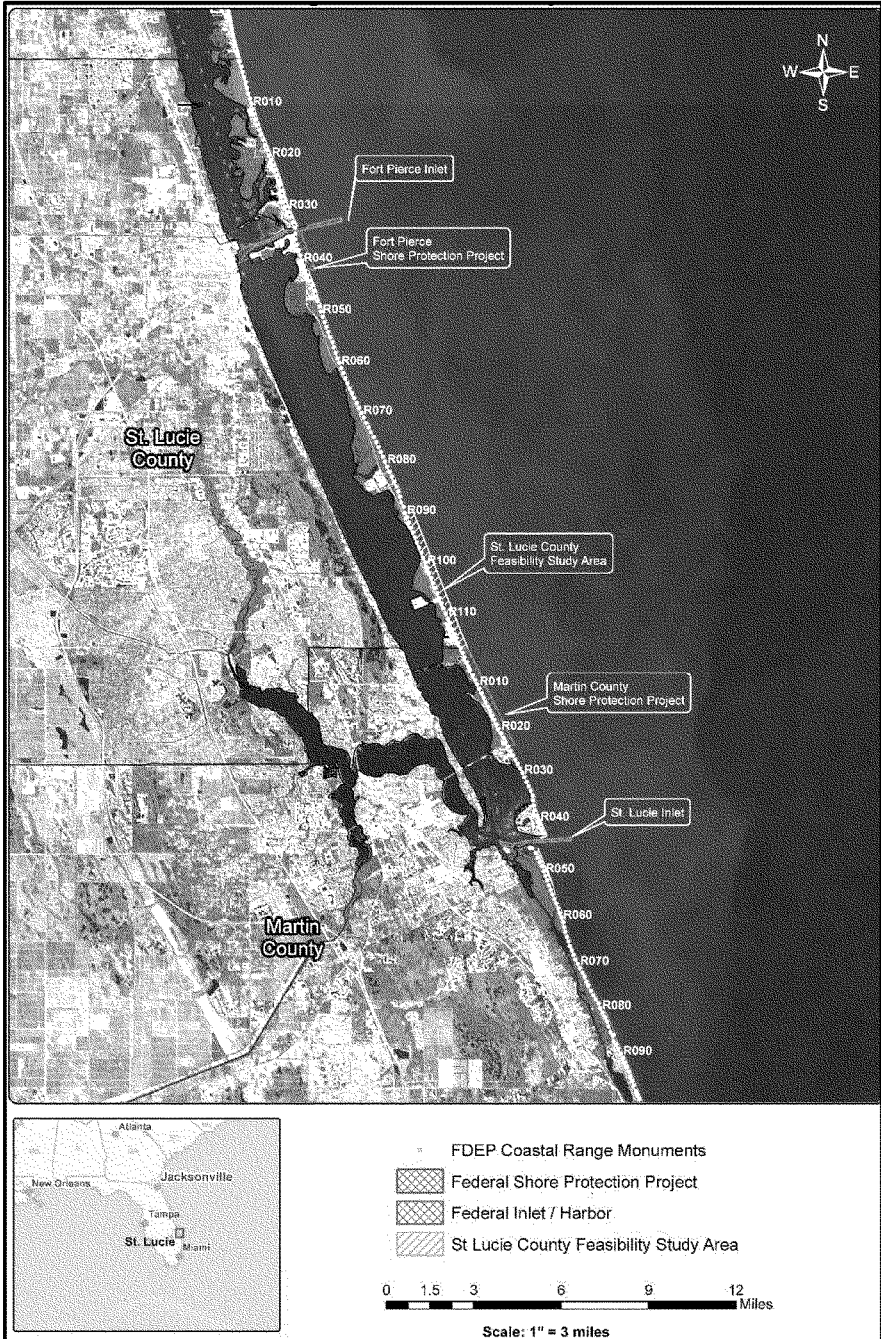


Figure E-9: St. Lucie Potential Project is nearby Ft. Pierce and Martin County projects

RECOMMENDATION NO. 9 (18.0): Reconsider Beach-Fx Results/Reliability Analysis to Determine If a More Resilient and Cost Effective Plan Can Be Developed Based on More Extreme Event Percentiles

PROPOSED RECOMMENDATION:

This proposed recommendation includes several ideas for looking at Beach-fx model outputs in different ways, with the goal of designing a project that is more resilient and (possibly) more cost effective over the life cycle of the project.

The Beach-fx model, being used to calculate without project damages and project benefits, is a lifecycle model that generates a range of results and outcomes for any given alternative. Standard practice has been to present only the average from the range of outputs for alternative selection and justification. Presenting the benefits for a certain percentile of the range of outcome could potentially show that a project would have more benefits than is captured by only looking at the average. Specifically, if the expected damages are not normally distributed, a slightly larger or smaller project could be recommended. If, for example, some iterations of the model showed very large spikes in damage, the recommended plan could perhaps be larger in order to provide resiliency. Also, it may be possible to use the Beach-fx results to modify the recommended renourishment interval. The typical beach nourishment project has a renourishment interval between of 5-10 years. This idea here would be to use a renourishment interval in the 25-50 year range. Much more volume would need to be placed at each event, but there could potentially be a life-cycle cost savings based on reduced mobilization costs.

ADVANTAGES:

This recommendation could potentially provide decision makers with a more complete understanding of the possible range of outcomes associated with the recommended plan. This might make the report more approvable. Also, a larger project (with a smaller number of renourishment) could result in a direct project cost savings by reducing the number of times that mobilization is needed over the 50-year period of the project. Finally, this recommendation could make the project more resilient over a range of different plausible storm events.

DISADVANTAGES:

This recommendation could potentially confuse decision makers by providing a more complex picture of damages and benefits. This might result in more questions being asked than answers provided. The results of this analysis could also be neutral as far as making an alternative look better or worse. Finally, the recommendation could lead to selection of plan that may not be policy compliant. The selected plan should be the plan that maximizes the net benefits (based on expected annual damages in the with and without project condition). A different plan might be inconsistent with policy and precedent.

ACTIVITIES TO IMPLEMENT:

This recommendation would require additional analysis time and study funds to examine the range of results provided by Beach-fx. An additional week of labor and funding would probably be needed. Depending on the results of this analysis, a different plan could be selected for the TSP. This might add additional work for the study team, including the PTL and the cost estimator.

DETERMINATION:

An analysis and discussion of the full range of model results and variability will be included in the report. This is generally good practice for a coastal risk management study. Depending on the results of the analysis, it may seem prudent to modify the recommended plan. However, the team is unlikely

recommend a different plan because it probably would not be policy compliant. Therefore, this recommendation was not adopted by the PDT.

RECOMMENDATION NO. 10 (21.22): Specialized Truck Haul for Narrow Beach and Dune Gaps**PROPOSED RECOMMENDATION:**

Use beach compatible sand from various upland sources (via truck haul rather than offshore dredging) to fill in low areas and gaps in the St Lucie County dune system within the project area in order to minimize flooding and reduce damages due to storm tides.

ADVANTAGES:

Minimizing flooding by eliminating gaps and low areas in the dune may significantly reduce storm damages due to storm surge (flooding and erosion) without the need for additional flood management measures. Truck haul contracts have lower mobilization costs than dredging. Using sand from a DMMA would create capacity within the DMMA for new dredged material and provide beneficial use of the previously dredged material.

DISADVANTAGES:

Additional flood management measures may be required to supplement the protective measure in the event of sea level rise and/or increased storm intensity. Truck haul contracts have high unit prices (whether off-loading a DMMA or purchasing sand from a mine). Trucks cause increased noise and additional traffic/delays on highway systems.

ACTIVITIES TO IMPLEMENT:

A dune survey must be completed to determine the location and extent of gaps and low areas. Acceptable sand source(s) must be located. All viable sand sources must be tested for compatibility.

DETERMINATION:

This recommendation was not adopted by the PDT due to the disadvantages cited.

RECOMMENDATION NO. 12 (24.00): Coordinate with National Floodproofing Committee

PROPOSED RECOMMENDATION:

During the course of producing an estimate for initial screening of alternatives in the Feasibility Phase, it was determined that there may be problems with pursuing one of the alternatives. Specifically, the floodproofing alternative (meant to be combined with a small, one-time beach nourishment event) seemed to be potentially problematic. After presenting findings to the PDT, the team collectively decided to eliminate the whole alternative. Details of the findings can be found in the document written by CESAJ-EN-TC entitled "Draft Write Up – Eliminate Floodproofing".

Flood shields (considered to be dry floodproofing) were the floodproofing measure most appropriate, since it would be cost prohibitive and structurally difficult to use wet floodproofing measures (ie: elevate the condominiums in the area). In general, the analysis found that per FEMA "Design Considerations for Floodproofing" and FEMA "ASCE 24 design standard" Section 6.2.1, dry floodproofing of buildings is not permitted in Coastal High Hazard Areas (Zone V), where the study area is classified as Zone VE (included within V), shown in Figure E-10. Therefore the alternative containing this measure was screened out and eliminated from further analysis.

During the VE workshop, the proposal was created to coordinate with the USACE National Floodproofing Committee. They would review the findings of the team on dry floodproofing, and provide feedback as to whether this alternative was rightfully ruled out, and any other floodproofing options that may exist.

ADVANTAGES:

This expert feedback would provide the team with valuable insight on floodproofing from a national perspective.

DISADVANTAGES:

This effort would be a small additional cost to the project.

ACTIVITIES TO IMPLEMENT:

Planning Lead and Project Manager will coordinate with the USACE National Floodproofing Committee on funding and scope needs.

JUSTIFICATION:

Implementation of this recommendation would have a small cost to the project but would give the team valuable national feedback on the dry floodproofing findings to date.

DETERMINATION:

This recommendation was adopted by the PDT and will be further developed during PED phase.

Figure E-10: St. Lucie Study Area in Coastal High Hazard Area Zone VE (FIRM MAP, Panel 0314, 2012)



RECOMMENDATION NO. 13 (26.00): Account for National Environmental Restoration Benefits related to Sea Turtle Nesting

PROPOSED RECOMMENDATION:

The idea is to calculate National Environmental Restoration (NER) benefits for this coastal storm management risk project related to areas of high sea turtle nesting. Specifically from 2000-2009, State nesting data shows the project beach supported an average of 2367 loggerhead, 181 green, and 45 leatherback sea turtle nests (FWC INBS zones P-Z [St. Lucie R-84 to Martin R-7]).

Although NER benefits cannot be used to justify a project that is for coastal risk management (previously hurricane and storm damage reduction), they can be calculated and put in the report.

ADVANTAGES:

NER benefits could help to tell the story of the shoreline's importance to habitat, as well as to protection of man-made structures.

DISADVANTAGES:

Calculating NER benefits would take some amount of additional time and cost and would likely not help justify parts of the project.

ACTIVITIES TO IMPLEMENT:

Scope and funding requirements to calculate NER benefits should be discussed with the environmental lead and project manager for potential incorporation into the report.

DETERMINATION:

This recommendation was adopted by the PDT and will be presented in the Feasibility Report.

RECOMMENDATION NO. 14: *Coordinate with ERDC Programmatically for Modeling of Artificial Reefs, Groins, etc*

PROPOSED RECOMMENDATION:

Typically the preliminary array of alternatives for coastal projects includes a vast array of measures, such as artificial reefs, groins, etc. Measures are screened out or carried forward based on their own merit. If one of these types of measures is carried forward, then modeling of these alternatives in beach-fx takes significantly more time and effort than a project alternative concerning only dunes or nourishment. A 3-year study under the 3x3x3 paradigm is extremely time sensitive. This idea would be to reach out to ERDC programmatically to consider the idea of having them model more complicated and time consuming alternatives and possibly parallel to our own modeling of other alternatives.

ADVANTAGES:

This would allow more time intensive alternatives that made it through screening to be modeled without potentially delaying a project schedule.

DISADVANTAGES:

The cost to involve ERDC could be expensive, and it is uncertain if they have the modelers to accommodate a request such as this.

ACTIVITIES TO IMPLEMENT:

Discuss further to see if there is a need programmatically. If so, arrange a meeting with ERDC to discuss these types of capabilities.

DETERMINATION:

This recommendation was not adopted by the PDT due to the disadvantages cited.