FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

LAKE WORTH INLET, PALM BEACH HARBOR
PALM BEACH COUNTY, FLORIDA

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT

January 2014

U.S. ARMY CORPS OF ENGINEERS NAVIGATION MISSION

Provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems for movement of commerce, national security, and recreation.

U.S. ARMY CORPS OF ENGINEERS ENVIRONMENTAL OPERATING PRINCIPLES

- Foster Sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all Corps activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL IMPACT STATEMENT JANUARY 2014

LAKE WORTH INLET, PALM BEACH HARBOR PALM BEACH COUNTY, FLORIDA

RESPONSIBLE AGENCIES: The lead agency is the U.S. Army Corps of Engineers, Jacksonville District. The Port of Palm Beach is the non-Federal cost sharing partner for the project.

ABSTRACT: Lake Worth Inlet connects Palm Beach Harbor to the Atlantic Ocean. The port is located in Riviera Beach, Palm Beach County, Florida. Lake Worth Inlet, serving as the entrance channel to the port, is inadequate both in width and depth, negatively impacting future port potential and creating economic inefficiencies with the current fleet of vessels. Based on existing vessel sizes, the port is operating with insufficient channel width and depth. These deficiencies cause the local harbor pilots in conjunction with the U.S. Coast Guard to place restrictions on vessel transit to ensure safety resulting in economic inefficiencies translating into costs to the national economy.

The recommended plan proposes the following (Refer to Figure ES-4 for a graphic depiction of the recommended plan and refer to the foldout at the end of the report showing existing and recommended plans): deepen the entrance channel from 35 feet to 41 feet and widen from 400 feet to between 440-460 feet plus a southern approach flare; deepen the inner channel from 33 feet to 39 feet and widen from 300 feet to 450 feet; deepen the main turning basin from 33 feet to 39 feet and extend the southern boundary of the turning basin an additional 150 feet. Suitable sand would be placed in the nearshore. Some material would be beneficially used for proposed mitigation; unsuitable material would be taken to the Palm Beach Ocean Dredged Material Disposal Site. Approximately 4.5 acres of seagrass habitat and 4.9 acres of hardbottom habitat would be affected through implementation of the recommended plan. In addition, immediately south of the main turning basin, a warm water outfall from the Florida Power and Light Riviera Plant creates a warm water refugium for manatees during cold periods.

This project was formally coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the Florida Department of Environmental Protection as well as other Federal, state, and local agencies, and federally recognized Tribes. The Draft Integrated Feasibility Report and Environmental Impact Statement was circulated for public review as per the requirements of the National Environmental Policy Act (40 CFR 1500-1508).

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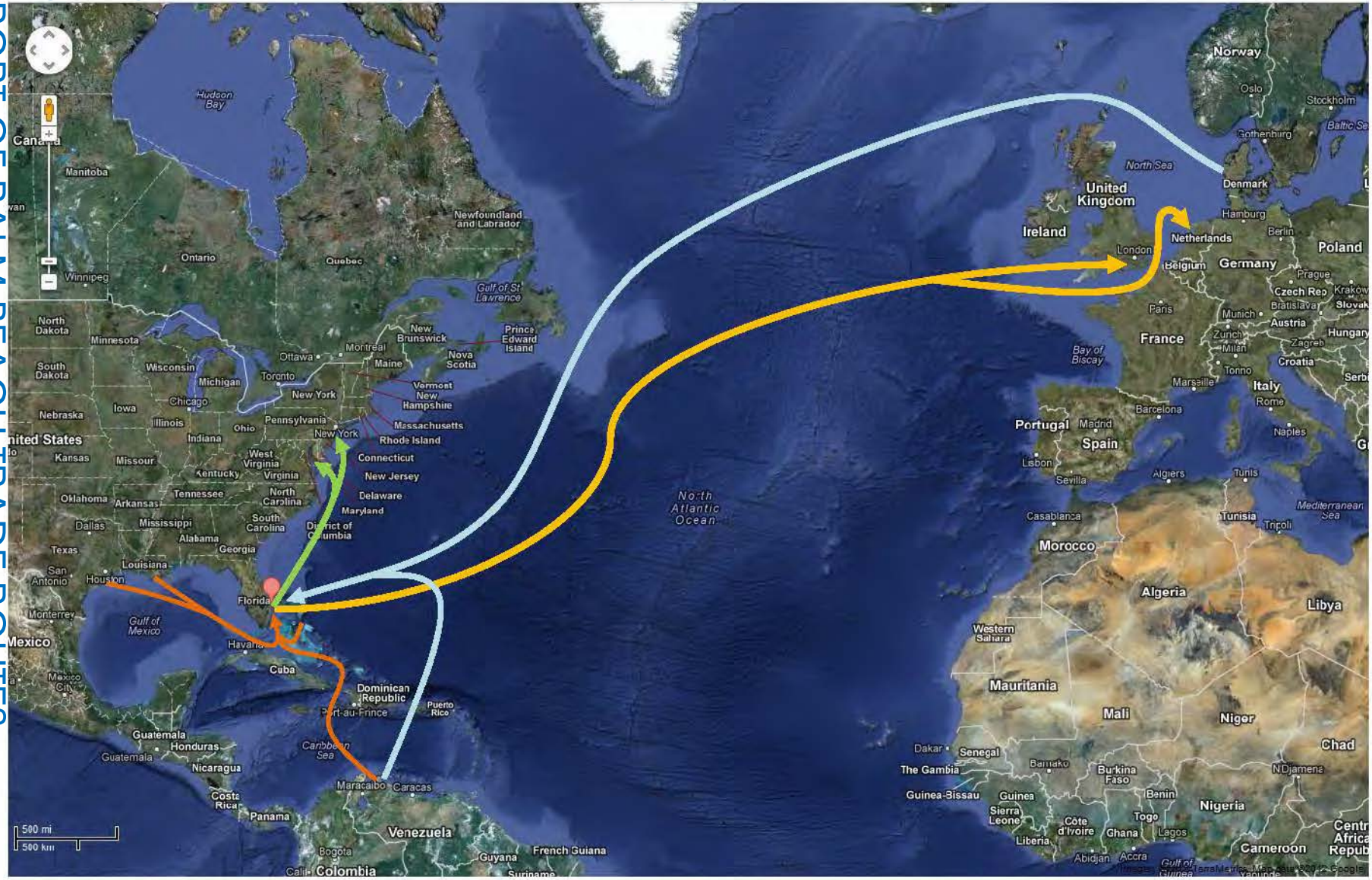
PORT OF PALM BEACH TRADE ROUTES

PORT OF PALM BEACH TRADE ROUTES



SUGAR MOLASSES CEMENT PETROLEUM

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More detailed tables of contents are provided by chapter. In addition, a glossary, index, graphics-oriented Executive Summary, and a comparative plan development map sequence (foldout in the back of the document) are provided for reference before, during, and after reading the document to facilitate readability and efficient navigation throughout the document.

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As with the construction of each chapter, the executive summary and its graphics illustrates how plan development progressed with consideration to the four integrated environments in which a port operates: the **built environment** (federal project, port facilities, disposal areas, transportation network, advance maintenance areas, etc.); the **natural environment** (species of concern); the **navigation environment** (currents, navigation restrictions, etc.), and the **economic environment**. Concerns relative to plan formulation and NEPA review are summarized and encapsulated in the discussions of these four main environments.

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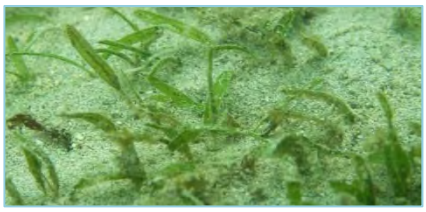

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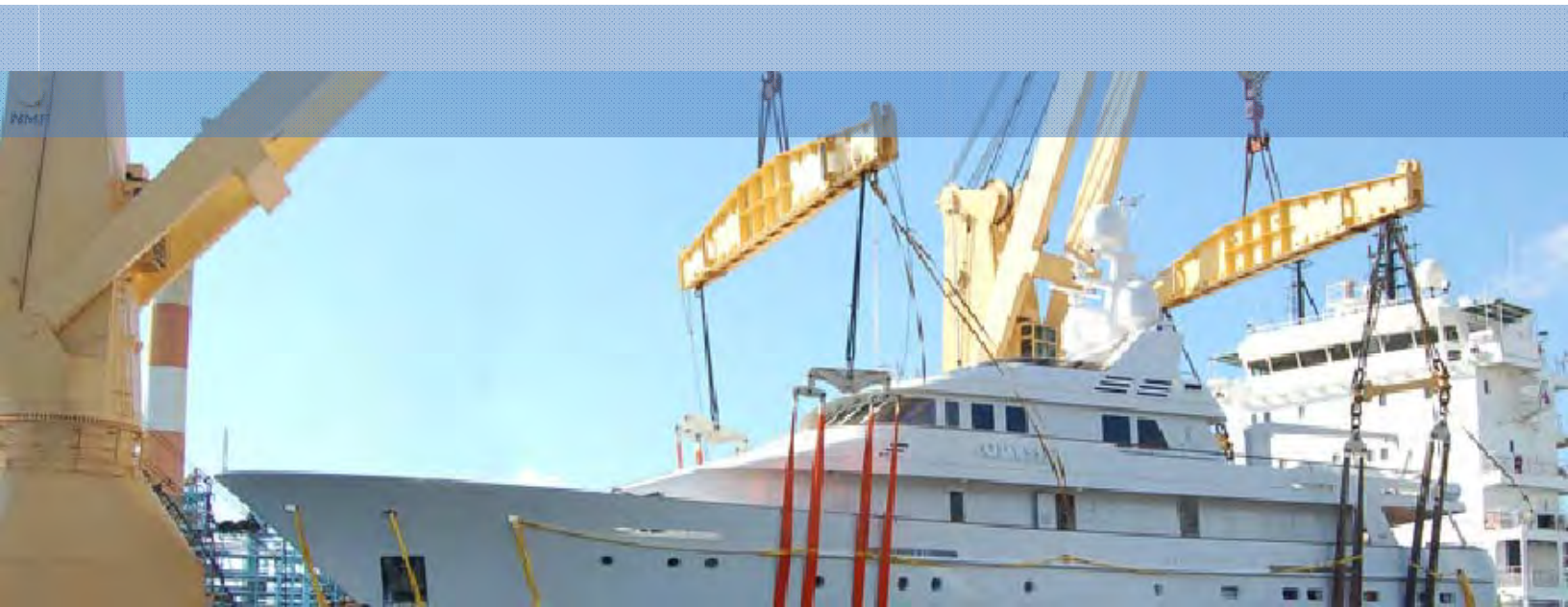


Final Integrated Feasibility Report
And Environmental Impact Statement
Lake Worth Inlet, Palm Beach Harbor
Palm Beach County, Florida

Executive Summary

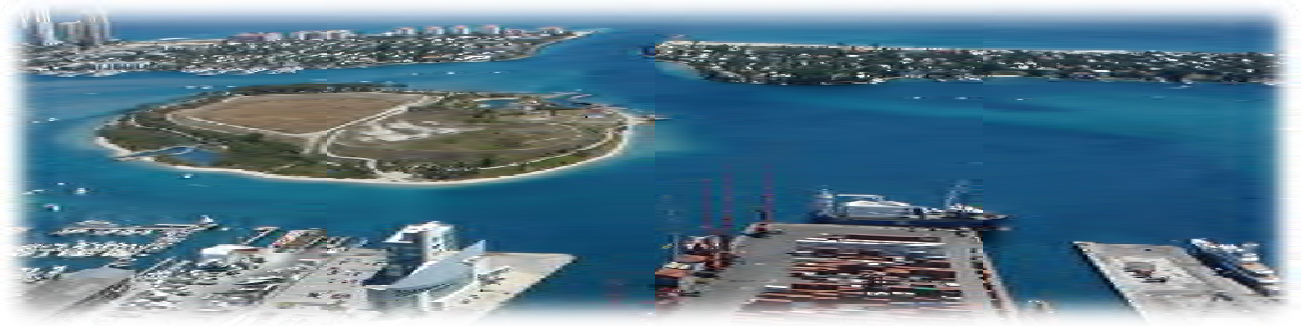
HOW TO USE THIS DOCUMENT

As with the construction of each chapter, the executive summary and its graphics illustrates how plan development progressed with consideration to the four integrated environments in which a port operates: the **built environment** (federal project, port facilities, disposal areas, transportation network, advance maintenance areas, etc.); the **natural environment** (species of concern); the **navigation environment** (currents, navigation restrictions, etc.), and the **economic environment**. 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 Impact Statement (EIS) 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 EIS format has been integrated into the planning process to develop a recommended plan that meets the requirements of both U.S. Army Corps of Engineers Plan Formulation Policy and NEPA.

More detailed tables of contents are provided by chapter in the main report. In addition, a glossary, index, this graphics-oriented Executive Summary, and a comparative plan development map sequence (foldout in the back of the document) are provided for reference before, during, and after reading the document to facilitate readability and efficient navigation throughout the document.

CHAPTER 1.0 – INTRODUCTION



This chapter describes the purpose and need of the study, as well as the initial problem statement as identified by the sponsor. As required by NEPA, this chapter briefly describes the "what, where, why and when" of the action proposed.

Refer to Figure ES-1 for an image-based depiction of purpose and need, and refer to the trade route graphic located immediately prior to the executive summary.

Background: Lake Worth Inlet connects Palm Beach Harbor to the Atlantic Ocean. The closest major ports to Palm Beach Harbor are Port Everglades, in Ft. Lauderdale, and Miami Harbor, approximately 40 miles and 65 miles to the south, respectively. Canaveral Harbor is approximately 90 miles to the north. The Port of Palm Beach is the fourth busiest container port in Florida and the eighteenth busiest in the continental United States. The port is positioned well for growth due to its access to inter-modal capabilities, as well as its acreage available for warehousing. The port has evolved into a net export port (one of 16 in the United States)[1] and is a major nodal point for the shipment of bulk sugar, molasses, cement, utility fuels, produce, and breakbulk items. Demand for all of the major commodities is anticipated to increase through 2067. Located in the heart of south Florida's tourism enclave, the port also serves significant recreational boat traffic. In addition, the Bahamas Celebration cruise ship is based at the port.

Purpose and Need: The overall purpose of this study and report is to address issues causing economic inefficiencies, as well as safety issues, at Lake Worth Inlet and the Port of Palm Beach, and to determine the feasibility of improvements to the Federal navigation project, both non-structural and structural in nature.

The inlet, serving as the entrance channel to the port, has not had major improvements to the existing Federal project in over 50 years and is inadequate both in width and

[1] A net export port is defined as a port in which the amount of exports is greater than 50% of all cargo moved at the port.

depth for today's existing vessel fleet. These deficiencies cause the Palm Beach Harbor Pilots Association in conjunction with the U.S Coast Guard to place restrictions on vessel transit to ensure safety. In turn, these restrictions lead to light loading, tidal delays, and maneuvering difficulties – resulting in economic inefficiencies that translate into costs to the national economy.

More specifically, the project as currently built results in:

Transportation Costs: The major commodities imported and exported through the port are carried on tanker vessels and bulk vessels, both of which are draft constrained at the Port of Palm Beach. These vessels typically light load, only using 87% to 91% of vessel capacity on average. (With an improved channel, vessels could utilize a greater proportion of their capacity, and larger, more efficient vessels could be employed.) Containerships are also affected but not to the degree of tanker vessels and bulk vessels.

Safety Issues: Tanker vessels, bulk vessels, containerships, and cruise ships are subject to safety issues because of insufficient channel widths. These issues are most notable in the entrance channel where vessel beams of less than 100 feet are increased to effective beams of close to 400 feet due to the need to crab into the channel because of difficult currents. This activity brings vessels dangerously close to the sides of the channel. Other width-related safety issues involve maneuvering near channel turns and turning basins (refer to Figure ES-2).

Inadequate Service of Current and Future Vessel Fleets: Trade routes and industry vessels have changed significantly over the past 50 years and since the harbor's last major improvement. The harbor is designed to service vessels with a maximum sailing draft of 30 feet or less. Fully loaded, bulk vessels and tanker vessels currently transiting the port (24 to 34.5 feet design drafts) would need 27 to 37.5-foot sailing drafts in the inner channel, and 29 to 39.5-foot sailing drafts in the outer channel.

South Florida Hinterland: The major ports closest to Palm Beach Harbor are Port Everglades and Miami Harbor to the south, and Port Canaveral to the north. Although the ports share the same hinterland, the Port of Palm Beach is considered a niche port, meaning one that specializes in a particular cargo or market segment. Most notable at the Port of Palm Beach, is its equipment to handle sugar and molasses, which no other port in South Florida can accommodate. It also specializes in an overnight cruise service to the Bahamas, a day cruise that sails twice daily, and a containership operator that services the Caribbean islands on small containerships. These vessel types are limited to feeder-size vessels, with the largest size of 1700 TEUs[2] that have design drafts of 33 feet. Like its investment to service sugar and molasses products and

[2] A TEU is a unit of measure used to quantify capacity in container transportation. Each TEU represents the equivalent volume of one container with dimensions 20 feet x 8 feet x 9 feet (1440 cubic feet).

associated bulk vessels, the Port of Palm Beach has further embraced its "niche port" status by investing in assets suited to its Caribbean cargo market and cruise operators.

Chapter 2.0 - Existing and Future Conditions

This chapter describes the built, navigation, natural, and economic environments in which the port operates. Both baseline conditions and the "future without-project" setting are explored, providing the basis for sound plan formulation (Chapter 3). Relevant resources of the area (existing condition) and the "no action" alternative are succinctly described as required by NEPA. The "no action" alternative and the plan formulation "future without-project" setting are equivalent.

Refer to Figure ES-2 for graphic depiction of existing and future without-project summaries.

The existing economic environment focuses on the width problems in specific areas of the channel, as well as the 4 main commodities which relate to the most draft-constrained vessels (tanker vessels and bulk vessels): cement and concrete, asphalt, molasses, petroleum products. General cargo is also draft constrained. In the future without-project, these vessels will continue to light load, leading to inefficient vessel calls, and increased transportation costs. The width in the entrance channel, as well as between the inner and entrance channel, will also continue to be a safety concern.

The existing navigation environment relates to problems relating to insufficient depth and width, as well as navigation concerns relating to strong tidal currents and the northward cross current (related to the Gulf Stream) at the entrance channel, and existing navigation restrictions (such as only daylight transit for larger vessels and restriction to high slack tide for vessels drafting more than 30 feet) in place by the harbor pilots for safety. The future without-project conditions for the navigation environment will remain unchanged.

The existing built environment is the current Federal project, with dimensions 33 feet deep in the inner channel and 300 feet wide, and 35 feet deep in the entrance channel and 400 feet wide, with a turning basin with is a 1200-foot diameter and 33 feet deep. Shoaling rates in the inner and entrance channel, turning basin, settling basin and advance maintenance areas are a total of approximately 117,500 cubic yards per year on average. Operation and maintenance dredging of the shoaled material occurs once per year. All material is sandy and is placed on the beach or in the nearshore south of the inlet, as the least cost placement option and for the benefit of the public and natural environment. The sand transfer plant, located on the north jetty, currently pumps 160,000 cubic yards per year from north of the inlet to south of the inlet. This quantity of sand pumped from the plant mitigates for the downdrift erosion from the existing Federal project. The future without-project conditions for the built environment will remain unchanged, with the exception of the Port of Palm Beach's independent Slip 3 deepening and improvement to the associated bulkheads, which is currently underway.

The existing natural environment, in the vicinity of the project, has seagrasses and hardbottoms outside of the current federal channel; 14 Federal threatened and endangered species, one of those being the West Indian manatee (endangered). Recreational boating and beach activities are enjoyed by local residents as well as tourists. The future without-project conditions for the natural environment will remain unchanged.

Chapter 3.0 - Plan Formulation

Based on a more refined problem statement (from Chapter 2 information), opportunities, constraints, and project objectives are identified to guide the selection of project measures and development of alternatives. Methodology used to evaluate and compare alternatives is discussed, as well as the reduction and minimization of potential environmental impacts.

This chapter is the heart of the integrated document blending the plan formulation mission to provide for safe, reliable, efficient, and environmentally sustainable waterborne transportation with NEPA policies and philosophy to develop an array of alternatives. The costs and benefits of the array of alternatives ("actions" under NEPA), including the "future-without" condition ("no action" under NEPA), are assessed within the context of the port's built, natural, navigation, and economic environments and resources discussed in Chapter 2.

Refer to Figure ES-3 for a graphic depiction of the plan formulation analyses.

Nine initial widening measures were identified to solve width problems and maximize safety opportunities in specific areas of the channel. These measures were consolidated into two different widening footprints, Plan 1 (larger) and Plan 2 (smaller), as a result of input from the harbor pilots and engineering judgment. Both Plans were simulated in a model at the Simulation, Training, Assessment, and Research (STAR) Center with 2 design vessels: a bulk carrier vessel (fully loaded) and a cruise ship. Plan 2 met design vessel needs for width needed to maneuver safely, and after further optimizations and environmental considerations, was recommended by the harbor pilots as the project footprint. The Plan 2 footprint was then paired with depths from 34 to 43 feet to address light loading inefficiencies, and analyzed for economic net benefits. The widening footprint plus depths of 38-41 feet had the highest net benefits and were considered as the final array. After further refinements in cost and economic estimating during analyses of the four alternatives, the 39-foot plus widening alternative had average annual net benefits of $4,010,720 and was identified as the USACE National Economic Development Plan (NED) plan (after applying the guidance issued in USACE ER 1105-2-100, Appendix G, Exhibit G-1), and was selected as the recommended plan. A locally preferred plan (LPP) has not been identified by the Sponsor.

Chapter 4.0 – Recommended plan

This chapter discusses the recommended plan in detail, including material quantities and classifications, integration of the environmental operating principles, mitigation, construction plan, advance maintenance, dredged material placement, costs and benefits, risk and uncertainty, and other pertinent information. When all required reviews, and coordination with agencies and the public are complete, the tentatively selected plan becomes the recommended plan that is ultimately sent to Congress for approval and funding.

Refer to Figure ES-4 for graphic depiction of the recommended plan.

In this chapter, the 39-foot deepening plus widening alternative was developed further as the recommended plan.

The widening footprint includes the addition of a new channel flare on the south side of the entrance channel, a widening of the entrance channel by 40 feet and 60 feet (varies) to the north, widening the inner harbor to provide for a minimum channel width of 450 feet, a 150-foot expansion of the Southern (Main) Turning Basin to the south, and an expansion of the Southern (Main) Turning Basin on the north side to remove a notch currently encroaching into the basin.

The inner channel would be deepened to a project depth of 39 feet. The plan includes an improved advance maintenance plan (including improvements to both the settling basin and existing advance maintenance), and sheet pile on the north jetty, for stabilization due to the close proximity of dredging to the existing jetty in that area in combination with the improved advance maintenance plan. The advance maintenance plan and jetty stabilization were not included in the plan formulation screening, as they are considered to be optimizations to the recommended plan. In this chapter, however, they are included and are reflected in the total project cost.

The plan will generate 1.4 million cubic yards of material which will be placed at the ODMDS. It will also generate 450,000 cubic yards of sand which will be placed in the nearshore, south of the inlet, below the Mean High Water (MHW) line and filling landward to seaward. As a result of the new advance maintenance plan, O&M events will change from dredging and placing approximately 117,500 cubic yards of sand every year (on average) to dredging and placing approximately 240,000 cubic yards of sand every two years (there will be a 2,500 cubic yard per year increase in shoaling from the project). The revised advance maintenance plan will result in an annualized cost savings to the O&M program of $850,000. All material from O&M events is anticipated to be sand and will continue to be placed south of the inlet, on the beach or in the nearshore. Mitigation compensation for seagrasses will be required and is not expected to exceed 11.25 acres of beneficial dredge material placement based on conservative calculations completed by USACE using the HEA model; mitigation compensation for hardbottom will be required and is not expected to exceed 11.25 acres of artificial reef creation based on conservative calculations completed by USACE using the HEA model. After final refinements in modeling and cost estimating, as well as application of a risk based contingency, the total project cost is estimated at $88,556,000 with a benefit to cost ratio of 2.0 to 1.

Chapter 5.0 – Effects of the Recommended plan

This chapter explains how the recommended plan could potentially affect all elements of the surrounding environment. These effects are directly compared to the baseline and "future without-project" (or no action alternative) settings described in Chapter 2.0.

In the economic environment, the project effects will be transportation cost savings which will result primarily from more efficiently loaded vessels, reduced vessel calls, and increased safety.

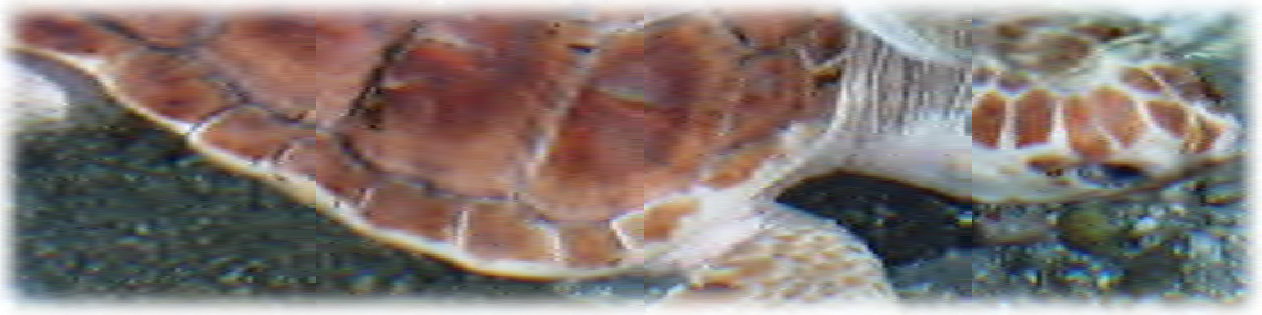
In the navigation environment, tides and currents will remain the same; however, the ways that vessels adjust to them will improve in terms of time, efficiency and safety.
The difference in storm surge elevations (0.328 ft) between the with-project and without-project condition is a minor increase compared to actual storm surge water level which would occur in a 100 year storm event (10 feet). Therefore, no significant impact of the recommended project to storm surge is anticipated.

In the built environment, the existing federal project would be modified to the new widening footprint and depth. Operation and maintenance activities would remove approximately 240,000 cubic yards every 2 years, rather than 117,500 cubic yards every year (on average), which would cause fewer disturbances to the environmental and the community. All material would be placed on the beach or in the nearshore for a benefit to the community and natural environment. There will be no change in the amount pumped by the sand transfer plant (160,000 cubic yards per year). Sea level rise is not expected to affect the project.

In the natural environment, some seagrasses and low relief hardbottoms would be impacted and therefore would be mitigated. The following species may be in or near the action area and thus may be affected by the proposed project: green turtle, loggerhead turtle, Kemp's ridley turtle, Hawksbill sea turtle, leatherback turtle, humpback whale, sperm whale, Johnson's seagrass, and smalltooth sawfish. The loggerhead turtle, green turtle, smalltooth sawfish and Johnson's seagrass have the potential to be effected by the proposed dredging project. Manatee windows and sea turtle nesting windows would be in effect during construction. Deepening and

widening the channels in Lake Worth Inlet is not expected to result in any change of use of the area by manatees. No changes to manatee-vessel interactions within the harbor are expected as a direct result of the expansion project. The human environment would experience temporary noise, aesthetic disruptions, and recreational disruptions associated with the construction.

Chapter 6.0 – Environmental Compliance



This chapter shows that the study coordination of the recommended plan is in compliance with all environmental requirements and that the process has been shared with the public at the required intervals, through the NEPA process, and have been coordinated under the various Federal laws and regulations.

This study began scoping in 2007, with an initial public meeting held in 2008. The most recent public meeting was held in 2013. Public comments were taken into consideration during each review period. General comment themes can be grouped into erosion concerns south of the inlet, making economics assumptions clearer, additional environmental information, opposition to specific mitigation sites in the potential array (turtle cove and little Lake Worth) and suggestions for improving report readability. This report/EIS has completed formal coordination with U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) and is compliant with all environmental requirements and shows how the recommended plan meets U.S. Army Corps of Engineering (USACE) environmental operating principles.

Chapter 7.0 – Recommendations

This chapter concludes with a restatement of the official project recommendations and outlines sponsor responsibilities.

This chapter presents the District Commander's concurrence with the findings in the report, widening by the proposed footprint and deepening to a project depth of 39 feet Mean Lower Low Water (MLLW) in the inner harbor and 41 feet MLLW in the entrance channel, with recommended advanced maintenance features, be authorized by Congress for implementation. Mitigation compensation for seagrasses will be required and is not expected to exceed 11.25 acres of beneficial dredge material placement based on conservative calculations completed by USACE using the HEA model; mitigation compensation for hardbottom will be required and is not expected to exceed 11.25 acres of artificial reef creation based on conservative calculations completed by USACE using the HEA model. Relocation, establishment, and disestablishment of aids to navigation are to be funded by the United States Coast Guard (USCG).

The total estimated cost of the project, including the cost of aids to navigation, is $88,556,000. The average annual costs were determined to be $3,960,000 and average annual benefits were $7,940,000, with a benefit to cost ratio of 2.0 to 1. Average annual net benefits are $3,980,000.

The total project first cost, which does not include the cost of aids to navigation, is $88,531,000, with a Federal share of $66,393,000 and a non-federal share of $22,138,000.

1.0 INTRODUCTION

BACKGROUND

Lake Worth Inlet connects the Palm Beach Harbor to the Atlantic Ocean. The port is located in Riviera Beach, Palm Beach County, Florida – 80 miles north of Miami and 135 miles (217 km) south of Port Canaveral. The Port of Palm Beach is the fourth busiest container port in Florida and the eighteenth busiest in the continental United States. The port is positioned well for growth due to its access to inter-modal capabilities, as well as its acreage available for warehousing. The port has evolved into a net export port (one of only 16 in the United States) and is a major nodal point for the shipment of bulk sugar, molasses, cement, utility fuels, produce, and breakbulk items. In addition, the Bahamas Celebration cruise ship is based at the port. Located in the heart of south Florida's tourism enclave, the port also serves significant recreational boat traffic. **Lake Worth Inlet, serving as the entrance channel to the port, has not had major improvements to the existing Federal project in over 50 years and is inadequate both in width and depth for today's modern vessel fleet. This negatively impacts future port potential and creates economic inefficiencies, as well as safety concerns, with the current fleet of vessels.**

The Port of Palm Beach, along with its tenants, is an economic engine for the county, state, and nation - contributing $260 million in business revenue and $12 million in state and Federal taxes . Over $7 billion worth of commodities move through the port each year, and approximately 2,400 people are employed directly and indirectly because of the port.

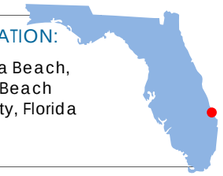
PURPOSE OF THIS REPORT

Based on modern vessel sizes, the port is operating with insufficient channel width and depth. These deficiencies cause the local harbor pilots to place restrictions on vessel transit to ensure safety. In turn, these restrictions lead to light loading, tidal delays, and maneuvering difficulties – resulting in economic inefficiencies that translate into costs to the national economy.

GENERAL

LOCATION:

Riviera Beach, Palm Beach County, Florida



SPONSOR:

The Port of Palm Beach District is an independent special taxing district, a sub-division of the state of Florida. Established under the provisions of the Laws of Florida, Acts of 1915, Chapter 7081, as amended and supplemented.

AUTHORIZED PROJECT DIMENSIONS:

Inner: Width = 300 feet, Depth = 33 feet
Entrance: Width = 400 feet, Depth=35 feet
Main Turning Basin (south) = 1200 Diameter, Depth = 33 feet
Local (north) Turning Basin = 25 feet

MAJOR COMMODITIES

Sugar and Molasses

Petroleum/Utility Fuels

Cement/Concrete

Asphalt

Refrigerated Cargo

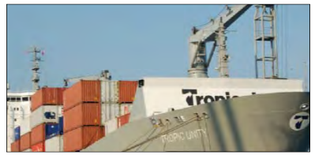
Specialty Cargo

FLEET

Tanker (Petroleum/Molasses)

Bulker (Cement)

Cruise


Container

INTEGRATED FEASIBILTY REPORT and ENVIRONMENTAL IMPACT STATEMENT FIGURE ES-1 (excerpt only)

EXISTING CONDITIONS

BUILT ENVIRONMENT

FEDERAL CHANNEL
- Dimension/locations (see map below)
- Sand Transfer Plant mitigates for the downdrift erosion from existing project
- 2011Advance Maintenance Plan: annual O&M dredging of channel & settling basin mitigates for high shoaling rate

PLACEMENT OPTIONS (O&M)
- Ocean Dredged Material Disposal Site 5 miles offshore
- Beach and/or Nearshore Placement
- Upland Disposal Site - Peanut Island (limited capacity)

PORT FACILITIES
- NMW: Slip 1, Berths 1- 6
- MMW: Slip 1& 2, Berths 7 - 12
- MID MW: Slip 2 & 3, Berths 13 - 16
- SMW: Slip 3, Berth 17
- 156 acres of landside facilities
- In proximity to major roadways
- Rail access directly to/from port
- Sponsor improvements to Slip 3

NATURAL ENVIRONMENT

THREATENED & ENDANGERED SPECIES
Sea Turtles: Green, loggerhead, Kemp's ridley, Hawksbill, leatherback
Seagrass: Johnson's
Whales: Blue, humpback, sei, fin, sperm whales
Fish: Smalltooth sawfish
Other: West Indian (Florida) manatee

FISH & WILDLIFE RESOURCES
Beach habitat, marine life, common shorebirds, seagrasses

HARDBOTTOM HABITAT
Sponges, bryozoans

ESSENTIAL FISH HABITAT (EFH)
Federally managed species of fish (i.e., brown shrimp, spiny lobster); prey species (i.e., horse conch, bay anchovy)

NAVIGATION ENVIRONMENT

UNIQUELY STRONG CURRENTS AT ENTRANCE REQUIRE CRABBING
Mainly due to the harbor's proximity to the Gulf Stream, most vessels approach the inlet from the southeast (safety reasons) & crab into the entrance channel, correcting the crab angle after entering the jetties (see ship plot diagram below).

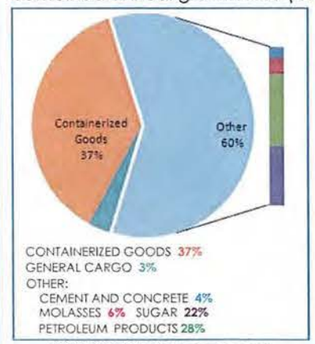
EBB TIDE CURRENTS
Strong currents plus a sharp turn from the entrance channel into the inner channel, and a drop in channel width from 400' to 300', complicate navigation further.

FLOOD TIDE CURRENTS
Suction effects in Main Basin.

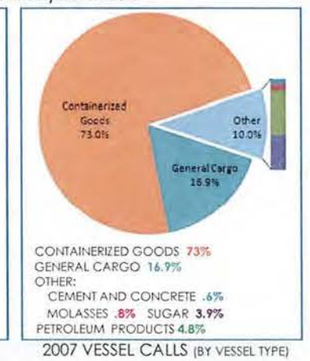
NAVIGATION RESTRICTIONS
One-way, no passing or overtaking; safety distance of 0.25 miles before/after all vessels; speeds maintained at 3-4 knots.

ECONOMIC ENVIRONMENT

COMMODITIES
Total major bulk cargo (period 1996 through 2010 associated with the deepest draft vessels calling the port) grew from 1.71 million metric tons in 1996 to 2.42 million metric tons in 2004 for a combined annual growth rate (CAGR) of 4.42%.



2007 TONNAGE (BY VESSEL TYPE)



2007 VESSEL CALLS (BY VESSEL TYPE)

Cement and concrete, molasses, sugar, & petroleum products accounted for roughly 10% of vessel calls in 2007, but almost 60% of total tonnage.

FLEET
Vessels are draft constrained by existing project depths and length constrained due to the sharp turn in the entrance channel. Molasses product tankers, liquid petroleum tankers, and cement bulk carriers are the most draft-constrained vessels of the current fleet calling the port.

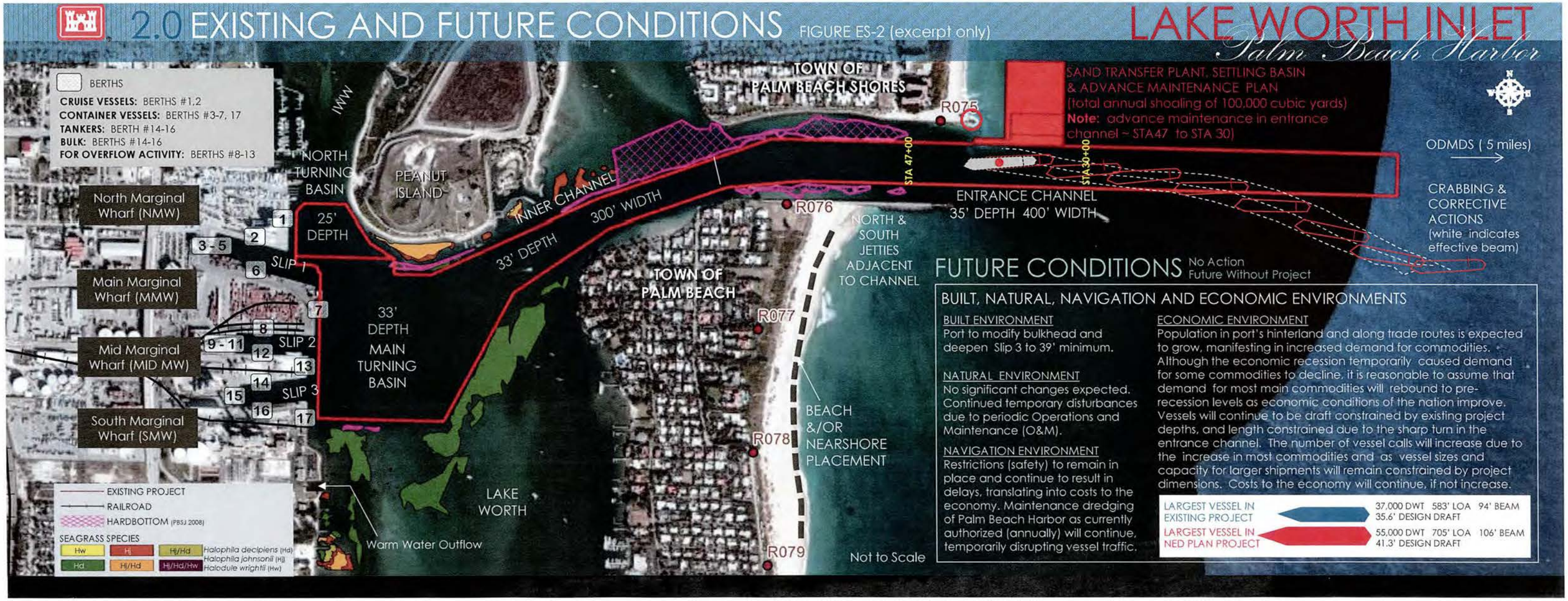
BENEFITING FLEET CHARACTERISTICS (not including cruise ships)

COMMODITY	VESSEL TYPE	AVE DESIGN DRAFT	POTENTIAL DESIGN DRAFT	AVE LOA	POTENTIAL LOA	AVE CALLS PER YEAR
Molasses	Self-propelled tanker	34.5	41	554.5	619	8
Liquid Petroleum	Tanker barge	29	36	485.2	640	38
Asphalt	Tanker barge	24.6	30.6	453.6	490	5
Cement	Self-propelled bulker	31.2	37.7	514.6	612	5
General Cargo	General Cargo	14.3	36.8	253.3	655	178

* Measured in feet ** LOA: length overall

2.0 EXISTING AND FUTURE CONDITIONS

FIGURE ES-2 (excerpt only)



OPPORTUNITIES/OBJECTIVES/CONSTRAINTS

OPPORTUNITIES

More efficient navigation and safer maneuvering; less light loading and tidal delays, & improved operations and maintenance (O&M) event intervals.

OBJECTIVES (2017 start date)

1. Reduce transportation costs from light loading, tidal delays, or other commercial navigation issues due to insufficient depths in the MTB & from the entrance channel to the inner channel
2. Reduce navigation concerns & improve vessel safety in the harbor related to insufficient widths
3. Maintain or improve O&M event intervals for the Federal channel (December 2011 approved plan)

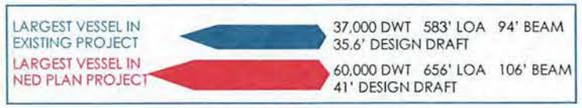
CONSTRAINTS

1. Avoid/minimize potential impacts to manatees & grassbeds
2. Avoid/minimize impacts to environment (seagrass, hardbottom, & softbottom resources)
3. Avoid adverse impacts of shoreline erosion in proximity to Lake Worth Inlet

ANALYZING MEASURES AND DEVELOPING ALTERNATIVES WHILE MEETING OBJECTIVES/ADDRESSING CONSTRAINTS

All potential non-structural measures are already used at the Port of Palm Beach and will likely continue to supplement structural measures. During plan formulation, the following structural measures were combined into alternatives that meet objectives and address constraints.

While developing alternatives for a navigation project, it is important to consider the design dimensions (vessel requirements of the existing project versus the current needs of the vessel fleet.)



Widths: Combinations of measures (measures: large map; combination into Plan 1 and Plan2: small map) were based on dialogue with harbor pilots, historical accounts of harbor transits, ship simulation, and engineering models.

Depths: Measures related to channel & basin depths were based on the safety & efficiency needs of the current and future vessels calling on the port, as well as economic modeling.

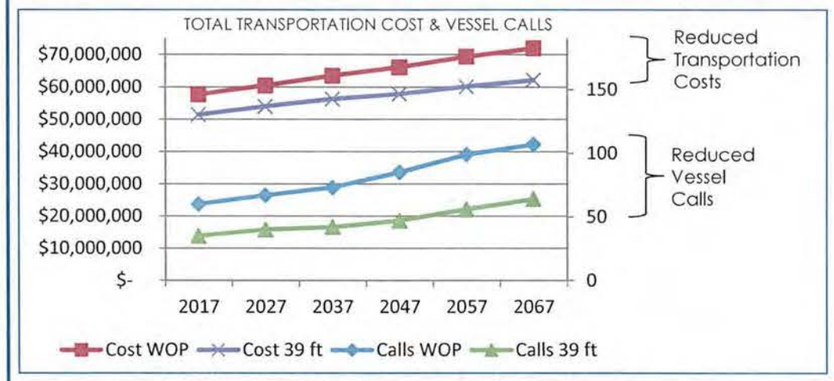
PLAN 2 WIDENING PLUS DEEPENING ALTERNATIVES

PROJECT DEPTH	AVERAGE ANNUAL BENEFITS	AVERAGE ANNUAL COSTS	AVERAGE ANNUAL NET BENEFITS	BCR
38'+ Widening Plan 2	$6,416,498	$2,982,771	$3,433,727	2.15
39'+ Widening Plan 2	$7,325,811	$3,311,091	$4,014,720	2.21
40'+ Widening Plan 2	$7,746,616	$3,599,861	$4,146,755	2.15
41'+ Widening Plan 2	$7,793,759	$4,297,090	$3,496,669	1.81

39' and 40' project depths were similar in net benefits, but per ER 1105-2-100, 39' was selected. ER 1105-2-100 states the following: "Identification of the NED plan is to be based on consideration of the most effective plans for providing different levels of output or service. Where two cost effective plans produce no significantly different levels of net benefits, the less costly plan is to be the NED plan, even though the level of outputs may be less."

Costs estimated to construct each project plan alternative (width scenarios plus depth scenarios) included rough orders of magnitude costs for construction, mitigation, & for placement of dredged material.

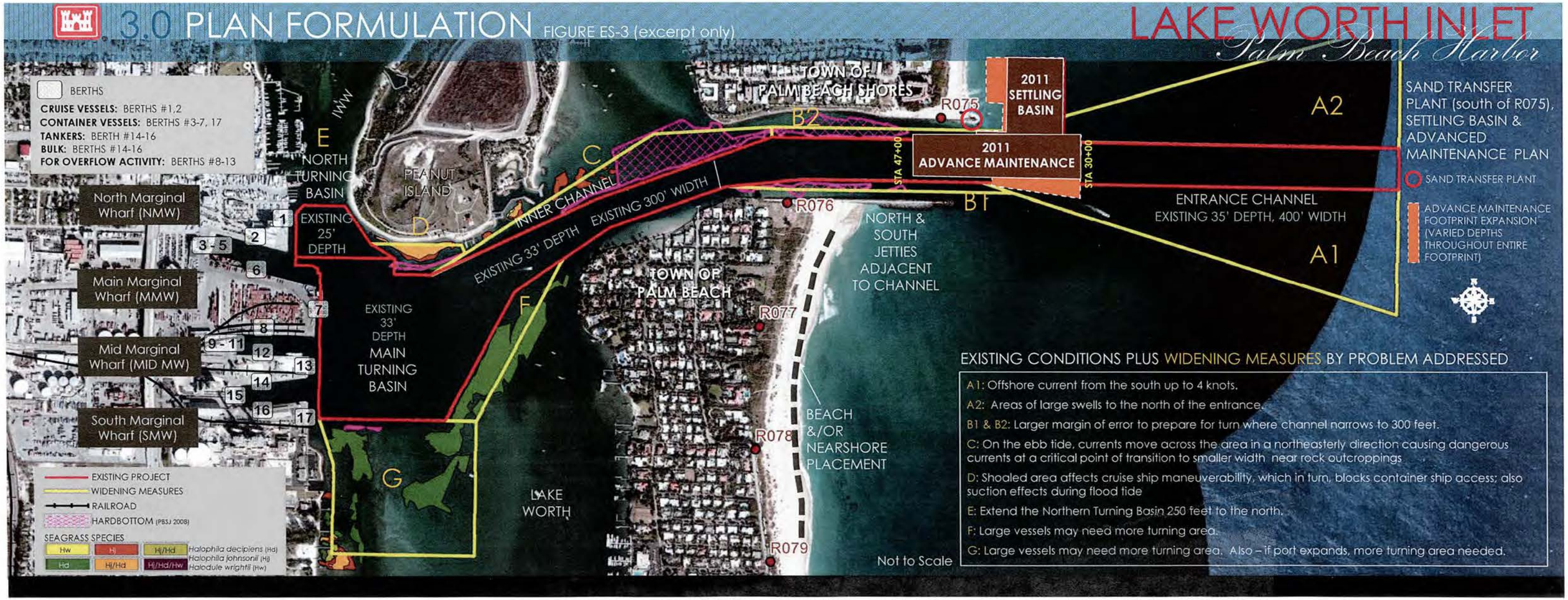
PROJECT SAVINGS: WITHOUT PROJECT VS. WITH PROJECT



ADVANCE MAINTENANCE - POTENTIAL COST SAVINGS AND REDUCED IMPACTS

Studies must account for O&M needed during the life of a project. Lake Worth Inlet has a high shoaling rate & requires channel and settling basin dredging up to twice a year. In 2011, an improved plan was developed/approved to reduce dredging to once a year. This current study used one of the most state of the art models to determine if further refinements to the advanced maintenance plan & settling basin were possible – pursuing the objective to improve O&M intervals, achieving cost savings, and reducing impacts to the community & environment during the life of the project. These improvements would be needed for the existing project, so they were not included in plan formulation, but later as an optimization to the plan.

3.0 PLAN FORMULATION FIGURE ES-3 (excerpt only)



BUILT ENVIRONMENT

FEDERAL CHANNEL

- Inner Channel: Deepen (from 33' to 39'); Widen (from 300' to 450' minimum)
- Entrance Channel: Deepen (from 35' to 41'); Widen (from 400' to between 440' and 460'); plus south approach flare
- North Turning Basin: same
- Main Turning Basin: Depth: Deepen (from 33' to 39'); Width: 150' extension to the south & removal of notch on north side
- North and South Jetties: North Jetty will need sheetpile stabilization primarily because of the revised maintenance plan
- O&M: refer to advance maintenance discussion below

PLACEMENT OPTIONS

- Sandy material to be placed in the nearshore
- Non-beach compatible material will be placed at the Palm Beach Ocean Dredged Material Disposal Site (ODMDS) 5 miles offshore – in compliance with ocean disposal criteria; study will increase allowable disposal to > 500,000 cy per event
- Refer to Natural Environment discussion regarding Turtle Cove Dredged Hole Site and Singer Island Artificial Reef Mitigation Sites
- Peanut Island not a viable option due to limited capacity

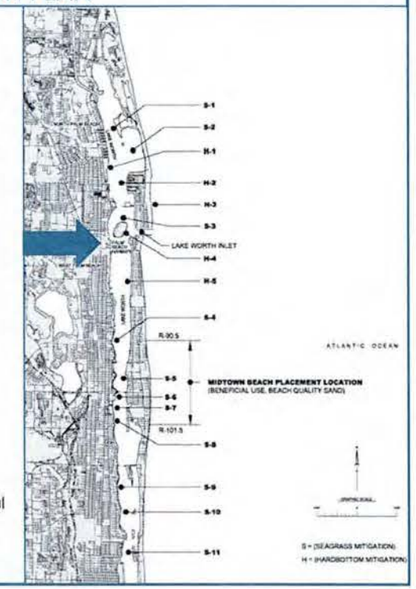
NATURAL ENVIRONMENT AND MITIGATION PLAN

MITIGATION

- Seagrass: 11.25 acres
- Hardbottom: 11.25 acres
- Proposed seagrass mitigation will fill dredged hole(s) to surrounding elevation using dredged material to allow restoration of seagrass
- Proposed hardbottom mitigation will place rock in artificial reef sites to allow establishment of species

(Refer to Chapter 5.0 for a full comparison of the Tentatively Selected Plan to the Future-Without Plan/No Action Condition)

Major Affected Environmental Resources: Manatee & Seagrass



NAVIGATION ENVIRONMENT

- Improved maneuverability/safety for large vessels (tankers, bulkers and cruise ships)
- Improved access into inlet when considering currents and wind
- Less dependence on tide windows (for underkeel) during transit

DESIGN VESSEL:
60,000 DWT Bulker 656' LOA
106' Beam 41' Design Draft

ECONOMIC ENVIRONMENT

- Benefiting Vessels: Tankers, Bulkers
- Allows for larger vessel capacity:
  - More loads per vessel and more efficient vessels
  - Fewer vessels calling
- Less vessel operating costs = cost savings to economy

PROJECT	39' DEPTH +WIDENING
Sum of Present-Value Benefits	$ 166,220,000
Total Costs (with Interest During Construction)	$ 92,930,000
Annualized Transportation Cost Savings (Benefits)	$ 7,090,000
Annualized Advanced Maintenance Cost Savings (Benefits)	$ 850,000
Total Average Annual Benefits	$ 7,940,000
Total Average Annualized Costs	$ 3,960,000
Net NED Benefits	$ 3,980,000
BCR	2.0

Note: The costs and benefits in the table reflect a more refined analysis focused on the recommended plan.

4.0 RECOMMENDED PLAN FIGURE ES-4 (excerpt only)

LAKE WORTH INLET
Palm Beach Harbor

1.0 INTRODUCTION

LAKE WORTH INLET

Palm Beach Harbor

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1 INTRODUCTION

STUDY BACKGROUND

Lake Worth Inlet connects Palm Beach Harbor to the Atlantic Ocean. The closest major ports to Palm Beach Harbor are Port Everglades, in Ft. Lauderdale, and Miami Harbor, approximately 40 miles and 65 miles to the south, respectively. Canaveral Harbor is approximately 90 miles to the north. The Port of Palm Beach is the fourth busiest container port in Florida and the eighteenth busiest in the continental United States. The port is positioned well for growth due to its access to inter-modal capabilities, as well as its acreage available for warehousing. The port has evolved into a net export port[1] (one of 16 in the United States) and is a major nodal point for the shipment of bulk sugar, molasses, cement, utility fuels, produce, and breakbulk items. In addition, the Bahamas Celebration cruise ship is based at the port. Located in the heart of south Florida's tourism enclave, the port also serves significant recreational boat traffic.

The Port of Palm Beach, along with its tenants, is an economic engine for the county, state, and nation - contributing $260 million in business revenue and $12 million in state and Federal taxes. Over $7 billion worth of commodities move through the port each year, and approximately 2,400 people are employed directly and indirectly because of the port.

Lake Worth Inlet, serving as the entrance channel to the port, has not had major improvements to the existing Federal project in over 50 years and is inadequate both in width and depth for today's existing vessel fleet. This negatively impacts future port potential and creates economic inefficiencies, as well as safety concerns, with the current fleet of vessels.

PROJECT SPONSOR

The Port of Palm Beach District is an independent special taxing district, a sub-division of the state of Florida, established under the provisions of the Laws of Florida, Acts of 1915, Chapter 7081, as amended and supplemented.

PURPOSE AND NEED

Based on existing vessel sizes, the port is operating with insufficient channel width and depth. These deficiencies cause the Palm Beach Harbor Pilots Association in conjunction with the U.S Coast Guard to place restrictions on vessel transit to ensure safety. In turn, these restrictions lead to light loading, tidal delays, and maneuvering difficulties – resulting in economic inefficiencies that translate into costs to the national economy. The purpose of this study and report is to address these issues and to determine the feasibility of improvements to the Federal navigation project, both non-structural and structural, at Lake Worth Inlet and at the Port of Palm Beach.

[1] A net export port is defined as a port in which the amount of exports is greater than 50% of all cargo moved at the port.

More specifically, the project as currently built results in:

Transportation Costs: The major commodities imported and exported through the port are carried on tanker vessels and bulk vessels, both of which are draft constrained at the Port of Palm Beach. These vessels typically light load, only using 87% to 91% of vessel capacity on average. (With an improved channel, vessels could utilize a greater proportion of their capacity, and larger, more efficient vessels could be employed.) Containerships are also affected but not to the degree of tanker vessels and bulk vessels.

Safety Issues: Tanker vessels, bulk vessels, containerships, and cruise ships are subject to safety issues because of insufficient channel widths. These issues are most notable in the entrance channel where vessel beams of less than 100 feet are increased to effective beams of close to 400 feet due to the need to crab into the channel because of difficult currents and winds. This activity brings vessels dangerously close to the sides of the channel. Other width-related safety issues involve maneuvering near channel turns and harbor nooks or turning basins (refer to Figure ES-2).

Inadequate Service of Current and Future Vessel Fleets: Trade routes and industry vessels have changed significantly over the past 50 years and since the harbor's last major improvement. The harbor is designed to service vessels with a maximum sailing draft of 30 feet or less. Fully loaded, bulk vessels and tanker vessels currently transiting the port (24 to 34.5 feet design drafts) would need 27 to 37.5-foot sailing drafts in the inner channel, and 29 to 39.5-foot sailing drafts in the outer channel.

South Florida Hinterland

The major ports closest to Palm Beach Harbor are Port Everglades and Miami Harbor to the south, and Port Canaveral to the north. Although the ports share the same hinterland, the Port of Palm Beach is considered a niche port, meaning one that specializes in a particular cargo or market segment. Most notable at the Port of Palm Beach, is its equipment to handle sugar and molasses, which no other port in South Florida can accommodate. It also specializes in an overnight cruise service to the Bahamas, a day cruise that sails twice daily, and a containership operator that services the Caribbean islands on small containerships. These vessel types are limited to feeder-size vessels, with the largest size of 1700 TEUs[2] that have design drafts of 33 feet. Like its investment to service sugar and molasses products and associated bulker vessels, the Port of Palm Beach has further embraced its "niche port" status by investing in assets suited to its Caribbean cargo market and cruise operators.

[2] A TEU is a unit of measure used to quantify capacity in container transportation. Each TEU represents the equivalent volume of one container with dimensions 20 feet x 8 feet x 9 feet (1440 cubic feet).

STUDY AUTHORITIES

House Resolution Docket 2559 dated 25 June 1998 authorized the Lake Worth Inlet study:

"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 on the Palm Beach Harbor, Florida, published as House Document 283, 86th Congress, 1st Session, and other pertinent reports, with a view of determining if the authorized project should be modified in any way at this time, with particular reference to widening the existing interior channel through Lake Worth Inlet."

Table 1-1: OTHER RELATED AUTHORIZATIONS.

DATE	WORK AUTHORIZED	DOCUMENTS
March 13, 1934 P.W.A. Program[3]	Maintenance of improvements previously constructed by local interests.	H.Doc 185/73/2
August 30, 1935	Authorized work previously approved by the P.W.A. and restoration of jetties, removal of south point, revetment of banks, widening of channels, and enlargement of turning basin.	H.Doc. 185/73/2 and R&H Comm. Doc 42/74/1
December 10, 1935 P.W.A. Program	Deepening channels and turning basin to 20 feet.	Recommended by U.S. Army Corps of Engineers to P.W.A., October 17, 1934
March 2, 1945	Deepening channels and turning basin to 25 feet.	H.Doc 530/78/2
May 17, 1950	Extending turning basin southward 550 feet.	H. Doc 704/80/2
July 14, 1960	Deepening channels to 35 and 33 feet and enlarging turning basin.	H.Doc 283/86/1
November 17, 1986	Maintenance of locally expanded turning basin to a depth of 25 feet on north side of existing basin.	Public Law 99-662
July 11, 1992	Authorized Port of Palm Beach to deepen the northern side of existing basin from 25 feet to 33 feet.	Permit Number 199130682
December 23, 2011	FY11 Request to Construct and Maintain Additional Advance Maintenance Features, Palm Beach County, FL	Memorandum

RELATED DOCUMENTS

Related National Environmental Policy Act (NEPA) documents are listed below, and are available upon request from the USACE:

- Feasibility Report and Environmental Assessment, Palm Beach Harbor, Florida. 1984.
- Environmental Impact Statement, Coast of Florida Erosion and Storm Effects Study Region III, Palm Beach, Broward, and Dade Counties, Florida. October 1996.
- Environmental Assessment and Finding of No Significant Impact, Maintenance Dredging, Palm Beach Harbor, Palm Beach County, Florida. October 1998.
- Environmental Assessment, Section 107 Small Navigation Project, Palm Beach Harbor-Lake Worth Access Channel Expansion, Palm Beach County, Florida. 2001.
- Environmental Assessment, Sand Transfer Plant Rehabilitation and Extended Outfall, Palm Beach Harbor-Lake Worth Inlet, Palm Beach County, Florida. May 2004.

[3] Public Works Administration Program

- Revised Environmental Assessment, Sand Transfer Plant Rehabilitation and Addition of Second Discharge Point and Permanent Booster Pump, Palm Beach Harbor-Lake Worth Inlet, Palm Beach County, Florida. August 2006.
- Environmental Assessment, Palm Beach Harbor Operations and Maintenance Activities, Palm Beach Harbor-Lake Worth Inlet, Palm Beach County, Florida. January 2012.

OTHER PROJECTS IN STUDY AREA

- Lake Worth Inlet Sand Transfer Project
- Peanut Island Environmental Enhancement Project Section 1135

FIGURE 1-1: RELATED USACE PROJECTS ADJACENT TO LAKE WORTH INLET.

RELATED USACE PROJECTS ADJACENT TO LAKE WORTH INLET

SLIP 3, PALM BEACH HARBOR

2.0 EXISTING/FUTURE CONDITIONS LAKE WORTH INLET

Palm Beach Harbor

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2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

Keeping in mind the initial problem statement in Chapter 1, this chapter describes the existing economic, navigation, built, and natural environment in which the port operates, all of which are analyzed through the National Environmental Policy Act (NEPA) regulations. This chapter provides both the existing conditions (a baseline) as well as a forecast of the "future without-project" conditions, which will provide a sound basis for plan formulation in Chapter 3. The "future without-project" condition is also known as the No Action Alternative for the NEPA analysis. The topics in this chapter mirror the topics in Chapter 5: Effects of the Recommended Plan, where the "future with-project" conditions are considered.

2.1 GENERAL SETTING

Figure ES-2 in the executive summary can be referred to for a map showing the existing conditions at Lake Worth Inlet. The foldout reference map on the last page of this report, entitled REF-2 also shows the existing conditions, and can remain folded out while reading this chapter to allow the reader to view a consistent graphic for reference.

Lake Worth Inlet connects Palm Beach Harbor to the Atlantic Ocean. The closest major ports to Palm Beach Harbor are Port Everglades, in Ft. Lauderdale, and Miami Harbor, approximately 40 miles and 65 miles to the south, respectively. Canaveral Harbor is approximately 90 miles to the north. The harbor entrance (also known as Lake Worth Inlet) is an artificial cut through the barrier island and limestone formation connecting Lake Worth, a coastal lagoon, with the Atlantic Ocean. Lake Worth Inlet contains a federally authorized channel and associated features that support a deepwater port located on the Atlantic Ocean in Palm Beach County, Florida. Communities bordering Palm Beach Harbor are Palm Beach Shores on the barrier island, Singer Island, to the north, Riviera Beach on the west shore of Lake Worth, and the town of Palm Beach on the barrier island to the south. West Palm Beach is located immediately south of Riviera Beach and is the largest community in the area.

Lake Worth exhibits characteristics typical of estuarine systems in southeast Florida. Much of the beach and dune ecosystem in this vicinity have been altered by development. Structures such as seawalls and bulkheads have reduced a significant amount of the vegetation that would naturally occur here (Applied Technology and Management Inc. 1995).

The existing channel sediments in Lake Worth Inlet are predominantly sand and shell and are subject to considerable shifting by wave and tidal action. Limestone rock outcrops are found on either side of the Federal channel at the interface between the inlet channel and the Intracoastal Waterway (IWW). Littoral drift in the area is predominantly north to south. The tide is the most important factor in the circulation of water within the Harbor as it controls variation of water elevations. Tide plays an important part in navigation, as the tide range

increases the available sailing draft. The tidal currents and the northward cross current (related to the Gulf Stream) are both important to navigation for maneuverability. High shoaling rates are a recurring problem in Palm Beach Harbor and lead to unplanned, in addition to annual, maintenance dredging events to maintain navigable depths.

Jetties separate the inlet on the north and the south to create the entrance channel. A sand transfer plant is located on the north jetty. The sand transfer plant slurries the accumulated sand material with sea water, and passes it under the inlet through a pipeline. The sand is discharged on the beach south of the south jetty.

2.2 ECONOMIC ENVIRONMENT

2.2.1 OVERVIEW – COMMODITIES

EXISTING CONDITIONS

More details and assumptions which support the brief economic summaries in this chapter can be found in Socio-Economic Appendix C. See Figure ES-2 for a frame of reference for the port facility and vessel berths, relating to the discussions below.

The Port of Palm Beach is a niche port, meaning, a relatively small number of commodities make up a large portion of the total tonnage that transits the port. For example, cement and concrete, molasses, sugar, and petroleum products represented roughly 10% of vessel calls in 2007. However, these same four commodity groups accounted for almost 60% of total tonnage that year (Figure 2-1). In addition to traditional bulk commodities and general cargo, the Port is also home to the cruise ship *Bahamas Celebration*, which runs a two-day route every other day to the Bahamas, a day cruise operator, and Tropical Shipping, a containership operator that services the Caribbean islands on small containerships. Throughout the following analysis, 2007 data is shown as the baseline as it represents a typical level of historical commodity tonnage and vessel calls prior to the economic recession.

Figure 2-1: Comparison of Tonnage and Vessel Calls by Commodity Type.[1]

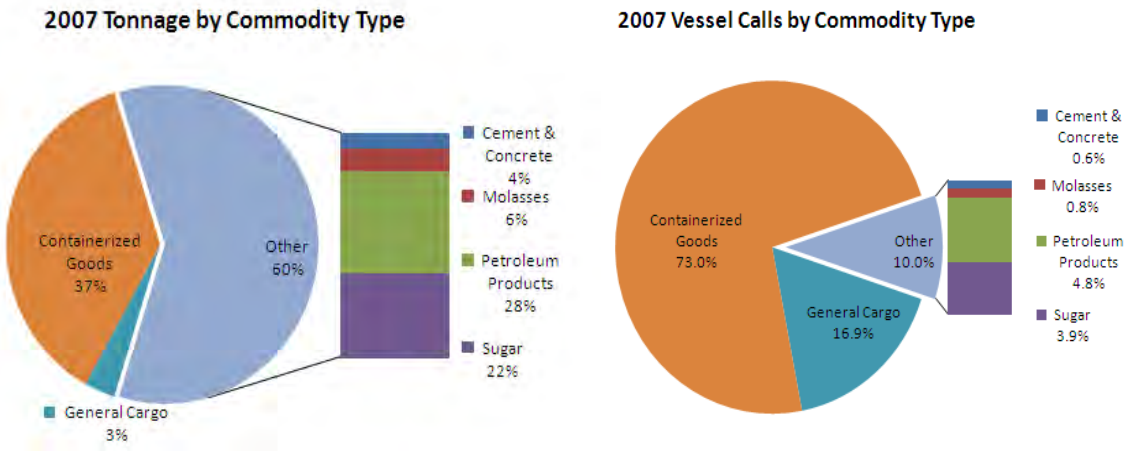
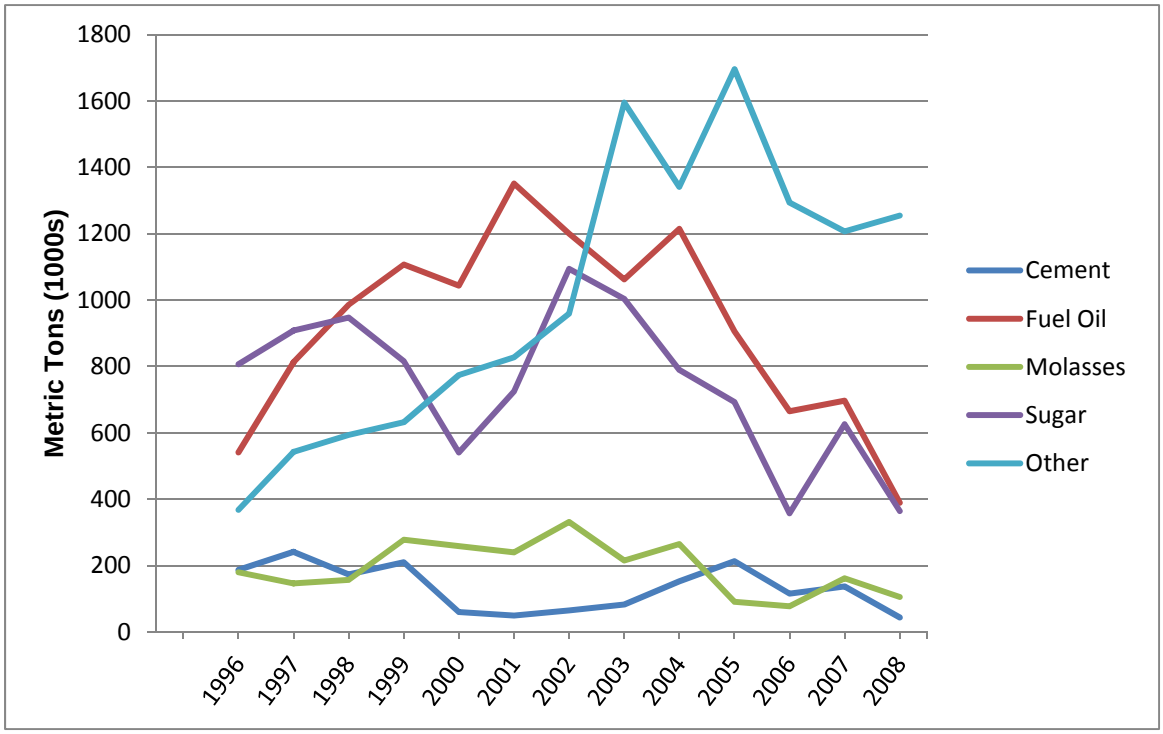


Figure 2-2 depicts the major bulk commodity tonnages for the period 1996 through 2008 that are associated with the deepest draft vessels calling the port. Total major bulk cargo grew from 1.71 million metric tons in 1996 to 2.42 million metric tons in 2004 for a combined annual growth rate (CAGR) of 4.42 percent. Bulk cargoes declined in 2005-2006 largely related to hurricane and storm disruptions, for example, exports of molasses and coast-wise shipments of sugar. Fuel oil has been declining recently due to the closure of the Riviera Beach power generation facility for renovations and modernization. Cement has declined due to the recent housing market price decreases. Not shown on this figure is the recent substantial increase in diesel fuel and asphalt tonnage due to a new port tenant who is importing diesel and asphalt.

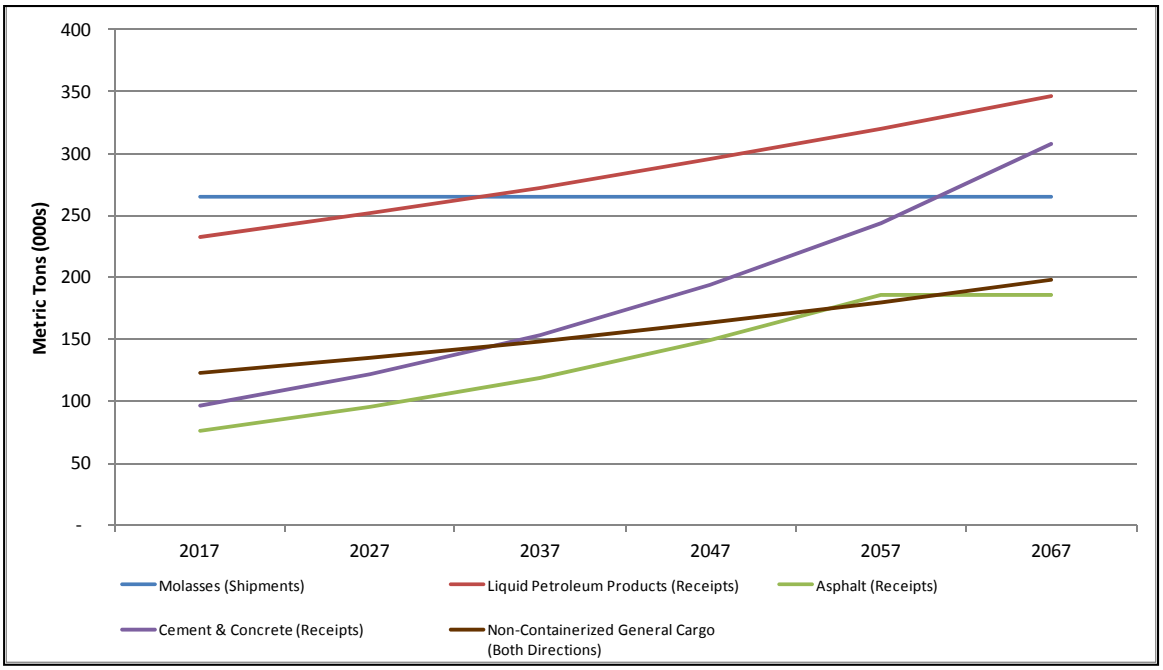
Figure 2-2: Annual Cargo Tons through the Port of Palm Beach (1996-2008).



FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The future commodity growth for the 50-year planning horizon from the base year of 2017[2] to 2067 is shown graphically in Figure 2-3. In the following subsections, the assumptions and caveats behind each of the predictions are detailed.

Figure 2-3: Future Commodity Movement Forecasts for Port of Palm Beach (2017-2067).



2.2.2 OVERVIEW - FLEET

EXISTING CONDITIONS

Figure 2-4 shows the total annual inbound and outbound vessel trips at the port between 1996 and 2010. The sharp decline in total vessel trips, which occurred between 1996 and 1999, is primarily due to a reduction in small domestic vessel calls. From 2000 to 2005, annual vessel trips were steady, while cargo tonnage continued to increase from 2000 to 2003. Since 2005, both annual cargo tonnage and annual vessel trips have steadily declined.

[2] The base-year of 2017 was used throughout the economic evaluation process for feasibility-level analysis. The current schedule shows construction will be complete in June 2018.

Figure 2-4: Port of Palm Beach Total Annual Number of Vessel Trips.

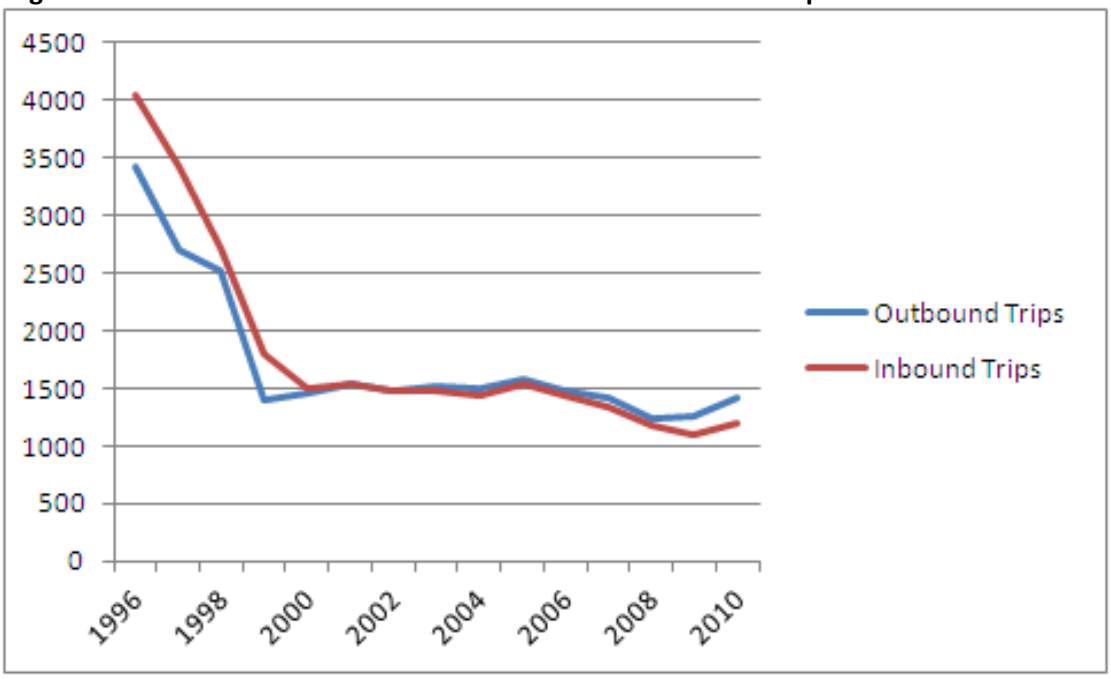


Figure 2-5 shows the number of vessel movements by draft from 2004 to 2010. The existing authorized channel depth is 33 ft at mean lower low water (MLLW). Generally, 2.5 ft of tide or greater is available about 32% of the time, and 3 ft of tide or greater is available about 15% of the time. Therefore, any calls with sailing drafts at 30 ft or greater are draft-constrained and high tide-constrained. Note that the number of calls at 33 ft draft or deeper peaked in 2005, which corresponds to the highest throughput of cement since 1997. Since that time, total tonnage has declined due to reduced demand for some goods. As the total movements have declined, movements that are 27 feet of draft and above have remained steady from 2006 through 2010 (Figure 2-5). A number of vessels in this range of sailing drafts are likely draft-constrained, and could be subject to deeper loading with greater available channel depth.

Figure 2-5: Number of Vessel Movements by Draft.

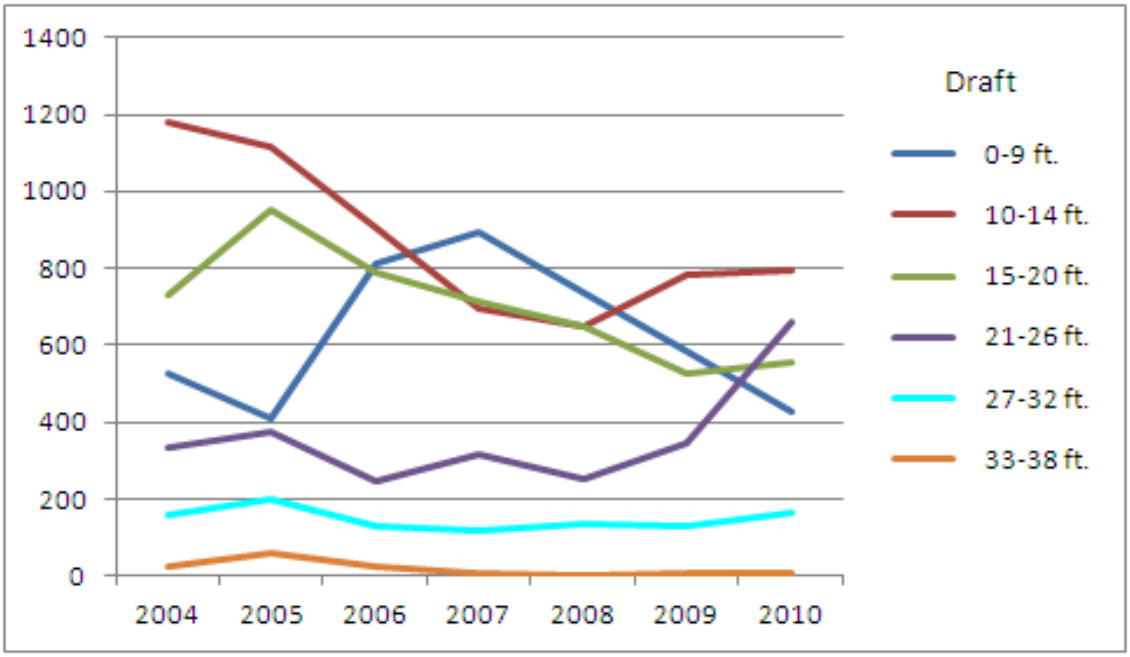


Table 2-1: Draft-constrained Vessel Characteristics by Vessel Type (2007-2009).

Commodity	Vessel Type	Average Design Draft	Max. Design Draft	Average LOA	Max. LOA	Average Calls/Yr
Molasses	Self Propelled Tanker vessel	34.5	41.0	554.5	619	8
Liquid Petroleum	Tanker barge	29.0	36.0	485.2	640	38
Asphalt	Tanker barge	24.6	30.6	453.6	490	5
Cement & Concrete	Self Propelled Bulk vessel	31.2	37.7	514.6	612	5
General Cargo	General Cargo	14.3	36.8	253.3	655	178

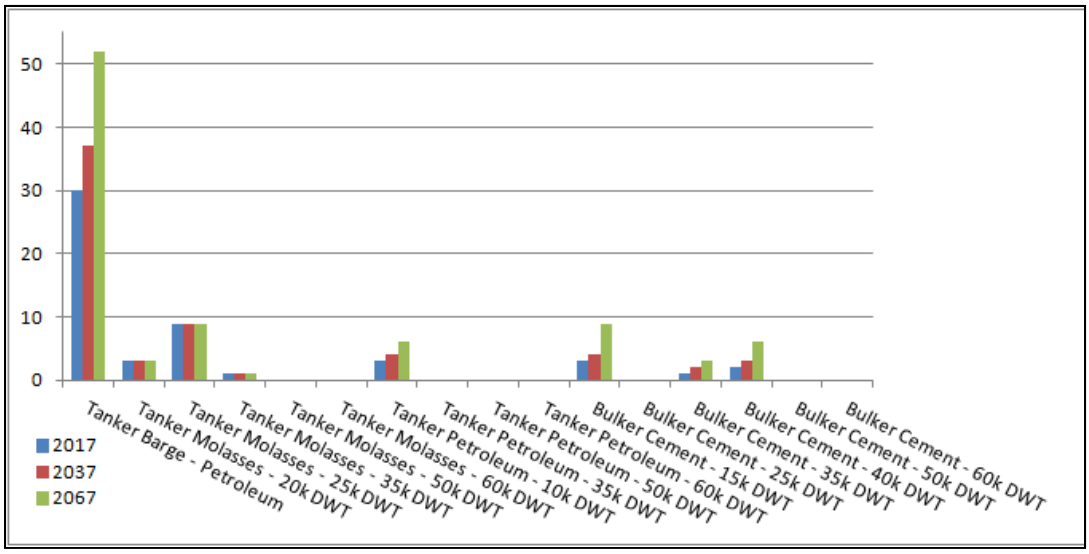
Notes: Averages taken across 2007-2009 data. Missing and erroneous data was excluded from average.
Liquid Petroleum includes: Residual Fuel Oil and Distillate Fuel Oil. LOA = Length Overall.
"Max. Design Draft" is the deepest design draft observed in the 2007-2009 dataset.
"Max. LOA" is the longest length overall observed in the 2007-2009 dataset.

Table 2-1 above shows characteristics of the most draft-constrained vessels in the existing fleet. The average design draft by vessel type was calculated over three years (2007-2009). When comparing the maximum design drafts of the existing fleet to the existing channel depth of 33 feet, it is clear that these vessels are light loading under current conditions. Each of these vessels is also length constrained, as shown by the maximum length overall.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The future without-project vessel fleet will be similar to the composition of the existing fleet, particularly in the fact that it will be draft-constrained by the existing project depth minus underkeel clearance; and length-constrained by the sharp turn in the entrance channel. Under without-project conditions the future fleet will call at 30-foot drafts maximum for (non-petroleum) liquid bulk and dry bulk (33-foot project depth minus 3 feet of underkeel clearance requirements). Compared to the existing condition, one main difference will be the number of vessel calls. The future without-project vessel calls were projected by applying the forecasted commodity tonnage for each commodity type to a vessel fleet distribution that is similar to the existing condition fleet mix. The future without-project vessel movements are summarized in Figure 2-6, below. In the following subsections, the assumptions and caveats behind each of the vessel fleet predictions are summarized.

Figure 2-6: Benefiting Vessel Call Forecasts for Future Without-Project Condition.



2.2.3 MAJOR COMMODITIES

Major commodities at the Port of Palm Beach include: Liquid Petroleum, sugar and molasses, cement and asphalt, cruise ships and passengers, containerized cargo, and non-containerized cargo and specialty shipments.

Liquid petroleum, sugar and molasses, and cement and asphalt, as highlighted in the previous section, are especially important to this study since 1) They are the commodities which make up almost 60% of the total tonnage (2007) transiting through the Port of Palm Beach, 2) Most of these commodities are carried by draft-constrained vessels (bulk vessels and tanker vessels) and would be most likely to benefit from a deepened channel; and 3) Bulk vessels and tanker vessels are the least maneuverable vessels, needing tug assistance, and would be the most likely to benefit from a widened channel.

LIQUID PETROLEUM

EXISTING CONDITIONS: COMMODITY AND FLEET

Commodity: Liquid Petroleum includes residual fuel oil and diesel fuel.

For the purposes of this analysis, tonnage estimates for fuel oil and diesel fuel were combined into a single "liquid petroleum" category. Also, note that even though asphalt is a liquid petroleum product, it is estimated separately and discussed in the cement section because the drivers of demand for asphalt relate more closely to the demand for cement and dry bulk construction materials.

Historically, residual fuel oil (also known as "No. 6" fuel oil) receipts were a large percentage of port cargo traffic because it was used by the Riviera Beach electricity generating facility, owned and operated by Florida Power & Light Company (FPL), which was adjacent to the Port of Palm Beach. In order to meet future energy demands and potential emissions requirements, FPL has recently shut down the Riviera Beach plant with plans to replace it with a more efficient Combined Cycle plant, which will run primarily on natural gas.

Diesel fuel is also received in substantial quantities. One tenant at the Port of Palm Beach currently imports and receives through domestic shipments diesel for resale.

Fleet: Fuel oil and diesel move by domestic tug and barge, primarily from Gulf Coast ports.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodity: The new Riviera Beach power generation facility will be operational by 2014. Due to the Riviera Beach power plant conversion to natural gas, there has been a large reduction in residual fuel oil receipts. The natural gas will be transported to the facility exclusively by pipeline. The rebuilt plant will have the capability to operate on diesel fuel, but this feature would only be used in an emergency in the event of a disruption in the supply of natural gas. The volume (between 120,000 and 150,000 barrels of low-sulfur diesel) that the facility would keep on hand for emergencies is so low that it will likely be brought into the facility through truck rather than by barge.

Diesel fuel consumption is expected to grow at rates similar to the general demand for energy in the transportation sector. The U.S. Energy Information Administration (USEIA) projects an average annual growth rate of 0.6 percent from 2008 to 2035 (USEIA, 2010). Furthermore, with the addition of a biofuel firm at the port, there may be a slight increase above the national rate in traffic of refined petroleum products. However, additional biofuel cargo movements were not assumed in the economic analysis.

The 2017 base year for the overall category of liquid petroleum projections assumes that growth will continue from 2010, as the nation's economy recovers. The 2017 level of liquid petroleum products was determined by first calculating the 2010 tonnage of imports for diesel fuel and residual fuel oil, as self-reported by port tenants. Then growth rates were applied to these commodities using the projected national rates of growth of demand for electricity and transportation energy, respectively (USEIA, Annual Energy Outlook 2010). The 2017 level of gasoline receipts was based on a pre-recession level of imports, taken from the 2006 tonnage reported by Waterborne Commerce Statistics.

Fleet: In the without-project condition, receipts of fuel oil will continue to move primarily by domestic tug and barge (which are not draft-constrained). With the large reduction in fuel oil receipts because of the Riviera Beach power plant conversion to natural gas, it is less likely that the fleet of tanker barge carrying fuel oil will transition to self-propelled tanker vessels in the without-project condition. Diesel fuel will continue to be brought in by domestic tug and barge as well, with some small self-propelled tanker movements. Panamax tanker vessels, even light-loaded, cannot utilize the harbor in the without-project condition because they are too long to maneuver safely through the turn in the inner channel.

SUGAR AND MOLASSES

EXISTING CONDITIONS: COMMODITY AND FLEET

Commodity: Sugar and molasses have traditionally been two major domestic shipments and foreign export commodities of the Port of Palm Beach. The Port of Palm Beach is the only nearby port with the specialty equipment for storing and load sugar and molasses onto

ocean-going vessels. Sugar and molasses are produced in the agricultural areas of Palm Beach County and central and southern Florida. In 2007-2008, Florida contributed an estimated 48 percent of the cane sugar and 24.3 percent of the total sugar produced in the U.S., from sugarcane and beets, combined. (University of Florida Institute of Food and Agricultural Sciences (UF/IFAS), Florida Sugarcane Handbook, SS-AGR-232, August 2009). About half of that amount was shipped out via domestic barge through the Port of Palm Beach. Molasses is generally used as an additive in feed for livestock in Northern Europe.

Fleet: Domestic sugar refineries that typically receive Florida sugar are located in Yonkers, New York; Baltimore, Maryland; Savannah, Georgia; Chalmette, Louisiana; and Gramercy, Louisiana, moving on domestic tanker vessels with tug assistance. Molasses is shipped through the port of Palm Beach via foreign-flagged products tanker vessels to ports in Northern Europe. The self-propelled molasses tanker vessels are currently draft-constrained, as the largest vessels that have called in recent years have design drafts up to 41 feet. Molasses product tanker vessels (like bulk vessels) also use the greatest amount of tug assistance.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodity: These commodities[3] will likely experience very slow but steady growth in the future until the limit of production capacity in Florida is reached, at which point growth in production will remain constant. On a national level, the U.S. Department of Agriculture (USDA) expects sugar for human consumption to grow at approximately 0.6 percent per year (USDA 2010). This level of growth is less than the projected growth rate of the population of the U.S. Therefore, this projection leads to a scenario in which per capita sugar consumption will decline slightly by 2019. In the future without-project scenario for this analysis, sugar and molasses tonnage movements are expected to return to 2004 levels by 2017, and then experience no growth over the period of analysis because of how close the production level will be to the limit of sugar production in Florida, which is constrained by land available for production.

Fleet: Sugar would continue to move by domestic tanker barge with tug assistance in the without-project condition because it is not viable to sell on the world market due to national price supports for U.S. sugar production. Molasses would continue to move on draft-constrained foreign-flagged tanker ships.

[3] Molasses production is a direct by-product of sugar production and therefore its growth is inherently related to growth in production of sugar.

CEMENT AND ASPHALT

EXISTING CONDITIONS: COMMODITY AND FLEET

Commodity: "Cement tonnage" for the purpose of this report is used as proxy for all cement and cement input materials, such aggregate, bauxite, alumina, gypsum, and silica sands. Some of these input minerals must be imported for use in domestic cement production, as they are not produced domestically. Therefore, there will always be a demand to import some input minerals, even if demand for cement is relatively low.

Demand for cement is primarily related to the demand for infrastructure construction and repairs (roadways), as well as for residential and commercial construction and repairs. Long-run demand for these types of construction is ultimately dependent upon population growth.

The hinterland of the Port of Palm Beach for construction materials includes undeveloped land north and west of the Port in Palm Beach and Martin counties. The proximity of the port is also close to other high growth areas in Florida, such as Indian River, Osceola, and Orange Counties, which are home to the cities of Vero Beach, Kissimmee, and Orlando, respectively. In 2011, the U.S. Census Bureau estimated the Orlando-Kissimmee Metropolitan Statistical Area to have almost 2.17 million people.

The Port of Palm Beach traditionally has moved a large amount of cement and other construction materials through its facilities since the 1990s. Cemex, a large cement company who acquired Rinker in 2007, has cement storage and processing facilities on-site at the port, and they are currently under a lease agreement with the Port. The facility is now idle but ready to return to service. This indicates that as soon as demand for cement rises, imports of cement will resume at normal rates, and should increase into the future along with the demand for new construction.

Demand for asphalt is primarily related to the demand for infrastructure construction and repairs (roadways), as well as for residential and commercial construction and repairs (roofs, driveways, and parking lots). It is important to note that although the demand and growth for asphalt is related to cement, it travels on tanker barge like petroleum products, rather than bulk vessels like cement products, and is therefore "counted" as a petroleum product in terms of costs and benefits.

The amount of asphalt that can be moved through the Port is constrained by the available storage facilities at the Port. However, the on-dock storage capacity limitation for asphalt receipts only limits the volume that can be received in a single shipment - it does not limit the total throughput capacity at the port.

Fleet: Cement has traditionally been imported on foreign-flagged dry bulk carriers from various countries such as Mexico, Denmark, and Egypt. Cement bulk vessels are currently draft-constrained, given the evidence that the largest cement vessels calling in recent years

have had up to 37.7-foot design drafts. These types of vessels also use tug assistance frequently.

Asphalt has historically moved through the Port of Palm Beach by domestic tanker barge (which are not draft-constrained), coming from U.S. Gulf Coast ports and some small foreign-flagged tanker vessels from East Coast South America and transshipment hubs in the Caribbean, usually requiring tug assistance for larger vessels. Panamax tanker vessels, even light-loaded, cannot utilize the harbor in the without-project condition because they are too long to maneuver safely through the turn in the inner channel.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodity: Nationwide, unadjusted growth in expenditures for residential construction remains slow but constant over the next 30 years after an expected rebound from recession levels (IHS Global Insight 30-year Focus, May 2009). The projected post-recession compound annual growth rate in construction expenditures from 2012 to 2039 is 3.14 percent. However, the compound annual growth rate of expenditures on residential construction from 2012 to 2039 in chained 2000 dollars[4] is 0.68 percent.

The Port of Palm Beach traditionally has moved a large amount of cement and other construction materials through its facilities, in the hundreds of thousands of tons since the 1990s. This volume has dropped off because of the decline in new construction, but it is expected to return to pre-recession levels by the base project year of 2017, as new construction rates return to normal. Cement and asphalt are complementary goods, and their growth rates both depend upon construction. The same level of growth that was applied to asphalt receipts was applied to cement. The comparatively less-developed hinterland in northern and western Palm Beach County, and neighboring counties, makes this level of growth a likely scenario.

Future demand for asphalt is ultimately dependent upon population growth. Future population projections for surrounding counties range from 0.95% to 3.81% (Florida Demographic Database, August 2009). One port tenant that imports asphalt owns a subsidiary construction company that does business all over south Florida, and up to the Orlando metropolitan area.

The 2010 base amount of tonnage for asphalt was calculated based on self-reporting by port tenants. Then, to yield the future levels of asphalt receipts, the compound annual growth rate of expenditures on residential construction from 2012 to 2039 in chained 2000 dollars from IHS Global Insight, 0.68 percent, was applied to the 2010 base level of asphalt receipts. However, the amount of asphalt that can be moved through the port is not only constrained

[4] Chained dollars are adjusted to account for inflation by indexing them to a reference year, in this case, 2000.

by demand from the hinterland, but also from the available storage facilities at the port. However, the on-dock storage capacity limitation for asphalt receipts only limits the volume that can be received in a single shipment - it does not limit the total throughput capacity at the port.

Fleet: In the future without-project scenario, self propelled bulk vessels carrying cement would continue to be draft-constrained and require use of tug assistance.

Asphalt would also continue to travel primarily by domestic tanker barge and some small foreign-flagged tanker vessels.

CRUISE SHIPS

EXISTING CONDITIONS: PASSENGERS AND FLEET

Commodity: From 1997 to 2010, the *Palm Beach Princess* operated as a day-cruise out of the Port of Palm Beach. The day-cruises offered dining and gambling once the ship reached international waters. The *Princess* sailed twice daily. In late 2009, the *Princess* suffered mechanical and financial troubles, which were compounded by decreased attendance because of poor economic conditions nationwide. The operators of the *Princess* filed for bankruptcy and have relocated the ship as of April 7, 2010.

As of March, 2010, a new overnight cruise ship, the *Bahamas Celebration* (with Celebration Cruise Line), has been operating out of the Port of Palm Beach. The *Bahamas Celebration* can accommodate up to 1311 passengers at maximum capacity (not including crew), on approximately 178 vessel calls per year. They run a two-day route to Freeport, Bahamas and back, every other day. The Celebration Cruise Line has been operating at an average of 67% of maximum capacity from their first voyage throughout the remainder of calendar year 2010 (U.S. Customs and Border Protection).

In 2012, the Port accepted a contract from an operator of the vessel *Black Diamond*, a 160 ft long cruise vessel with a capacity of 600 passengers and 150 crew members. The *Black Diamond* began service in November 2012 and operates on a twice-daily schedule. The *Black Diamond* also provides regional economic development benefits because it is a U.S. flagged vessel and it employs 150 local workers. The Port of Palm Beach will realize increased revenues from parking and passenger fees as well. In 2013, the *Black Diamond* came under new ownership, and has been renamed *Island Breeze II*. It has stopped sailing briefly due renovations, but it is expected to begin a normal schedule in early 2014. The vessel operators have a 10-year contract with the port, which guarantees 125,000 passengers annually.

Fleet: Currently, the *Bahamas Celebration*, at 673.4 feet long, is the largest cruise vessel that will fit through the turn in the entrance channel of Lake Worth Inlet. Due to its length, the cruise vessel is restricted to slack-water transit at less than 2 knots of current when winds are 30 knots or greater, and local tug may be required. Additionally, the *Bahamas*

Celebration must make a sharp turn when backing out to avoid the shoal at the south side of Peanut Island. This turn prevents cargo vessels from berthing at Berth 6 (opposite Berths 2-3 in Slip 1) when the cruise ship is present.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodity: The only way for Celebration Cruise Lines to expand their current service would be to add a second vessel to their route, which would effectively double their current passenger capacity. This scenario is a best-case future growth scenario. Since the cruise line has only been operating since March 2010, and the industry exhibits high seasonality, a future growth estimate was not determined. The economic analysis was kept more conservative by assuming existing cruise traffic throughout the period of analysis. Before the *Bahamas Celebration* began to sail out of the Port of Palm Beach, the port renovated its current cruise passenger terminal to accommodate the larger vessel and greater quantity of passengers.

The port will likely also continue service with the *Island Breeze II*, or a similar service.

Fleet: In the future without-project condition, the *Bahamas Celebration* cruise vessels will remain length-constrained because of the sharp turn in the entrance channel. So, if Celebration Cruise Line were to add a second vessel to their fleet, it would likely be of a similar length. The restriction when winds are greater than 30 knots would remain in place.

CONTAINERIZED CARGO

EXISTING CONDITIONS: COMMODITY AND FLEET

Commodity: The port has a niche business with a containership operator that services the Caribbean islands on small containerships. The container traffic through the Port of Palm Beach is primarily moved by Tropical Shipping, who services the Caribbean islands with consumer goods, food, and retail products from the United States and Canada. The hinterland of goods within the containers encompasses the entire U.S. and beyond. Tropical Shipping has experienced steady historical growth up to the recession of 2008-2009.

Fleet: These vessel types are limited to feeder-size vessels, with the largest size of 1700 TEUs[5] that have design drafts of 33 feet. Port Everglades and Port of Miami collectively serve longer international trade routes with Northern Europe, the Mediterranean, Asia, and Central and South America. Tropical currently offers at least 6 different liner services, which visit almost 30 Caribbean ports with a total average capacity of 3000 TEUs per week through the Port of Palm Beach for all of their liner services combined. Extrapolated over the entire

[5] A TEU is a unit of measure used to quantify capacity in container transportation. Each TEU represents the equivalent volume of one container with dimensions 20 feet x 8 feet x 9 feet (1440 cubic feet).

year, the total annual capacity for all Tropical Shipping services through the Port of Palm Beach is approximately 156,000 TEUs per year.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodity: The post-recession number of container shipments is expected to continue to grow into the future at a rate of about 3 percent per year, according to Tropical's own estimate (personal communication on July 21, 2010).

The rate of growth attributed to containerized cargo exports from the Port of Palm Beach is directly related to demand for goods in the Caribbean islands, which is primarily influenced by growth of travel and tourism in the area. Real growth of demand for the travel and tourism industry in the Caribbean is projected to increase by 3.9% per year to U.S. $107 billion by 2020 (World Travel and Tourism Council, 2010). Therefore, the tenant's own growth estimate of 3 percent per year appeared reasonable, and it was then applied to the 2011 Port Import-Export Reporting Service (PIERS) forecast, through 2025, at which point the port will likely approach its throughput capacity.

Fleet: In the future without-project scenario, some of the largest container ships in Tropical's fleet will likely increase in size to take advantage of economies of scale. In recent years, ships as large as the *Dorian* with a 1,524 TEU capacity and 32.5 foot design draft have been chartered to meet spikes in demand or to replace other ships while they were in service. Tropical currently charters two vessels with an average TEU capacity of nearly 1,100 TEUs on their weekly service to Saint John, New Brunswick, and Canada. Without the project, draft restrictions will limit the size of the vessels to the 1,350-1,500 TEU capacity range, since Tropical only uses vessels that are self-geared in order to unload in the some of the Caribbean ports of call that do not have as advanced dock-side facilities.

By chartering vessels to meet excess demand, Tropical can expand their liner services accordingly in a relatively short time period compared to building or purchasing a new vessel. However, once demand reaches a certain point it is more economical for Tropical to build or purchase a new vessel for their fleet.

NON-CONTAINERIZED GENERAL CARGO AND SPECIALTY SHIPMENTS

EXISTING CONDITIONS: COMMODITY AND FLEET

Commodity: Although general cargo movements have historically made up a smaller portion of commodity traffic at the Port of Palm Beach, a relatively new tenant, Port Contractors, Inc., has been handling various types of break bulk, project cargo, and specialty cargo since the fourth quarter of 2008. They move many different goods, from many different markets, such as heavy equipment, wire rod, linerboard paper, telephone poles, and equipment for

FPL. Additionally, they specialize in large yacht relocation services. The yachts shipped are typically up to 200 feet long.

Fleet: The largest vessels that have called in recent years have had lengths up to 655 feet, and design drafts up to 36.75 feet. These large vessels are calling already nearly fully loaded (where the channel depth permits) in order to pick up or deliver specialty shipments, such as yachts or project cargo. The vessels arrive heavily loaded and then add project cargo or specialty cargo to the deck before departing at the limits of the channel depth. Alternatively, the vessel may arrive at the maximum sailing draft in the channel, and then drop off only the cargo on its deck and depart heavily loaded. So, the large general cargo ships are using the maximum available draft or near the maximum draft both inbound and outbound. The existing fleet of the largest general cargo ships is already draft-constrained by the current channel depth, and it is length-constrained by channel width.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE): COMMODITY AND FLEET

Commodities: Port Contractors, Inc. has grown its commodity movement tonnages exponentially in the first two years of operation at the port and expects to continue to move a greater quantity of miscellaneous break bulk goods, and specialty cargo each year. The rate estimated for the growth of all non-containerized general cargo is the compound annual growth rate of the historical commodity tonnage throughput from 1996-2006, 1.9 percent.

Fleet: Even with relatively low commodity tonnages and growth rates, the vessels calling the Port of Palm Beach in the future for general cargo shipments will likely be some of the largest vessels calling the Port. In the future without-project scenario, current physical limitations at the port will continue to place hardships on the port tenants that move these types of goods. If the channel depth is limited, then the ships must light load to be able to call the Port of Palm Beach as the first stop or last stop in their route with the specialty goods (cargo and yachts) on the top deck. In the future without-project, these vessels will continue to be draft and length-constrained.

2.3 NAVIGATION ENVIRONMENT

2.3.1 TIDES

EXISTING CONDITIONS

Tide plays an important part in navigation. The existing channel depth and underkeel clearance requirements constrain vessel transit, but the high tide allows vessels to increase their maximum sailing drafts through “tide riding” behavior. In Lake Worth Inlet, the mean tidal range is 2.8 feet and spring tidal range is 3.3 feet. The critical relationship is between

the depth of the channel at low tide and the vessel characteristics. The low tide is important because this is how the "project depth" is measured, and the vessel characteristics, such as the sailing draft and required underkeel clearance, are important because they will establish the maximum sailing draft without having to wait for tide. It is not the range by itself that matters but the larger the range, the lower the low tide which in conjunction with the existing channel depth is the constraint. The tide range can also indicate the time available for transit when there is a transit restriction. Generally, two high tides and two low tides occur each day along the Atlantic coast. On many days, the high tide may occur only once during daylight hours, which greatly impacts navigation of draft-constrained vessels that are also subject to daylight-only sailing restrictions because of their cargo and/or sailing draft.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Tides will generally remain the same as the existing condition, with some potential changes related to sea level rise projections by the mid-century.

2.3.2 CURRENTS

EXISTING CONDITIONS

The tidal currents and the northward cross current (related to the Gulf Stream) are both important to navigation at the entrance.

Tidal currents in the Palm Beach Harbor entrance channel are strong and must be carefully guarded against, according to the 2010 U.S. Coast Pilot 4. The maximum currents occur in the entrance channel where maximum flood currents of 6.0 feet per second (3.6 knots) are experienced and the maximum ebb velocity is 4 feet per second (2.4 knots). Average flood and ebb velocities in the entrance channel are 3 feet per second (1.75 knots) and 2 feet per second (1.25 knots) respectively. At the Inner channel, the average flood and ebb velocities are 1 foot per second (1.6 knots) and 2.5 feet per second (1.5 knots). In the IWW, at Peanut Island the average flood and ebb velocities are both 1.3 feet per second (0.75 knots).

The U.S. Coast Pilot 4, Chapter 10, 26 Jan 2013, page 328 mentions: "A northern gulf stream current almost all year makes an approach to the inlet from the southeast the safest, however, at times large swells from the north do occur and alternate approaches may be instructed by the pilots for safety reasons. Large vessels are taken in only at slack water and may be restricted to daylight hours under certain conditions."

Most vessels approach the inlet from the southeast for safety reasons due to a northward longshore current (not related to wave activity) which occurs most of the year. Some

vessels, after entering the jetties, must correct the crab angle resulting from the northern Gulf Stream current by steering in a port (left) direction.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Currents will generally remain the same as the existing condition described above, with some changes due to global cooling and warming trends.

2.3.3 SEA LEVEL RISE

EXISTING CONDITIONS

Based on historical sea level measurements taken from National Ocean Service's (NOS) gage 8723170 at Miami Beach, Florida, the historic sea level rise rate was determined to be 2.39 mm/year (0.0078 ft/year). See Engineering Appendix A, Hydrodynamic Attachment A, for more information.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

In order to meet the requirements of Engineer Circular 1165-2-212, the full range of possible relative sea level rise (RSLR) rates, which were developed in accordance with a specific methodology prescribed in the guidance, is evaluated in Engineering Appendix A, Hydrodynamic Attachment A. Following procedures outlined in EC 1165-2-212, baseline, intermediate, and high sea level rise values were estimated over the life of the project. Sea level rise could be expected by 0.39 feet (baseline), 0.89 feet (intermediate), and 2.27 feet (high) over the next 50 years. The potential impacts of rising sea level include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. Seagrasses are found in the Intracoastal waterway and Lake Worth Lagoon vicinity in water depths up to 12 feet. Current seagrass beds would more than likely survive with the proposed sea level rise scenarios within their current range adjacent to the project area. As a result, it is expected that the seagrass beds would continue to exist, although photosynthetic efficiency may decrease with increasing depth.

2.3.4 STORM SURGE

EXISTING CONDITIONS

According to “Introduction to Storm Surge”, National Oceanographic and Atmospheric Administration (NOAA), storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tide. Storm surge is caused primarily by the strong winds in a hurricane or tropical storm; the low pressure of the storm contributes minimally. Storm surge is the change in the water level that is due to the presence of the storm. Since

storm surge is a difference between water levels, it does not have a reference level. All locations along the U.S. East coasts are vulnerable to storm surge, which makes it relevant to the Lake Worth Inlet area. The existing storm surge water level for the 100 year storm event within the project vicinity is up to 10 feet.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

According to the Federal Emergency Management Agency (FEMA) Final Report for Task Order 333 Hurricane Frances Rapid Response, Florida CHWM Collection, January 31, 2005, Hurricane Frances hit Florida in 2005 with reported maximum sustained winds of over 105 mph with storm surges over five feet. It is likely that another storm of this magnitude, and lesser magnitudes, could hit Florida again, and create a storm surge in the Lake Worth Inlet area. The storm surge water level within the project vicinity will continue to be up to 10 feet during the 100 year storm event.

2.3.5 NAVIGATION RESTRICTIONS

EXISTING CONDITIONS

The existing conditions at Palm Beach Harbor, Lake Worth Inlet, cause vessels to be restricted by light loading, tidal delays, and maneuvering difficulties. These translate into transportation costs to the economy, navigation concerns and safety issues. Existing project depths range from 35 feet in the entrance channel to 33 feet in the inner channel, and existing project widths range from 400 feet in the entrance channel to 300 feet in the inner channel.

The Palm Beach Harbor Pilots have placed the following navigational restrictions for traffic at the Port of Palm Beach, shown in Table 2-2.

These rules show that as cargo vessels increase in size, they face greater restrictions in terms of tide and current conditions, draft restrictions, daylight transit, and use of tugs, which means that the vessel will have less available time to transit through the harbor, and/or the entire voyage will be more costly. Additionally, large vessels may be forced to call light-loaded to either avoid restrictions or to even transit the harbor at all. All of these constraints increase total transportation costs.

Table 2-2: Summary of Pilots' Rules for Existing Conditions.

Rule #	Rule Description	Ship Types/Classes Affected	Applicable Condition	Tide Dependent?	Current Dependent?
1	One Way Traffic Only: No Passing, No Overtaking	All Vessels	Always	N	N
2	>= 600' LOA: Daylight Inbound Transit Only	All Single-screw Vessels >= 600' LOA	Daylight	N	N
3	>30' Sailing Draft: Restricted to High Slack Water (+/-0.5hrs); Daylight Inbound Transit Only	All Single-screw Vessels >30' Sailing Draft	Always/ Daylight	Y	Y
4	3rd Tug MAY be Req'd for ships >=600' LOA and >=28' Draft	All Single-Screw Vessels meeting dimension criteria	Always	N	N
5	3rd tug MAY be req'd for ships >=550' LOA and >30' draft OR >=85' beam and >30' draft	All Inbound Single-Screw Vessels meeting dimension criteria	Always	N	N
6	Petroleum-carrying vessels restricted to slack water only (+/-0.5hrs); daylight transit only	All Petroleum-carrying Tankers and Barges	Daylight	N	Y
7	Inbound Petroleum-carrying vessels restricted to 32'0" max sailing draft in high slack water, and 29'0" in low slack water	All Inbound Petroleum-carrying Tankers and Barges	Always	N	N
8	Large Cruise vessel restricted to slack-water (<2kts) transit when winds >=30 knots, and local tug may be required	Cruise - Bahamas Celebration	Always	N	Y
9	Safety Distance: 1/4 Mile fore and aft of all vessels	All Vessels	Always	N	N
10	33' 0" Max Sailing Draft at High Slack Water; 30' 0" Max Sailing Draft at low slack water	All (non-petroleum-carrying) Vessels	Always	Y	Y

Source: Palm Beach Harbor Pilots Association

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The number of vessels will continue to increase and will be restricted by light loading, tidal delays, slack-water transit restrictions, daylight transit restrictions and maneuvering difficulties. These will continue to translate into transportation costs to the economy, navigation concerns, and safety issues.

2.4 BUILT ENVIRONMENT

2.4.1 EXISTING FEDERAL PROJECT

EXISTING CONDITIONS

The authorized channel for the existing Federal project is summarized in Table 2-3 and includes the following: an entrance channel 35 feet deep, 400 feet wide, and 0.8 miles long, merging with an inner channel 33 feet deep, 300 feet wide and 0.3 miles long, then flaring into a turning basin, 1,400 feet north-south along the side next to the berthing area by a minimum of 1,210 feet east-west; maintenance of a local turning basin to the north of the project turning basin of 25 feet; and jetties and shore revetments at the inlet. The entire length of the project is approximately 1.6 miles. Maintenance of the northern turning basin including the area of slip 1 is authorized to 25 feet; however much of this area is constructed to 33 feet by the non-federal sponsor.

Table 2-3: Existing Federal Project Features

Feature	Authorized Depth (feet)	Width (feet)	Length (miles)
Entrance Channel	35	400	0.8
Inner Channel	33	300	0.3
Main (South) Turning Basin	33	1200 (diameter)	n/a
Local (North) Turning Basin	25	n/a	n/a

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The Federal project would remain as designed in its current dimensions in the future without-project condition. No changes to the footprint of the Federal project, as described in Table 2-3, would occur.

2.4.2 OPERATIONS AND MAINTENANCE

ADVANCE MAINTENANCE AND SETTLING BASIN

EXISTING CONDITIONS

The Federal channel is a rapidly shoaling channel requiring annual dredging events to remain open for safe navigation. Dredged material placement is typically on the downdrift beach or in the adjacent nearshore. Numerous emergency dredging events have also been required to maintain a safe operational channel. In the past, maintenance dredging has occurred up to 2 times per year.

The existing Federal project has had several maintenance features that assist in keeping the channel operational and reducing costs (see Figure ES-2 in the Executive Summary and foldout reference map, REF-2, on the last page of this report). These features include a settling basin to the north of the entrance channel and additional advance maintenance depth within the entrance channel from station 30+00 to station 47+00.

These features allow the dredging cycle to be extended. The strategy is not to reduce the volume of material required to be dredged, but rather, for more material to be trapped in the settling basin or under the channel, rather than the channel itself. This allows for cost savings by reducing the number of maintenance dredging events, while providing an operational channel for longer periods of time.

In December 2011, USACE approved an advance maintenance plan (2011 Advance Maintenance Plan) which recommended additional improvements to existing advance maintenance features in order to the reduce dredging frequency for maintenance material from 2 times per year to 1 time per year and which would result in savings of $4,362,336 (present worth savings), or $207,433 (average annual equivalent). The 2011 Advance Maintenance Plan recommended two main improvements which have been constructed as of the fall of 2012:

1) Construction and maintenance of an expanded settling basin north and west of the existing settling basin. The dimensions of the new basin are 550 feet by 500 feet at a dredging depth of 35 feet + 2 feet MLLW; and

2) Construction and maintenance of an additional 2 feet (39 feet + 2 feet MLLW) of advance maintenance from Sta. 30+00 to Sta. 47+00 in the entrance channel.

The 2011 Advance Maintenance Plan was analyzed in the January 2012 Palm Beach Harbor Operations and Maintenance Activities Environmental Assessment (EA) and Finding of No Significant Impact (FONSI). Annual maintenance dredging of Palm Beach Harbor currently authorized footprint occurs 1 time annually to remove sediment that has shoaled within the

channel. Temporary disruptions of vessel traffic due to dredging activities occur during these events.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

It is expected shoaling would continue in the future without-project condition. Although the 2011 improvements are expected to greatly reduce the frequency of operation and maintenance dredging operations from twice per year to once per year, shoaling in the entrance channel continues to be problematic in terms of maintaining the channel depths, especially after storm events, for safe navigation. Additional improvements could possibly further reduce the frequency of dredging, allow safe navigation for longer durations of time, and provide cost savings through less frequent mobilization and demobilization of equipment. Further information related to past and current advance maintenance can be found in the January 2012 Palm Beach Harbor Operations and Maintenance Activities EA and FONSI.

2.4.3 DREDGED MATERIAL PLACEMENT

A preliminary assessment was written in 1996 and determined that the following five areas were available for placement of dredged material: 1) on the beach south of the inlet; 2) along the near shore area south of the inlet; 3) in an ocean dredged material disposal site (ODMDS); 4) on Peanut Island; and 5) other beneficial use sites.

A map showing current placement sites is located on Figure ES-2. During the time since the preliminary update was written, the interim ODMDS site was replaced with a new ODMDS site in 2004, located approximately 4.5 miles east of Lake Worth Inlet. The new ODMDS has been used once since its establishment, for disposal of 3,500 cubic yards of material, for Palm Beach Harbor Operations and Maintenance activities. Peanut Island is only potentially available for a limited amount of material. Beach and nearshore placement sites are still being used. The original beneficial use site mentioned in the preliminary assessment is filled to capacity; however, other beneficial use opportunities exist and are identified in Figure ES-3 of this document.

BEACH PLACEMENT

EXISTING CONDITIONS

Beach quality material from past operation and maintenance dredging events (on average 100,000 cubic yards per year per Engineering Appendix A, Hydrodynamic Modeling Sub-Attachment A), has been placed on the beach above the Mean High Water (MHW) line to vegetation between FDEP reference monuments R-76 to R-79. Capacity ranges from 150,000 cubic yards to 400,000 cubic yards, depending on the timing of the most recent operation and maintenance event.

At the time of this report, the Town of Palm Beach, Florida, acquired approximately 23 temporary construction easements as part of the existing Palm Beach Harbor Maintenance Dredging Beach Placement Project. The easements, as well as the additional 20 parcels, (R-76 through R-81), are in the acquisition process. The easements will expire in May 2015. The easements extend from approximately R-76.5, 2,500 feet to R-79. These parcels have been certified for the Palm Beach Harbor Navigation Operation and Maintenance Project. A Memorandum of Agreement (MOA) between the Town of Palm Beach and the USACE, in conjunction with the easement, allows the USACE to nourish, renourish, protect, operate and to perform any other work necessary and incident to the maintenance between MHW and vegetation for maintenance events, with all real estate costs to place above MHW line paid for by the Town of Palm Beach.

As set forth in the 2011 Final Statewide Programmatic Biological Opinion (BO), beach quality material may be placed on the beach between November 1 and April 30 to avoid impacts to nesting sea turtles. Beach compatible fill, as described in the 2011 Final Statewide Programmatic Biological Opinion (BO) is material which maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. The fill material must be similar in both coloration and grain size distribution to the native beach. Fill material would comply with Florida Department of Environmental Protection (FDEP) requirements pursuant to the Florida Administrative Code (FAC) subsection 62B-41.005(15).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Beach quality material from operation and maintenance dredging events will continue to be placed on the beach (above the MHW line to vegetation) between FDEP range monuments R-76 to R-79, with the support of the Town of Palm Beach, as described above. As identified in previous National Environmental Policy Act (NEPA) documents (Chapter 1, Related Documents) and FDEP Permit Number 0216012-007-JC, the nearshore disposal and the beach fill templates are located immediately south of the jetty, between FDEP reference monuments R-76 and R-79 (Sections 2 and 3, Township 43 South, Range 43 East). All activities are within Palm Beach County, Lake Worth Lagoon (Atlantic Intracoastal Waterway), or the Atlantic Ocean, Class III Waters, not Outstanding Florida Waters. If needed, the dredged material could also be placed on Peanut Island, or at the Palm Beach Harbor ODMDS location, or at beneficial use locations.

NEARSHORE PLACEMENT

EXISTING CONDITIONS

Material which is not of beach quality from past operation and maintenance dredging events, containing less than 20% fines and does not contain rock, has been placed in the nearshore (below the MHW line out to the -17 ft contour) between FDEP range monuments R-76 to R-79. As currently authorized, dredged material that does not meet the

requirements for placement on the beach may be placed in the nearshore. In addition, during sea turtle nesting season (May 1 through October 31), dredged material may be placed in the nearshore as per the 2011 Final Statewide Programmatic BO. Dredged material should not be stacked so high that it is exposed during low tide.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Material which is not of beach quality from operation and maintenance dredging events will continue to be placed in the nearshore (below the MHW line) between FDEP range monuments R-76 to R-79, as described above.

OCEAN DREDGED MATERIAL DISPOSAL SITE (ODMDS) PLACEMENT

EXISTING CONDITIONS

Due to the sandy material typically dredged from operation and maintenance events and its suitability for placement on the beach or nearshore, the ODMDS site has not been used for Palm Beach Harbor operation and maintenance material (with the exception of a one-time use for 3,500 cubic yards of material).

The "2004 Final Environmental Impact Statement (EIS) for the Designation of the Palm Beach Harbor ODMDS" and "2004 Site Management and Monitoring Plan (SMMP)," through coordination with the EPA, designated the Palm Beach Harbor ODMDS. This ODMDS is one square nautical mile in area centered at coordinates 26°47.00'N latitude and 79°56.59'W longitude (NAD83) or state plane coordinates 891846.0 N and 1000961.1 E (NAD83). The site is approximately 4.4 nautical miles (5 miles) offshore at a depth range of 160 to 190 meters (525 to 625 feet).

The 2004 SMMP[6] states the following: "The capacity of the Palm Beach Harbor ODMDS has not been determined. Modeling conducted by the Coastal Engineering Research Center (CERC) was conducted for a single project volume up to 500,000 cubic yards. Therefore, use of the ODMDS will be restricted to 500,000 cubic yards of dredged material per project. Projects in excess of 500,000 cubic yards of dredged material will require additional capacity studies prior to utilization of the ODMDS."

In 2009, based on post-disposal monitoring efforts at other South Florida ODMDS areas, the Palm Beach Harbor ODMDS disposal release zone was modified as a result of the "2009 Revisions to the Palm Beach Harbor ODMDS and SMMP." The new release zone is a rectangle approximately 1,250 meters (4,100 feet) by 300 meters (1,000 feet).

[6] The SMMP was updated in 2009 with revisions, but this requirement was transferred with the update.

No specific disposal technique is required for this site. Disposal would be initiated within the disposal zone and would be completed prior to departing the ODMDS disposal zone. Prior to disposal in the ODMDS, the USACE would assess the dredged material to determine if it meets the Ocean Dumping Criteria in 40CFR226, in accordance with the 2009 Palm Beach ODMDS SMMP.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Due to the sandy material typically dredged from operation and maintenance events and its suitability for placement on the beach or nearshore, this site is unlikely to be used in the future for operation and maintenance material. As stated above in the existing conditions, no specific disposal technique is required for use of the ODMDS site. Disposal would be initiated within the disposal zone and would be completed prior to departing the ODMDS disposal zone. Prior to disposal in the ODMDS, the USACE would assess the dredged material to determine if it meets the Ocean Dumping Criteria in 40CFR226, in accordance with the 2009 Palm Beach ODMDS SMMP.

OTHER BENEFICIAL USE SITES

EXISTING CONDITIONS

Historically, dredged material from operations and maintenance activities has been placed on the beach or in the nearshore. There are several previously dredged holes and artificial reef sites available within the lagoon for placement of dredged material. The Mid-town beach placement area is located south of Lake Worth Inlet between R-90.4 and R-101.4 but is not currently a Federal project and has not been used for placement by the USACE to date. Reference ES-3 or Figure 4-2 (Chapter 4) for a map showing locations of above mentioned sites.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

It is expected future dredging events would continue to be of beach quality and therefore placed on the beach south of the south jetty. Many of the beneficial use sites mentioned above will likely still be available for use if a non-federal agency partnered with the USACE to place material in a location other than the beach or nearshore template.

2.4.4 PORT FACILITIES

EXISTING CONDITIONS

The port facilities in Palm Beach Harbor consist of four wharves (North Marginal Wharf, Main Marginal Wharf, Mid Marginal Wharf and South Marginal Wharf), three slips (slip 1, 2 and 3) and 17 berthing areas. The current site consists of approximately 156 total acres of

land. The Port of Palm Beach handles general cargo, containerized and bulk cargo, and is home to the Bahamas Celebration cruise ship. The top commodities handled at the port include petroleum products, cement, break bulk, and food and farm products (including sugar and exports of molasses). The following is a description of the existing terminal facilities at Palm Beach Harbor.

- North Marginal Wharf (Berth 1) – used exclusively for smaller day cruise vessels; it was previously occupied by the *Palm Beach Princess*, which had two scheduled off-shore sailings per day. The service catered primarily to the local gaming market. Another day cruise vessel has already begun operating and is assumed to be in place throughout the 50-year planning horizon.
- Slip 1 (Berths 2-6) – used by Tropical Shipping for container and Ro/Ro cargoes. The north side of the slip (Berth 2) is also used for the Bahamas Celebration, a cruise ship that transits to Freeport, Bahamas every other day from the Port of Palm Beach. Slip 1 is also used by small general cargo ships.
- Main Marginal Wharf (Berth 7) – used primarily by Tropical Shipping and small general cargo ships.
- Slip 2 (Berths 8-12) – generally an overflow slip for vessels that cannot be accommodated by slips 1 and 3. Slip 2 is primarily used by smaller Ro/Ro vessels as well as general cargo vessels. It is also used by Tropical Shipping, as needed.
- Mid Marginal Wharf (Berth 13) – used in conjunction with slips 2 and 3 by small general cargo ships.
- Slip 3 (Berths 14-16) – the major berth of the Port for all bulk cargoes, especially those on vessels with sailing drafts over 25 ft; primarily used for cement and fuel receipts and for shipments of sugar and molasses. Diesel and asphalt is also received at Slip 3. Large general cargo vessels carrying project cargo or other large break bulk will also use Slip 3.
- South Marginal Wharf (Berth 17) – primarily used by small general cargo ships.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The land area available at the Port is currently fixed at approximately 156 acres. During a meeting with the Port of Palm Beach on July 20, 2010, the Port discussed options for expansion. There is a 9-acre vacant lot about a quarter-mile from the Port. The area was formerly a drive-in movie theater, and it is currently zoned as a Light Industrial District. A new biofuel company signed an agreement to build fuel storage facilities in an area that was previously occupied by the Port's former maintenance building and shop. The cruise terminal has retained its capacity to service a second smaller "Day Cruise" vessel with bi-daily calls. The Port has awarded a contract to make bulkhead improvements in Slip 3 and to deepen Slip 3.

2.4.5 NORTH AND SOUTH JETTIES

EXISTING CONDITIONS

North Jetty: The north jetty is 1700 feet long. The 2002 survey indicated no specific areas of concern where slopes were less than 1 foot vertical to 2 feet horizontal. Analysis found that the jetty is stable in its current state.

South Jetty: The south jetty is 2150 feet long. The 2002 survey showed that a portion of the jetty (extending from approximately STA 42+50 (the jetty toe) to STA 45+50) contained existing side slopes steeper than one foot vertical to two feet horizontal. After more analyses, results indicated that at certain elevations in the area, the south jetty in its current state has an inadequate factor of safety. See Engineering Appendix A, Attachment C, for the geotechnical analysis of the south jetty.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

North Jetty: The north jetty will continue to perform its function and may undergo maintenance as needed.

South Jetty: The south jetty will have an inadequate factor of safety until it is further inspected through the operation and maintenance program (separate from this study) and is evaluated for appropriate maintenance needs.

2.4.6 SAND TRANSFER PLANT

EXISTING CONDITIONS

The Lake Worth Inlet sand transfer plant, a Federal project and locally maintained, is located on the west end of the north jetty and is operational year-round. Its purpose is to pump 160,000 cubic yards of sand per year from the vicinity near the settling basin through a 12 inch pipeline below the inlet to three discharge points located at 750 feet, 1250 feet, and 1750 feet along the beach south of the inlet. The quantity of sand it pumps was determined from the 1996 Chief's Report which was based on the 1996 Coast of Florida Report which indicates that the Federal Navigation Project at Lake Worth Inlet is responsible for 67% of the downdrift erosion, or 160,000 cubic yards per year. Through Section 111, the Sand Transfer Plant is funded 100% Federal, with Operation and Maintenance carried out and funded by the project's non-federal sponsor, the Town of Palm Beach. It has been recently upgraded with a new electrical service, pump, and intake structure. The upgraded plant is more reliable and efficient but does not pump more sand than in the past. The plant is fixed and can only transfer sand that is within the reach of the intake structure. The upgraded plant will reduce operating costs for Palm Beach County and the Town of Palm Beach.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The sand transfer plant will continue to pump 160,000 cy of sand per year and may undergo future maintenance when necessary. There are plans, per the USACE February 2008 Report, to extend the discharge to a 4th area, 2500 feet south of the south jetty.

2.4.7 PEANUT ISLAND

EXISTING CONDITIONS

Peanut Island was created in 1918 as a result of material excavated when the Lake Worth Inlet was created. Peanut Island, originally called Inlet Island, amounted to only ten acres. In 1923 the Port of Palm Beach was using the island as a spoil site for the maintenance of the inlet and the Port shipping channel. In 1991, the Port sold the northern half of the island to the Florida Inland Navigation District (FIND) as a spoil site for the Intracoastal Waterway maintenance dredging. The primary use of the island is as a spoil site but the Port of Palm Beach and FIND have made the perimeter of the island available to the public as a park through an agreement with Palm Beach County.

The Peanut Island Environmental Enhancement Project Section 1135 was completed in 2005 with the following partners: U.S. Army Corps of Engineers, Palm Beach County, Florida Department of Environmental Protection, Florida Inland Navigation District, Port of Palm Beach, the U.S. Department of Agriculture, and the Florida Fish and Wildlife Conservation Commission. The project added environmental enhancement features on Peanut Island to include reef, lagoons and upland habitats, to include clearing exotic plant species. The project also created public access features including floating docks, bridges, boardwalks and swim platforms.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Peanut Island will continue to be enjoyed by the community for a variety of recreational activities and will continue to provide habitat for wildlife as it does in the existing condition.

2.5 NATURAL ENVIRONMENT

2.5.1 VEGETATION

EXISTING CONDITIONS

The Palm Beach Harbor and Lake Worth Inlet project area support sub-tropical and tropical seagrass communities, including *Halophila decipiens*, *H. johnsonii*, and *Halodule wrightii*.

Quantitative seagrass surveys were conducted by USACE most recently in August 2011 and are included as Appendix D, Attachment 5. *Halophila johnsonii* is a threatened species, protected under the Endangered Species Act (ESA), and is further discussed below in Section 2.5.2. In addition to the above mentioned seagrasses, hardbottom habitat was identified and quantified. The surveys are shown on executive summary Figure ES-2.

Seagrasses provide food, shelter, and essential nursery areas to commercial and recreational fishery species and to countless invertebrates living in seagrass communities. While some organisms, including the endangered Florida manatee and green sea turtle, graze directly on seagrass leaves, others use seagrasses indirectly to provide nutrients. Bottlenose dolphins are often found feeding on organisms that live in seagrass areas. Detritus from bacterial decomposition of dead seagrass plants provides food for worms, sea cucumbers, crabs, and filter feeders such as anemones and ascidians. Further decomposition releases nutrients (such as nitrogen and phosphorus), which, when dissolved in water, are re-absorbed by seagrasses and phytoplankton. The relative safety of seagrass meadows provides an ideal environment for juvenile fish and invertebrates to conceal themselves from predators. Seagrass leaves are also ideal for the attachment of larvae and eggs, including those of the sea squirt and mollusk. Much of Florida's recreationally and commercially important marine life can be found in seagrass meadows during at least one early life stage. While seagrasses are ideal for juvenile and small adult fish for escape from larger predators, many infaunal organisms (animals living in soft sea bottom sediments) also live within seagrass meadows. Species such as clams, worms, crabs, and echinoderms, like starfishes, sea cucumbers, and sea urchins, use the buffering capabilities of seagrasses to provide a refuge from strong currents. The dense network of roots established by seagrasses also helps deter predators from digging through the substratum to find infaunal prey organisms. Seagrass leaves provide a place of anchor for seaweeds and for filter-feeding animals like bryozoans, sponges, and forams.

Seagrass communities were dominated by sparse cover of *H. johnsonii* in single species and mixed beds in shallow to mid-water depth (0-4 meters or 0-13 feet), while *H. decipiens* predominated in water depth greater than 4 meters (13 feet). *Halodule wrightii* was also found in shallow water, primarily less than 2 meters (6.5 feet). Frequency of occurrence, cover abundance scores, and density were relatively low for all seagrass beds documented. Cover abundance scores for all species, *H. johsonii*, *H. decipiens* and *Halodule wrightii* were less than 26% cover across all transects; which means that seagrasses covered less than 26% of the bottom where they were found. The highest density score, which is the sum of cover abundance scores for a species, divided by the total number of quadrats within a transect, was 0.72. Overall, the survey covered over 80 acres of bottom, seagrass were present for a total of 14.6 acres within the project area, though coverage was low (USACE 2011).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Direct impacts to vegetation within the Federal channel in the future without-project condition are not expected because operation and maintenance dredging would occur only

within the currently authorized Federal project. Vegetation, including submerged aquatic vegetation communities, adjacent to the existing Federal project limits, would continue to be subject to some turbidity and/or sedimentation resulting from vessels that pass nearby. Impacts to vegetative communities as a result of continued operations and maintenance activities were discussed in previous National Environmental Policy Act (NEPA) documents for Palm Beach Harbor (Chapter 1, Related Documents) and would remain valid. These discussions are incorporated by reference into this Environmental Impact Statement (EIS).

2.5.2 THREATENED AND ENDANGERED SPECIES

The USACE has determined that the following listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) occur in the action area: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), Hawksbill sea turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), Johnson's seagrass (*Halophila johnsonii*), blue (*Balenoptera musculus*), humpback, (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), fin (*Balenoptera physalus*) and sperm (*Physeter macrocephalus*) whales, and smalltooth sawfish (*Pristis pectinata*). The USACE has relied heavily upon the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Biological Opinion that was updated by NMFS in 2010 for biological information concerning the biology, life history and status for the large whale species discussed in this assessment. This document was accessed from the NMFS website at: http://www.nmfs.noaa.gov/pr/pdfs/permits/07pr_mariannas_prog_2010_final.pdf.

In addition to the above species, the USACE has determined the endangered West Indian (Florida) manatee (*Trichecus manatus*) and the piping plover (*Charadrius melodus*) also occur within the action area. These species fall under the purview of the U.S. Fish and Wildlife Service (USFWS).

SEA TURTLES

EXISTING CONDITIONS

The loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp's Ridley (*Lepidochelys kempii*) sea turtles can occur within the coastal waters near the project area (Dodd 1992, Ogren 1992, Meylan 1992, Ehrhart 1992, Pritchard 1992). All of these species are federally endangered, except the loggerhead, which is classified as threatened. Monitoring by Palm Beach County DERM shows sea turtles utilize a number of habitats within and adjacent to the project area for feeding, resting, and nesting including the following: beaches, reefs, seagrass beds, and inlet jetties. Three of these species (loggerhead, green, and leatherback) are known to nest within the beach placement areas. Loggerheads have nested in Palm Beach County as early as April 16 and as late as September 27. Green sea turtle nests have been observed as early as May 14 and as late as August 15. Leatherback nests have been recorded as early as April

9 and as late as June 29 in Palm Beach County (Applied Technology and Management Inc. 1995). Table 2-4 lists the number of sea turtle nests recorded by Palm Beach County for the beach placement area south of the south jetty (http://www.co.palm-beach.fl.us/erm/permitting/sea-turtles/nesting.htm).

Table 2-4: Sea Turtle Nesting Data for Beach Placement Area South of the South Jetty.

Year	Loggerhead	Green	Leatherback
2006	155	9	10
2007	99	9	8
2008	161	5	8
2009	136	3	15
2010	289	4	6
Mean	168	6	9.4

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Effects on sea turtles resulting from operation and maintenance activities in the future without-project condition would not change. Dredging and placement of material would occur as per the terms and conditions of the 2011 Final Statewide Programmatic Biological Opinion (BO).

WHALES (HUMPBACK AND SPERM)

EXISTING CONDITIONS

Sperm whales may be found year round near the project area, while humpbacks are found seasonally during their migration to and from breeding grounds in the Caribbean.

Humpback whales were listed as endangered under the Endangered Species Act (ESA) in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the Marine Mammal Protection Act (MMPA). Critical habitat has not been designated for the species. Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. The whales occupy tropical areas during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding, primarily on small schooling fish and krill (Caldwell and Caldwell 1983). Humpback whales feed on krill and small schooling fish on their summer grounds.

Humpback whales use the mid-Atlantic as a migratory pathway and as a feeding area, at least for juveniles. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993). Biologists theorize that non-reproductive animals may be establishing a winter-feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the

Caribbean. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, by targeting fish schools and filtering large amounts of water for the associated prey. Humpback whales have also been observed feeding on krill.

Sperm whales were listed as endangered under the ESA in 1973. They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for sperm whales. Sperm whales are distributed in the entire world's oceans. Sperm whales have a strong preference for the 3,280 feet (1,000 meters) depth contour and seaward. Berzin (1971) reported that they are restricted to waters deeper than 300 m (984 ft), while Watkins (1977) and Reeves and Whitehead (1997) reported that they are usually not found in waters less than 3,280 feet (1,000 meters) deep. While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in waters of 41-55 meters (135-180 feet) (Scott and Sadove 1997). When found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). They can dive to depths of at least 2000 meters (6562 feet), and may remain submerged for an hour or more (Watkins *et al.* 1993). Sperm whales feed primarily on buoyant, relatively slow-moving squid (Clark *et al.* 1993), but may also eat a variety of fish, including salmon (*Oncorhynchus* spp.), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*) (Caldwell and Caldwell 1983).

In the Atlantic Ocean, NMFS' most recent stock assessment report notes that sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer, and then south of New England in fall, back to the Mid-Atlantic Bight. There is also a very large population of sperm whales found in the Gulf of Mexico near the Mississippi River delta.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Of the six species of endangered marine mammals that may be found seasonally in the waters offshore southeastern Florida, the USACE believes that only the sperm and humpback whales may be adversely affected by activities associated with the proposed action. These effects would be a result of acoustic harassment. The blue, fin, northern right and sei whales are not discussed in detail because they are unlikely to be within the vicinity of the project. Additional information on blue, fin, and sei whales can be found in Waring *et al*. (1999). Due to the rarity of sightings of these four whale species near the project area, the Corps believes that any effects on them by the project are discountable. See also the Biological Assessment included in Pertinent Correspondence, Appendix E for additional discussion. No additional effects on either humpback or sperm whales are expected in the future without-project condition. Normal O&M activities would continue, and these impacts have been discussed in previous NEPA documents for Palm Beach Harbor (please

see Chapter 1, Related Documents, of this report) and are incorporated by reference in this EIS.

JOHNSON'S SEAGRASS

EXISTING CONDITIONS

Halophilia johnsonii was listed as a threatened species by NMFS on September 14, 1998 (63 FR 49035) and the final rule for critical habitat designation for *H. johnsonii* was published April 5, 2000 (65 FR 17786). *H. johnsonii* has one of the most limited geographic ranges of all seagrass species. The species has only been found growing along approximately 200 kilometers (124 miles) of coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world (Kenworthy 1993, 1997, 1999). Results from seagrass surveys conducted for the project (2011, 2009) demonstrated that *H. johnsonii* occurs within the proposed project footprint as mentioned in Section 2.5.1 above. The Biological Assessment (Pertinent Correspondence, Appendix E) provided to NMFS provides additional detail, including the life history and population dynamics of *H. johnsonii*.

From the 2011 survey, H. Johnsonii was present in areas around the turning basin, mainly in mixed beds with other grasses. Density of all grasses documented from this survey were sparse, with less than 5% average cover.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

No additional effects on Johnson's seagrass are expected as a result of the continuance of normal operations and maintenance activities in the future without-project condition. Impacts were discussed and analyzed in previous NEPA documents for operations and maintenance activities (Chapter 1, Related Documents) and are incorporated by reference into this EIS. Johnson's seagrass is not present within the current Federal channel.

WEST INDIAN MANATEE

EXISTING CONDITIONS

The West Indian manatee (*Trichechus manatus*) has been listed as a protected mammal in Florida since 1893. The manatee is federally protected under the Marine Mammal Protection Act (MMPA) as a depleted species and was listed as an endangered species throughout its range in 1967 (32 FR 4061) and received Federal protection with the passage of the ESA. Critical habitat was designated in 1976 for the Florida subspecies (*Trichechus manatus latirostris*) (50 CFR 19.95(a)) and includes Lake Worth Inlet and Palm Beach Harbor. Florida provided further protection in 1978 by passing the Florida Marine Sanctuary Act

designating the state as a manatee sanctuary and providing signage and speed zones in Florida's waterways.

Annual surveys document manatee congregations during the cold periods in the vicinity of the Rivera Beach Florida Power and Light (FP&L) Company power plant located at the southern extreme of the turning basin on the western shore of Lake Worth. As summarized in Table 2-5 hundreds of manatees have been observed in the vicinity of the plant (reference "warm water discharge" on Figure ES-2) during cold weather (USFWS 1993).

Table 2-5: Maximum number of manatees sited during surveys at Florida Power and Light Riviera Plant (Reynolds 2011).

Survey Year	Number of Manatees
1994-95	249
1995-96	345
1996-97	177
1997-98	102
1998-99	64
1999-00	297
2000-01	409
2001-02	373
2002-03	479
2003-04	80
2004-05	403
2005-06	313
2006-07	288
2008-09	454
2009-10	581
2010-11	554

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Effects on manatees resulting from operation and maintenance (O&M)activities have not changed since the January 2012 Operations and Maintenance Environmental Assessment (EA) for Palm Beach Harbor. In the future without-project condition, normal O&M activities would continue and precautions would be taken during dredging events as has been coordinated with the USFWS. The discussion of effects resulting from maintenance dredging contained within previous NEPA documents for Palm Beach Harbor (Chapter 1, Related Documents) is incorporated by reference into this EIS.

SMALLTOOTH SAWFISH

EXISTING CONDITIONS

The smalltooth sawfish (*Pristis pectinata*) has a circumtropical distribution and has been reported from shallow coastal and estuarine habitats. In U.S. waters, the smalltooth sawfish

historically occurred from North Carolina south through the Gulf of Mexico, where it was sympatric with the largetooth sawfish (*P. perotteti*) (Adams and Wilson, 1995). Individuals have also historically been reported to migrate northward along the Atlantic seaboard in the warmer months, as far north as New York, though it is rarely observed outside of peninsular Florida.

Smalltooth sawfish were once common in Florida, as detailed by the Final Smalltooth Sawfish Recovery Plan (NMFS, 2009), and are very rarely reported in southeast Florida. Their core range extends along the Everglades coast from the Ten Thousand Islands to Florida Bay, with moderate occurrence in the Florida Keys and at the mouth of the Caloosahatchee River. Outside of these areas, sawfish are rarely encountered and appear to be relatively infrequent (Simpfendorfer, 2006). It does not appear to be a coincidence that the core range of smalltooth sawfish corresponds to the section of Florida with the smallest amount of coastal habitat modification. Habitat use by sawfish appears to be divided by animal size. Small sawfish (0-79 inches/0-200 cm) use shallow water areas as nursery areas often dominated by red mangrove habitats.

At least one recorded observation has occurred within the vicinity of Palm Beach County (NMFS, 2000). Populations likely decreased due to a low intrinsic rate of natural increase, the long interval to time of reproduction, and human impacts, most notably overfishing, incidental take in nets (due in part to its body size and unusual morphology), and habitat loss (development of shoreline and nearshore habitats). As summarized and discussed in Carlson & Osborne 2012, the current smalltooth sawfish population is found mainly in marine waters surrounding Everglades National Park and its adjacent areas.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

In the future without-project condition, O&M dredging operations would continue, and vessels would continue to call at the Port of Palm Beach. As stated above, it is unlikely that this species occurs within the project area, and therefore it is not expected to be impacted within the future without-project condition.

PIPING PLOVER

EXISTING CONDITIONS

The piping plover (*Charadrius melodus*), a migratory shorebird known to frequent Palm Beach County, is protected as a threatened species under the ESA and the State of Florida, and is also protected under the Migratory Bird Treaty Act. The species breeds in the northern Great Plains of the U.S. and along beaches of Lake Michigan and Lake Superior. Individuals of the species winter along the Atlantic Gulf Coast from North Carolina to Texas (American Ornithologists' Union, 1998). Piping plovers migrate to Florida's coast in September and are found there through March (USFWS 1993). Piping plovers are small North American shorebirds approximately 17 centimeters long (Palmer 1967). They nest on

open sand, gravel, or shell-covered beaches above the high tide line and are often found on the accreting ends of barrier islands and along coastal inlets (USFWS 1996). Foraging areas include intertidal beaches, mudflats, sandflats, lagoons, and salt marshes, where they feed on invertebrates such as marine worms, insect larvae, crustaceans, and mollusks. Surveys for migratory birds and other protected species are completed prior to initiation of O&M activities and continue daily throughout the construction period. Please see also the Programmatic Biological Assessment for Sand Placement and Shore Protection along the Coast of Florida (USACE 2010) for additional information on the life history of the piping plover. There is no designated critical habitat for the piping plover within the project boundaries (66 FR 36105-36120).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

In the future without-project condition, O&M operations would continue, and vessels would continue to call at the Port of Palm Beach. Surveys for piping plovers would be completed prior to operations and maintenance activities. Surveys would begin on April 1 or 45 days prior to construction commencement, whichever is later, and be conducted daily throughout the construction period. Though the current beach placement location is adjacent to an inlet, piping plovers have not been observed during previous dredge material placement activities. The No Action Alternative, or future without-project condition, is not expected to affect the piping plover.

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

EXISTING CONDITIONS

The beaches of Palm Beach County are typical of other east-central Florida beaches subject to the full force of ocean waves. These beaches usually have low species diversity, but populations of individual species are often very large. The beach dunes contain sea oats (*Uniola paniculata*), sea oxeye (*Borrichia frutescens*), and sea grapes (*Coccoloba uvifera*). Species such as coquina clams (*Donax variabilis*), ghost crabs (*Ocypode ceratophthalma*), and sand drum (*Umbrina coroides*) are highly specialized to survive in this high energy environment.

Marine life common to east-central Florida can be found within the project channel and beach placement area. Sub-tidal oyster beds should not occur within the project channel due to depth and vessel traffic. Other macro invertebrates commonly found in soft-bottom estuarine habitat within Florida include annelids, a variety of mollusks besides oysters, arthropods, sponges and polyps (Hoffman and Olsen 1982). Bottlenose dolphins have also been observed within Lake Worth Lagoon and within Palm Beach Harbor.

Common shorebird and larid species such as black-bellied plover (*Pluvialis squatarola*), sanderling (*Caladris alba*), willet (*Catoptrophorus semipalmatus*), laughing gull (*Larus atricilla*), ring-billed gull (*L. delawarenisis*), and royal tern (*Sterna maxima*) have been observed feeding and resting adjacent to and within the project area.

There are no seagrass beds or vegetated shorelines located within the current Federal navigation channel or the existing settling basin though seagrasses are located within Lake Worth Lagoon and adjacent to the current project limits. (PBS&J 2009, USACE 2011).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

O&M activities would continue at the currently authorized project depths, including the existing settling basins, and are not expected to result in adverse impacts to the fish and wildlife resources described above. The standard USACE migratory bird protection conditions would be implemented for any construction work performed between April 1 and August 31. Impacts to fish and wildlife resources resulting from continued O&M activities were discussed in previous NEPA documents (Chapter 1, Related Documents) and are incorporated by reference into this EIS.

2.5.4 Bottlenose Dolphin

EXISTING CONDITIONS

The bottlenose dolphin, *Tursiops truncatus*, is a marine mammal with a robust body and thick, short beak. Bottlenose dolphins are commonly found in herds of two to 15 individuals. Bottlenose dolphins are generalists, meaning they feed on a variety of prey items. These mammals are found in temperate and tropical waters around the world and are protected by the Marine Mammal Protection Act (MMPA) of 1972 (Wells & Scott 2002). A small resident stock of dolphins have been observed, but not studied, within Lake Worth Lagoon.

There is not currently a stock assessment available from NMFS concerning the status of bottlenose dolphins in the inshore and nearshore waters off of south Florida (Lance Garrison, pers com, 2011). The stocks of bottlenose dolphins that reside closest to the project area, that have a completed stock assessment report available for review, are the western North Atlantic central Florida coastal stock; offshore stock, and the resident stock found in Biscayne Bay. The assessments for these groups were completed in 2008, 2009, and 2010, respectively (Waring et al., 2010).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

In the future without-project condition (No Action Alternative), O&M dredging operations would continue and vessels would continue to call at the Port of Palm Beach. The dolphins

that inhabit the waters in Lake Worth Inlet, Lake Worth Lagoon, and Palm Beach Harbor are acclimated to vessels (both recreational and large cargo vessels) that traverse the area. Impacts to the bottlenose dolphins in the future without-project condition are not expected.

2.5.5 HARDBOTTOM HABITAT

EXISTING CONDITIONS

Surveys from 2009 and 2011 (Appendix D) documented communities of continuous hardbottom, sand with scattered hardbottom, and hardbottom ledges (cut edge of channel). Continuous hardbottom areas were places where limestone hardbottom was at the surface or under a thin veneer (>1cm) of sand. The sand with scattered hardbottom habitat type included areas where sand pockets were interspersed with pockets of hard bottom. All hardbottom habitat types supported mixed juvenile and adult reef fish. Some transects had a mix of seagrass and hardbottom habitat types.

Hardbottom habitat occurs along the limestone walls of the entrance channel. Sponges and soft corals can be found along these vertical wall faces (USACE 1998, PBS&J 2009, DCA 2011). Surveys south of the inlet, between Florida Department of Environmental Protection (FDEP) markers R-76 and R-83 indicated that hard bottom communities are much more prevalent south of R-79. Commonly encountered organisms included red boring sponge (*Cliona* sp.), red algae (*Meristiella echiocarpum*), and the tube building annelid *Phragmatopoma lapidosa*. Hardbottom habitat significantly declines between R-76 and R-79. The only hardbottom habitat observed within this area was directly associated with the south jetty, a small section (27 square feet) of uncolonized exposed rock north of R-77, a small area of exposed rock in the intertidal region 350 feet north of R-78, and a lone outcropping of rock located midway between R-78 and R-79 (Applied Technology and Management Inc. 1995).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Continuing to perform O&M dredging at the currently authorized depths, including the existing settling basins, would result in impacts to benthos as discussed in previous NEPA documents for Palm Beach Harbor (Chapter 1, Related Documents). Hardbottom communities outside of the current Federal channel would not be impacted. The bottom of the channels would normally be recolonized with organisms such as annelids and arthropods from adjacent similar habitats following completion of dredging events. No intentional impacts to hardbottom habitats would occur in the future without-project, or No Action Alternative, condition. As larger vessels call the Port of Palm Beach, the potential for impacts to resources on the channel walls increase due to the unpredictability of the currents and the effect of the wind on the ships.

2.5.6 ESSENTIAL FISH HABITAT

EXISTING CONDITIONS

Essential fish habitat (EFH) is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" in the Magnuson-Stevens Fishery Conservation and Management Act. EFH includes all types of aquatic habitat such as wetlands, coral reefs, seagrasses, and rivers. Species managed by the NMFS that may occur within the project channel and Beach Placement Area can be found in Table 2-6 and possible prey species in Table 2-7.

Within southeast Florida, including the Lake Worth Inlet project area, nearshore bottom, live/hardbottom, seagrass, and coastal inlets are habitat areas of particular concern (HAPCs) (SAFMC 1998). Managed species that commonly inhabit the study area include pink shrimp (*Farfantepenaeus duorarum*); spiny lobster (*Panulirus argus*); and members of the 73-species snapper-grouper complex, including blue stripe grunts (*Haemulon sciurus*), yellowtail snapper (*Ocyurus chysurus*), and red grouper (*Epinephelus morio*). These species use inshore habitats as juveniles and sub-adults, and they use hardbottom and reef communities offshore as adults. Other species of the snapper-grouper complex commonly seen offshore in the study area include gray triggerfish (*Balistes capriscus*) and hogfish (*Lachnolaimus maximus*). Common snook (*Centropomus undecimalis)* are known to use the area as a spawning ground. Coastal migratory pelagic species also commonly utilize the offshore area adjacent to the study area, including cero mackerel (*Scomberomorus regalis*) and Spanish mackerel (*S. maculatus*).

A more detailed EFH assessment and discussion can be found in Environmental Appendix D, Attachment 6.

Table 2-6: Federally Managed Marine Species that May Occur within the Project Area.

Species	Life Stage	Substrate Preference[7]	
		Unconsolidated Sediment	Seagrass
Brown shrimp *Farfantepenaeus aztecus*	A, J, L	A, J, L	J, L
Pink shrimp *Farfantepenaeus duorarum*	A, J	A, J	J
White Shrimp *Litopenaeus setiferus*	A, J	A, J	J, L
Spiny Lobster *Panulirus argus*	A, J	A, J	A, J
Black seabass *Centropristis striata*	A, J	A, J	
Gag *Mycteroperca microlepis*	A, J	A, J	
Cobia *Rachycentron canadum*	J	J	
Mutton snapper *Lutjanus analis*	A, J	J	J
Gray snapper *Lutjanus griseus*	A, J, L	A, J, L	A, J, L
Lane snapper *Lutjanus synagris*	A, J	A, J	J
Yellowtail snapper Ocyurus *chrysurus*	A, J	J	J
White grunt *Haemulon plumieri*	A, J	A, J	A, J
Sheepshead *Archosargus probatocephalus*	A, J, L	A, J	J, L
Red drum *Sciaenops ocellatus*	A, J, L	A, J, L	J, L
Hogfish *Lachnolaimus maximus*	A, J	J	J
Spanish mackerel *Scomberomorus maculatus*	A, J	A, J	
Black drum *Pogonias cromis*	A, J	A, J	A, J
Southern flounder *Paralichthys lethostigma*	A, J	A, J	J
Common Snook *Centropomus undecimalis*	A, J	A, J	J

Source: South Atlantic Fishery Management Council 1998; Florida Museum of Natural History-Ichthyology website 2008.

[7] Substrate preference, unconsolidated sediment and seagrass habitats occur in or near the project area. A=adult; J=juvenile; L=larvae

Table 2-7: Prey Species that May Occur within the Project Area.

Species	Life Stage	Substrate Preference[8]	
		Unconsolidated Sediment	Seagrass
Thinstripe hermit crab *Clibanarius vittatus*	A, J	A, J	
Horse conch *Pleuroploca gigantea*	A, J	A, J	A, J
Bay anchovy *Anchoa mitchilli*	A, J, L	A, J, L	L
Sheepshead minnow *Cyprinodon variegatus*	A, J, L	A, J, L	
Atlantic menhaden *Brevoortia tyrannus*	A, J, L	A	J, L
Bay scallop *Argopecten irradians*	A, J, L	A, J	A, J, L
Atlantic rangia *Rangia cuneata*	A, J, L	A, J, L	
Quahog *Mercenaria mercenaria*	A, J	A, J	
Grass shrimp *Palaemonetes pugio*	A, J		A, J
Striped mullet *Mugil cephalus*	A, J	A, J	A, J
Spot *Leiostomus xanthurus*	A, J	A	J
Atlantic croaker *Micropogonias undulates*	A, J	A, J	
Silversides *Menidia menidia*	A, J, L	A, J, L	A, J, L
American eel *Anguilla rostrata*	A, J, L	J, L	A, J, L

Source: South Atlantic Fishery Management Council 1998; Florida Museum of Natural History-Ichthyology website 2008.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Under the No Action Alternative, no new EFH areas would be dredged within the Federal navigation channels. Only previously dredged EFH (unvegetated, unconsolidated bottom and inlet substrates) would continue to be impacted through previously permitted O&M dredging operations. Under this future without-project condition, the channels would shoal-in prior to O&M activities. Vessel and tug movements would re-suspend sediments in

[8] Substrate preference, unconsolidated sediment and seagrass habitats occur in or near the project area. A=adult; J=juvenile; L=larvae

the bottom of the channel with increasing frequency thereby increasing levels and associated effects of turbidity and sedimentation of habitats adjacent to the existing channels. This would temporarily adversely affect the estuarine (within harbor) water column EFH, although due to implementation of best management practices (BMPs), effects would be minimal.

The continued maintenance dredging of the existing settling basin and authorized channel depths would not have a substantial adverse impact on EFH or federally managed fisheries along the eastern coast of Florida as discussed in previous NEPA documents for Palm Beach Harbor Operations and Maintenance (Chapter 1, Related Documents). The substrate of the project area is naturally dynamic and unconsolidated, and measures are taken to protect adjacent habitat. Turbidity could affect vision of marine life within the sediment plume as well as those marine organisms with gills, but these effects would be temporary as they would be limited to the actual dredging and placement operations. Routine maintenance dredging may suppress re-colonization of certain benthic organisms and therefore could impact other trophic levels within the food chain. However, the project channels are man-made; the actual channel widths encompass a fraction of the entire water body, and similar habitat occurs immediately adjacent to the channels.

2.5.7 COASTAL BARRIER RESOURCES

EXISTING CONDITIONS

According to FWS's *Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service* (available online at http://www.fws.gov/laws/lawsdigest/coasbar.html), the Coastal Barrier Resources Act (CBRA), Public Law 97-348 (96 Stat. 1653; 16 U.S.C. 3501 et seq.), enacted October 18, 1982, designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System (System). Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the System.

There are no CBRA units in or near the project area. However, MacArthur Beach north of the project area is designated as "Otherwise Protected Area" (OPA) FL-18P as well as Hutchinson Island (P11) north of the project area (St. Lucie County). Under the Act, it is restricted only from receiving Federal funding for flood insurance on new buildings within the unit boundary.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

There will be no impacts on coastal barrier resources in the future without-project condition.

2.5.8 WATER QUALITY

EXISTING CONDITIONS

The waters within Palm Beach Harbor/Lake Worth Inlet are designated Class III by the Florida Department of Environmental Protection (FDEP) as defined by Rule 62-302.400. Class III water bodies are designated for recreation, propagation and maintenance of a healthy well-balanced population of fish and wildlife. In addition, Class III water bodies must meet minimum water quality criteria listed in Rule 62-302.500 and subsequent sections.

A Surface Water Improvement and Management (SWIM) plan for Lake Worth has been developed by Palm Beach County (Palm Beach County and FDEP 1998). The plan focuses primarily on improving freshwater discharge management into the lagoon (including sewage and stormwater), restoring wetlands, and diverting polluted water from the C-51 Basin to the Everglades instead of discharging it to Lake Worth Lagoon.

The Lake Worth Lagoon Salinity Distribution and Flow Management Project, sponsored by the South Florida Water Management District is aimed at reducing or eliminating wide salinity fluctuations. The model developed by this project is used to manage freshwater inflows to the lagoon with the goal of improving water quality and re-establishing the historic conditions conducive to long-term health of the system and its associated habitats and wildlife to the extent practicable (Port of Palm Beach 2006).

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Under the No Action Alternative, O&M maintenance dredging would cause temporary increases in turbidity along and adjacent to the beach disposal site as well as at the dredged sites. The State of Florida water quality regulations require that water quality standards not be violated during dredging operations. The standards state that turbidity outside the 150 meter mixing zone shall not exceed 29 Nephelometric Turbidity Units (NTU) above background. Results from turbidity monitoring at previous beach nourishment projects have shown that the turbidity did not exceed the standard. Maintenance dredging and beach placement rates would remain the same as described in previous NEPA documents for Palm Beach Harbor O&M Dredging (Chapter 1, Related Documents). Various protective measures and monitoring programs would be conducted during dredging operations to ensure compliance with state water quality criteria as stated in FDEP Permit Number 0216012-007-JC at both the dredge site and the beach disposal site. Should turbidity exceed

State water quality standards as determined by monitoring, the contractor would be required to cease work until conditions returned to normal.

2.5.9 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

EXISTING CONDITIONS

There are no known sources of hazardous, toxic, or radioactive wastes in the project area. USACE collects benthic samples prior to conducting maintenance dredging and information related to these samples is on file at the USACE.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

There are no known sources of hazardous, toxic, or radioactive wastes in the dredging area. Continued maintenance dredging would occur within the current navigational channel and advance maintenance areas as defined in previous NEPA documents on maintenance dredging for the project area (Chapter 1, Related Documents).

2.5.10 AIR QUALITY

EXISTING CONDITIONS

The study area's "region of influence" for air quality is defined by the administrative/regulatory boundary of Palm Beach County, in the Southeast Florida Airshed, part of the greater Miami-Fort Lauderdale-West Palm Beach Air Quality Control Region (AQCR).

Understanding air quality for the affected area requires knowledge of the following:

- Applicable regulatory requirements;
- Types and sources of emissions (for stationary sources) and the horizontal and vertical extent of emissions from mobile sources such as ships;
- Location and context of the affected area associated with the proposed action; and
- Existing conditions (or affected environment).

Regulatory Requirements. Air quality in a given location is described by the concentration of various pollutants in the atmosphere. A region's air quality is influenced by many factors including the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. The significance of the pollutant concentration is determined by comparing it to the Federal and state ambient air quality standards. The Clean Air Act (CAA) and its subsequent amendments (CAAA) established the National Ambient Air Quality Standards (NAAQS) for seven "criteria" pollutants. These "criteria" pollutants include the following:

- Ozone (O_3);
- Carbon monoxide (CO);
- Nitrogen dioxide (NO_2);
- Sulfur dioxide (SO_2);
- Particulate matter (PM) less than 10 microns (PM_{10}):
- PM less than 2.5 microns ($PM_{2.5}$); and
- Lead (Pb).

Pollutants considered in this EIS are SO_2 and other compounds (i.e., oxides of sulfur or SOx); volatile organic compounds (VOCs), which are precursors to ozone (O_3); nitrogen oxides (NOx), which are also precursors to O_3; and other compounds; CO; PM_{10}; and $PM_{2.5}$. These criteria pollutants are generated by the activities (e.g., construction and mobile source operations) associated with the proposed action alternatives. Airborne emissions of lead are not included because there are no known significant lead emission sources in the region or associated with the proposed action alternatives and the No Action Alternative.

Types and Sources of Air Quality Pollutants. The applicable criteria pollutants are generated by various activities (e.g., construction and mobile source operations) associated with the proposed action alternatives. Airborne emissions of lead are not included because there are no known significant lead emissions sources in the region or associated with the proposed action alternatives or the No-Action Alternative.

The Port is located in a highly urbanized area with an airport within six miles of the port. Additionally, an east/west highway (Beeline Highway), a north/south Interstate (I-95), and many four-lane roadways are less than five miles from the Port. As such, there is heavy vehicular traffic within the Port area resulting from these roadways. There are trucks leaving and entering the Port on a daily basis associated with the delivery of petroleum products as well as the transport of containerized and bulk cargos. These cargo transports produce emissions that affect local air quality. Three other factors also contribute to the air quality surrounding the Port: the presence of FP&L's fossil fuel plant, associated airport emissions, and Port vessel activity associated with international commerce.

Palm Beach County is part of the affected environment for air quality from Port of Palm Beach activities. Palm Beach County is included in the air-shed along with Miami-Dade and Broward Counties. Annual mean air quality data for Palm Beach County are summarized in Table 2-8 below and were taken from the FDEP 2011 Air Monitoring Report available at the following website: http://www.dep.state.fl.us/air/air_quality/techrpt/amr.htm.

These counties encompass portions of the Southeast Florida Intrastate Air Quality Control Region (USEPA, 2006). As of the Final EIS issue date, the air-shed is in attainment for all federally regulated criteria pollutants. These would include the standards for ambient concentrations of CO, SO_2, NO_2, PM, Pb and the 8-hr standard for ozone.

Table 2-8: Annual mean air quality data for Palm Beach County.

	Nitrogen Dioxide (NO_2)	Ozone (O_3)	Particle Pollution ($PM_{2.5}$)	Particle Pollution (PM_{10})	Sulfur Dioxide (SO_2)
FDEP Location Data Point	Lantana	n/a	Delray Beach	Lantana	Riviera Beach
2011	4	Annual means not available	5.9	22	2
2010	5	Annual means not available	6.4	20	1
2009	5	Annual means not available	6.0	No data available	1

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

The No Action Alternative would see a continued increase in ship calls from all ship types calling at the Port of Palm Beach based on baseline vessels calls in Socio-Economic Appendix D. Future without-project in 2067 estimates 2485 vessel calls, and many of these ships will be light loaded and not operating in the most efficient manner. Palm Beach County is currently in attainment, based on the existing fleet makeup, which includes smaller, older vessels that may not be in compliance with the IMO requirements and is expected to remain in compliance in the future without-project condition. This fleet makeup may remain the same, or there may be some shift to more lightloaded vessels that comply with the IMO requirements. The No Action Alternative (future without-project) would result in the status quo for air quality being maintained, when specifically addressing vessel fleet impacts to air quality.

2.5.11 NOISE

EXISTING CONDITIONS

The ambient sound level of a region is the total noise generated, including sounds from natural and artificial sources. The magnitude and frequency of environmental noise may vary considerably over the course of a day and throughout the month because of changing weather conditions and seasonal vegetative cover. Land use adjacent to the north and south jetties and beach placement area has been zoned residential. Background noise from vessel traffic, urban beach, residential development, and nearby roadways appears to be moderate.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Construction activity associated with normal maintenance dredging would result in a short term increase in noise over the existing background level though this would not cause a significant increase in ambient noise levels. Lake Worth Inlet is within an urban setting and noises related to transportation include trucks associated with the movement of petroleum products, containerized cargo, and private vehicles.

There is little noise produced as a result of vessel traffic except for the engine noise associated with vessel transit and tug operations. In the without project condition, affects on noise would result from the increase in ship calls at the Port.

2.5.12 AESTHETIC RESOURCES

EXISTING CONDITIONS

Lake Worth Lagoon, including Palm Beach Harbor and Lake Worth Inlet, is an estuarine system that runs from north to south and is further identified as North, Central, and South Lake Worth Lagoon. The Lagoon runs parallel to the Atlantic Ocean, coastal beaches, and the man-made Intracoastal Waterway. Lake Worth Lagoon is considered to be a picturesque waterway with adjacent marsh, wetlands, and proximity to Peanut Island. The Lake Worth Inlet is a man-made inlet and development associated with the harbor facilities has impacted the aesthetics of the area. Also, numerous private residences and commercial businesses have been constructed along the inlet and the adjacent beach areas. Roadways in the immediate area include US Highway 1, State Roads 708 and 710, and Interstate 95.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Maintenance dredging activities within the Palm Beach Harbor navigation channel would temporarily impact the aesthetics of the area due to presence of dredge equipment as discussed in previous NEPA documents on maintenance dredging for the project area (Chapter 1, Related Documents).

2.5.13 RECREATION RESOURCES

EXISTING CONDITIONS

There are a large number of recreational boaters that frequent the main turning basin, inner channel, the entrance channel, and areas outside the inlet entrance. Numbers of recreational boaters increase on the weekends and holidays. In addition, numerous scuba dive boats drift or anchor in different areas of the harbor and Lake Worth Lagoon though these vessels do not anchor in the entrance channels or turning basins. Commercial and privately owned fishing vessels regularly utilize the Lake Worth Inlet in order to access the nearby Atlantic Ocean and Gulf Stream. There were 39,795 pleasure craft and 1,057 commercial vessels registered in Palm Beach County in 2010 (http://www.flhsmv.gov/dmv/vslfacts.html). Beach access is somewhat limited due to the predominance of private property found in the vicinity of the inlet.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

There would be temporary impacts on recreational boating during continued maintenance dredging as identified and discussed in previous NEPA documents for Palm Beach Harbor (Chapter 1, Related Documents). Vessel traffic would be temporarily disrupted due to construction activities. Both the nearshore placement area and the beach would be temporarily impacted during placement of dredged material as identified in previous NEPA documents (Chapter 1, Related Documents).

2.5.14 CULTURAL RESOURCES AND HISTORIC PROPERTIES

EXISTING CONDITIONS

Initial consultation with the Florida State Historic Preservation Officer (SHPO) (DHR Project file No. 2000-03471) indicated the potential for cultural resources to be present in the project area. An underwater cultural resource survey including diver identification was conducted for the Intracoastal Waterway in 2001 (Hall 2001a, b). These surveys included the Palm Beach Harbor Inlet. No cultural resources were identified within the Lake Worth Inlet project area as a result of this survey. The Florida SHPO concurred with the USACE determination of no historic properties (DHR Project file No. 2000-5816). The proposed settling basin expansion area was surveyed for cultural resources in 2003 (Tuttle 2003). No cultural resources were located by this survey. The Florida SHPO concurred with the USACE determination of no historic properties (DHR Project File No. 2004-1138). In a letter dated September 13, 2012, (DHR Project file No. 2012-03897) the SHPO, responding to a USACE letter dated July 20, 2012, once again concurred with the USACE determination that no historic properties will be affected by the project. Although the September 13, 2012 letter refers to Lake Worth Inlet Maintenance Dredging, in a November 30, 2012 email from Michael Hart, Historic Sites Specialist Bureau of Historic Preservation, Division of Historic

Resources to USACE archeologist David McCullough, the SHPO confirmed that the letter also applies to the civil works project in this report.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

No impacts on cultural resources are anticipated from the continued O&M dredging or beach/nearshore placement of dredged material.

2.5.15 PUBLIC SAFETY

EXISTING CONDITIONS

Continued maintenance dredging of Palm Beach Harbor as currently authorized temporarily disrupts vessel traffic due to dredging activities. Notices to mariners are coordinated and issued prior to dredging activities as per U.S. Coast Guard regulations. It is the intention of the USACE to maintain a safe environment for recreational and commercial vessels through Operations and Maintenance dredging of Palm Beach Harbor while complying with U.S. Coast Guard regulations.

FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION ALTERNATIVE)

Continued maintenance dredging of Palm Beach Harbor as currently authorized would temporarily disrupt vessel traffic due to dredging activities. Maintenance dredging would continue to occur on an annual basis. Notices to mariners would be coordinated and issued prior to dredging activities as per U.S. Coast Guard regulations. It is the intention of USACE to maintain a safe environment for recreational and commercial vessels through Operations and Maintenance dredging of Palm Beach Harbor while complying with U.S. Coast Guard regulations.

SUGAR VESSEL

3.0 PLAN FORMULATION

LAKE WORTH INLET
Palm Beach Harbor

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3 PLAN FORMULATION

3.1 PLAN FORMULATION RATIONALE

This chapter identifies problems, opportunities, constraints, and objectives, building on initial problem identification in Chapter 1 (step 1 of the planning process) to create management measures using existing and forecasted information presented in Chapter 2 (step 2 of the planning process). A management measure is the building block of an alternative plan and can consist of a feature (a structural element that requires construction or assembly on-site) or an activity (a non-structural action) that can be implemented at a specific geographic site that is intended to cause a desirable change and results, preferably, in a positive output.

This chapter then develops the management measures and combines them into plans that meet planning objectives and avoid planning constraints (step 3 of the planning process). Alternative plans can be composed of a combination of various management measures or the same measures combined in significantly different ways.

The methodology used to evaluate (step 4 of the planning process) and compare (step 5 of the planning process) alternative plans is discussed in this chapter, as well as reduction and minimization of environmental impacts, towards the identification of the National Economic Development (NED) plan. If the non-federal sponsor supports the NED plan, then the plan becomes the tentatively selected plan (TSP) (step 6 of the planning process). When all required reviews, and coordination with agencies and the public are complete, the TSP becomes the recommended plan that is ultimately sent to Congress for approval and funding.

Integrated in plan formulation is the National Environmental Policy Act (NEPA) evaluation - reviewing a Federal action within the context of its surrounding environment. The alternatives, as they result from plan formulation, are the heart of a NEPA document.

Figure ES-3, located in the executive summary, can be used as a reference map for this chapter. The reference map located at the end of this report, entitled REF-3, can be folded out to also be used as a reference throughout this chapter.

3.2 SCOPING

As is further discussed in Chapter 6 of this report, a scoping meeting was held January 9, 2008 at the Port of Palm Beach. The following issues were identified through the scoping process as relevant to the proposed action and appropriate for detailed evaluation:

- Impacts to federally protected species occurring or potentially occurring within the project area (i.e., sea turtles, West Indian manatee);
- Essential Fish Habitat (EFH);
- Seagrasses;

- Migratory bird protection;
- Water quality degradation, specifically turbidity levels;
- Impacts to navigation; and
- Socio-economic impacts.

These issues, among other areas of the human environment, are discussed and evaluated within this integrated Feasibility Report and Environmental Impact Statement (EIS).

3.3 PROBLEMS AND OPPORTUNITIES

3.3.1 PROBLEMS

The existing conditions in Palm Beach Harbor cause navigation and economic problems within Lake Worth Inlet. The problems are that vessels are restricted by light loading, tidal delays, and maneuvering difficulties due to three navigation concerns:

1. Insufficient Depth: Depths are limited to 33 feet in the inner entrance channel and turning basin.
2. Insufficient Width: The channel width decreases from 400 feet to 300 feet at a turn in the inner entrance channel, limiting the safe transit of vessels. The turning basin dimensions also limit the vessel size that can safely turn.
3. Currents: The proximity of the Gulf Stream current to the entrance channel and perpendicular direction to the channel make entering the entrance channel and slowing to safe speeds problematic. Additional currents occur in the Area C (reference Figure ES-3) on ebb tide that effect the turning of vessels to stay in the channel.

3.3.2 OPPORTUNITIES

The opportunity at Palm Beach Harbor (mainly to benefit bulk vessels carrying cement and concrete, tanker vessels carrying liquid petroleum, asphalt, and molasses, and the *Bahamas Celebration* cruise ship) is more efficient navigation, resulting in a reduction in light loading, tidal delays, easier maneuvering, and reduced frequency of operation and maintenance dredging intervals.

3.4 CONSTRAINTS AND OBJECTIVES

3.4.1 CONSTRAINTS

- Avoid or minimize potential impacts on manatees and marine grass beds.

- Avoid or minimize impacts on environmental resources including seagrass, hardbottom and softbottom resources found in the study areas A1, A2, B, C, D, F, and G.
- Avoid adverse impacts of shoreline erosion in proximity to Lake Worth Inlet.

3.4.2 OBJECTIVES

The plan formulation was based on the following project objectives, while keeping the above constraints in mind:

- Reduce transportation costs caused by vessel light loading, tidal delays, or other transportation costs for commercial navigation relating to insufficient depth in the main turning basin and from the entrance channel to the inner channel, beginning in 2017.
- Reduce navigation concerns and improve vessel safety in the harbor relating to insufficient width, in areas A-1, A-2, B, C, D, F, and G, beginning in 2017.
- Maintain or improve operations and maintenance dredging intervals within the Federal channel, in conjunction with the options provided in the "FY11 Request to Construct and Maintain Additional Advance Maintenance Features, Palm Beach Harbor, Palm Beach County, Florida," approved December 23, 2011.

With these objectives as the target, appropriate management measures were developed.

3.5 SUMMARY OF MANAGEMENT MEASURES

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

Of the variety of measures considered during the feasibility phase, some were found infeasible due to technical, economic, or environmental constraints, and are described below in the following sections. The remaining feasible measures were formulated into alternative plans. The measures considered are listed below:

- **No Action**: For this measure, no action would be taken to deepen or widen Lake Worth Inlet. This measure is always considered during the planning process.

- **Non-Structural (an activity)**

  - Non-Structural Measure 1 (Tug Assists): Use additional tug assists to help larger vessels and vessels with decreased maneuverability transit the existing harbor.
  - Non-Structural Measure 2 (High-Tide Transiting): Time transits to use high tide to allow for the current fleet to transit the harbor under existing project conditions.
  - Non-Structural Measure 3 (Light-Loading): Light-load the larger vessels to allow the current fleet (larger than the existing project's design vessel) to transit the harbor under existing project conditions.

- **Structural (construction/assembly on-site)**
  - Maintenance Feature 1: Reconfigure the newly authorized expanded settling basin, which was constructed in the fall of 2012, to more effectively catch material before it enters the entrance channel.
  - Maintenance Feature 2: Consider additional advance maintenance of highest shoaling areas in the entrance channel.
  - Channel Deepening: Analyze deepening of the entrance channel, inner channel, main turning basin, and northern turning basin in one-foot increments from a 34-foot to a 43-foot project depth.
  - Channel Widening: See the descriptions below.

INITIAL WIDENING MEASURES

Widening measures were identified in key areas to solve specific problems and are discussed as follows.

For graphics of the following original widening measures, reference ES-3 or REF-3.

- A-1 (South Entrance Channel Flare Widening): Widen the outer portion of the Entrance Channel from Station 0+00 to just outside of the tip of the south jetty. This area would provide more width for vessels as they enter the entrance channel when they encounter the strong Gulf Stream current as they approach the inlet from the south to north. Note that dredging is required only for the inner portion of the flare due to naturally deep water in the outer portion.

Ship Simulation

Design vessels were selected based on a combination of world fleet analysis, vessel operating cost tables analysis (EGM 11-05), berthing constraints, and discussions with port tenants. **The bulk design vessel** was chosen for the following reasons: 1) it represents the size of a molasses product tanker, liquid petroleum tanker, and cement bulk vessels – all of which represent the most draft constrained-vessels and account for a large portion of total tonnage transiting through the port; 2) it is the largest vessel that would be able to fit in the dimensions of Slip 3 which is the major berth of the port for all bulk vessels with sailing drafts over 25 feet and 3) bulk vessels are the least maneuverable vessels to visit the port since they experience a lack of maneuverability and sluggish steering capabilities at low transit speeds which is amplified under fully loaded conditions. Two fully loaded bulk design vessels were used: The Palm Beach Brewer and the Black Rose.

The cruise design vessel was selected to represent a typical-sized cruise vessel that will likely replace the existing cruise ship during the project's period of analysis, and is the largest cruise vessel that would be able to fit at the existing cruise berth. The design cruise vessel was the Norwegian Sea.

Four experienced harbor pilots participated in the simulations. Ship tracks showed that Plan 2 (Figure 3-1), which had a lesser widening footprint in areas F, C, and A1, was maneuverable for all of the design vessels.

Tugs

The Port of Palm Beach owns a 2000 horsepower (hp) tug and 900 hp tug. These tugs are augmented when necessary by the more powerful tugs nearby at Port Everglades. A 2000 hp tug supplemented with a 5000 hp tug were simulated successfully and therefore would be required for all bulk carriers in the with-project condition in Plan 2. Tug boat assistance is not normally required for arriving or departing cruise vessels due to their exceptional maneuverability, and therefore were not used for the Norwegian Sea simulations; hence, tug assistance is not necessary for cruise vessels for Plan 2.

More details on the ship simulation process are located in the Ship Simulation Report Attachment B, of Engineering Appendix A.

- A-2 (North Entrance Channel Flare Widening): Widen the outer portion of the Entrance Channel from Station 0+00 to just outside of the tip of the north jetty. This area would provide more width for vessels entering the entrance channel due to swells to the north of the entrance channel. Note that dredging is required only for the inner portion of the flare due to naturally deep water in the outer portion.

- B-1 (Inner Channel Widening): Widen the inner portion of the Entrance Channel from just outside of the Jetties to Cut-1 by 100 feet to the south. This would provide a larger margin of error to prepare for the sharp turn when the channel narrows to 300 feet.

- B-2 (Inner Channel Widening): Widen the inner portion of the Entrance Channel from just outside of the Jetties to Cut-1 by 100 feet to the north. This would provide a larger margin of error to prepare for the sharp turn when the channel narrows to 300 feet.

- C (Inner Channel Turn Widener): Add a turn widener along the north side of Area C. The widener would provide an additional 400 feet of channel width at the widest point of the widener. This would allow a larger margin of error, due to the ebb tide, when currents move across the area in a northeasterly direction causing dangerous currents at a critical point of transition to smaller width near rock outcroppings.

- D (Peanut Island Widener): The Peanut Island Widener (Area D) would expand the radius of the Southern Turning Basin by approximately 290 feet. The *Bahamas Celebration* must make a sharp turn when backing out to avoid the shoal at the south side of Peanut Island. This turn prevents cargo vessels from berthing at Berth 6 (opposite Berths 2-3 in Slip 1) when the cruise ship is

present. There are also suction effects during flood tide which affect maneuverability. This measure would allow a larger margin of error around Peanut Island, for better maneuverability and would allow cruise vessels to have a straight back departure, which would allow containerships to access berth 6 when the cruise is present. The actual dimensions of the required dredging area are approximately 290 feet by 910 feet.

- E (Northern Turning Basin Widener): The Northern Turning Basin Expansion Area (Area E) would extend the Northern Turning Basin 250 feet to the north. This would allow for a larger turning radius for cruises if the existing cruise terminal were to be expanded. The actual dimensions of the required dredging area are approximately 250 feet by 400 feet (See Section 3.6 below).

- F (Main Turning Basin Widener): The Southern Turning Basin widener (Area F) would provide approximately 275 feet of additional width to the Southern Turning Basin. This would allow a larger turning radius for larger vessels. The actual dimensions of the required dredging area are approximately 275 feet by 1800 feet.

- G (South Main Turning Basin Widener): The Southern Basin Expansion Area (Area G) would extend the Southern Turning Basin 1300 feet to the south. This would allow for a larger turning radius for larger vessels. The actual dimensions of the required dredging area are approximately 1300 feet by 1500 feet.

MEASURES ELIMINATED FROM DETAILED EVALUATION

Non-structural measures may be combined with structural measures to achieve project objectives, but non-structural measures cannot stand alone, since they are already being used to every extent possible in the current project. Waiting for high tide, vessel light loading, and tug assistance are non-structural measures which are already used, and are not considered further as stand-alone options; however, they are inherently complementary with all other measures carried forward.

Area E was eliminated as a measure early on in the process, as requested by the Port of Palm Beach, as they no longer were going to consider expansion of the cruise terminal to the north. (See letter dated February 13, 2008 in Pertinent Correspondence, Appendix E, Attachment 2). Area A-2 was eliminated during discussions with the pilots since it would not be used frequently, as most vessels approach the channel from the south rather than the north.

3.6 SUMMARY OF INITIAL ARRAY OF ALTERNATIVES

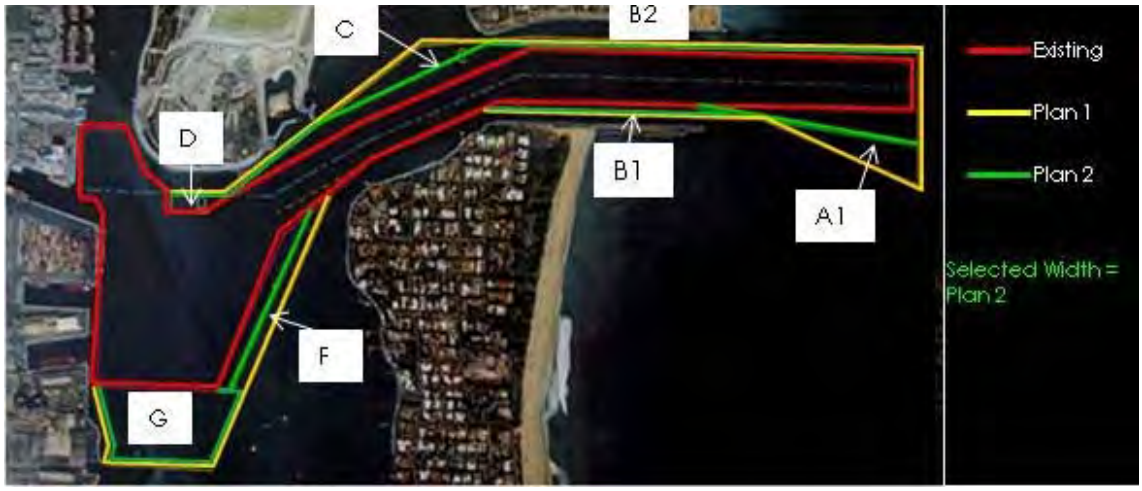
INTITIAL PLAN DEVELOPMENT - WIDENING

USACE agreed to ship simulation conducted with the harbor pilots, instead of an incremental widening analysis, to determine minimum vessel widening needs for safety and

maneuverability. This decision was made because the real experience of the pilots combined with the ship simulation would be a more effective way to determine the minimum width that would best solve problems in specific areas. Additionally, having one widening footprint would reduce combinations of plans when paired with deepening alternatives and therefore also reduce modeling time and costs.

Widening measures (with the exception of E) were then further refined based on dialogues with harbor pilots. The pilots shared their experience and historical accounts of harbor transits, and the refined measures were combined into a large and small plan, known as Plan 1 and Plan 2, shown below in Figure 3-1. In both plans, the channel and turning basin depths were the same; however, widening of those areas is less in Plan 2. Both Plans were simulated in a model at the Simulation, Training, Assessment, and Research (STAR) Center with 2 design vessels: a bulk carrier vessel (fully loaded) and a cruise ship. Plan 2 met design vessel needs for width needed to maneuver safely.

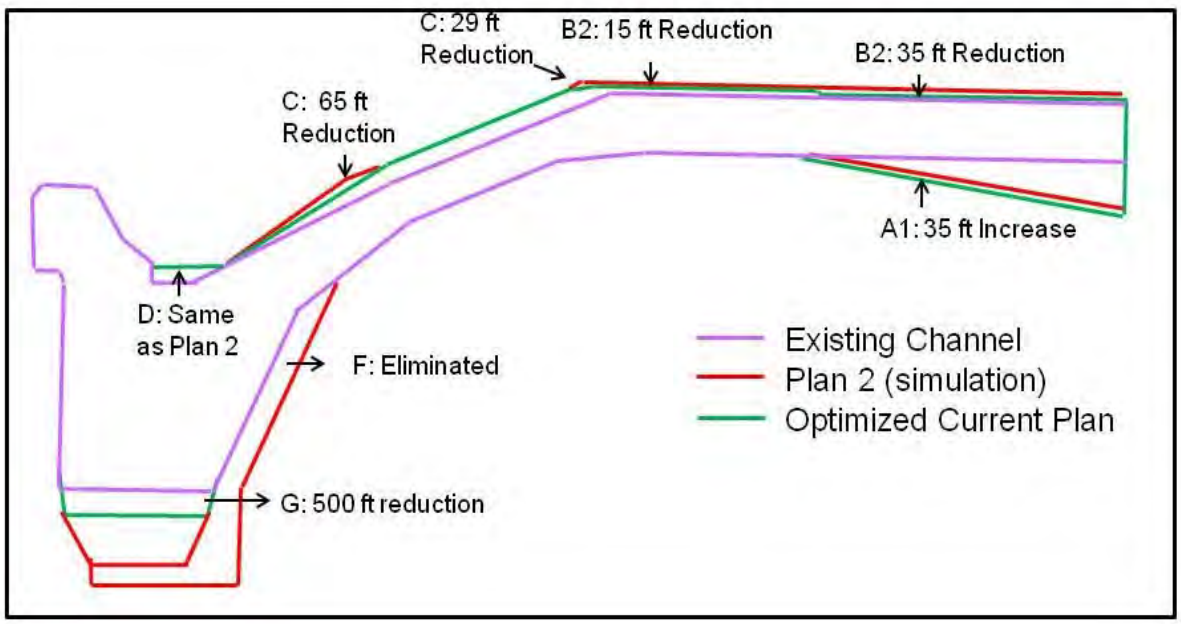
Figure 3-1: Plan 1 and Plan 2



WIDENING OPTIMIZATION

Since Plan 2 was considered to be sufficient for maneuvering the design vessels and involves less environmental impact, Plan 1 was discarded. Plan 2 was then further refined during a series of iterative meetings with the harbor pilots. Area F was rarely needed by the pilots in the ship simulation, as shown in the ship tracks, and was thus eliminated from Plan 2. Area G was reduced significantly (14 acres in Plan 2 down to 4.5 acres of seagrass impact in the recommended plan) upon further review of the ship tracks for design bulk vessels, along with input from the Port of Palm Beach and the harbor pilots, and with consideration to the environmental resources within the area. Area B2 and A1 were slightly modified to accommodate widening while maintaining a safe distance from the north jetty. Area C was reduced in order to optimize the plan to avoid building more project than is necessary for safe and efficient navigation. Area D remained in the plan as modeled and remains an important part of the widening footprint to the port and the harbor pilots for its ability to give safer maneuverability to cruise vessels and allow access for containerships to Berth 6. Figure 3-2 shows the refinements that were made.

Figure 3-2: Plan 2 Optimization.



WIDENING ALTERNATIVES CARRIED FORWARD

The refined Plan 2 shown described and shown above, known from this point forward as Plan 2, was carried forward as the widening footprint. The final Plan 2 footprint is shown in Figure ES-4. The no-action alternative was also carried forward.

3.7 INTERMEDIATE ARRAY OF ALTERNATIVES

Alternatives were formed in the intermediate array which paired the widening footprint (Plan 2) with deepening. Deepening alternatives, with the widening footprint, were formulated in one-foot increments from 34 to 43-foot project depths. A widening-only plan was also evaluated at the existing 33-foot project depth. Note that the no-action plan is always considered.

During this phase, the USACE economic model HarborSym was used to estimate cost savings, or benefits, that would be captured as a result of more efficient vessels, as well as related savings from reduced time delays. The average annual benefits (or cost savings), were then subtracted from the average annual costs, to determine net benefits. The average annual benefits were also compared to the average annual cost to find the benefit to cost ratios. The National Economic Development (NED) plan must have the highest net benefits of all the plans, and must have a benefit to cost ratio over 1.0. The base year for planning purposes was assumed to be 2017, as a likely year when the project benefits could begin to be realized after construction is completed. The end of the period of analysis is 50 years from the base year, or 2067. More information on the HarborSym model, assumptions, and calculations can be found in the Socio-Economic Appendix C. Model data is available upon request.

Advance maintenance was not included during formulation of the recommended plan; rather, it is included as an optimization after the recommended plan was determined. (See maintenance discussion on the next page) The most important factors that were considered during the plan formulation, and which are reflected in the cost estimates, are listed in Table 3-1.

Table 3-1: Important Factors Considered During Formulation.

Factor	Due to	Impact
Mitigation for seagrass and hardbottom	Widening	Seagrass and hardbottoms are at shallow elevations – any widening will impact – depth is not a factor.
Jetty Stabilization (north jetty)	Widening + Deepening	Combination of widening and deepening triggers the need for sheetpile at project depths 41-43 ft.
Dredge Equipment	Dredged Material Composition (sand and consolidated)	Two different types of dredge equipment may be needed.
Placement	Dredged material Composition (sand and consolidated)	Two different placement sites will be used (sand will be placed in nearshore; consolidated material will be taken to ODMDS).

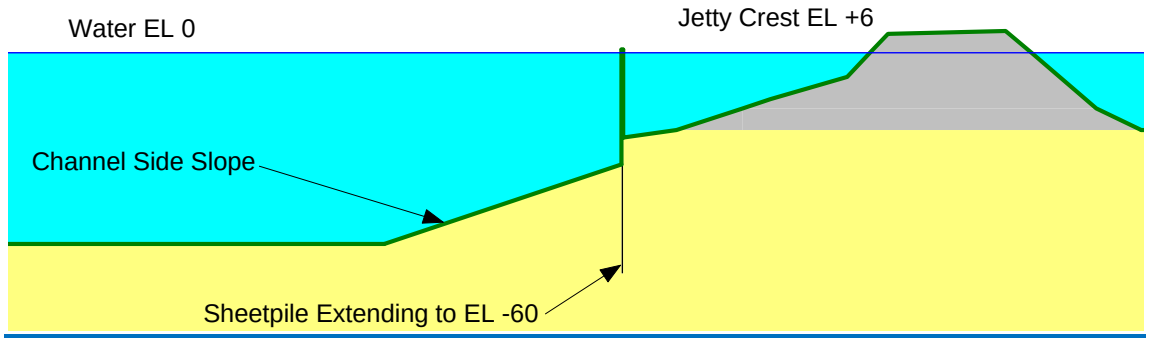
DESCRIPTION OF THE INTERMEDIATE ARRAY OF ALTERNATIVES

For each of the alternatives, total required mitigation was assumed to be the same. This assumption was based on the following: widening of the channel (required footprint already established) is the feature causing impacts to adjacent seagrass and hardbottom communities. Regardless of the proposed depth of the project, acreage of impacts would remain the same between alternatives. While it is true that the ultimate top width is dependent upon the final depth, the relative width increase for each foot of deepening (approximately 3 feet of width) is very small when compared to the actual widening measures that are necessary to accommodate the design vessel (range from 40 feet to over 150 feet of width). The minimal additional top width would not have any impacts on mitigation requirements. Additionally, a conservative impact for the side slopes was assumed which went slightly beyond the impact of the alternative depths. Therefore, regardless of the proposed depth of the project, acreage of impacts would remain the same between alternatives. Seagrass and hardbottoms typically exist at elevations of -6 feet MLLW (the natural lagoon elevation), which is in shallow areas outside of the proposed deepening alternatives. It should also be noted that no increases in shoaling would occur for any of the deepening alternatives with the widening footprint. Only marginal increases (approximately 2500 cy/yr) would be expected for each, as a result of the widening footprint. Therefore, throughout this analysis, any additional project induced operations and maintenance costs were negligible. The costs for this exercise were at a rough order of magnitude (ROM) to identify large variations between each alternative. Costs at this level included ROM mitigation costs, ROM dredging with mechanical and hydraulic, and placement at the Ocean Dredged Material Disposal Site (ODMDS) and beach template. Jetty stabilization costs are included for project depths of 41 to 43 feet.

The north and south jetty at the entrance to Lake Worth Inlet are in close proximity to the existing project. Chapter 2 discussed that the south jetty currently has an inadequate factor of safety in the existing and future-without project condition. Geotechnical analysis determined that the south jetty would not be affected by the proposed widening footprint or any of the depths in the intermediate array. Therefore the existing, future without-project conditions and future with-project conditions are the same for the south jetty. However, the proximity of the alternatives to the north jetty, due to depth and respective width, became a significant factor in cost as depths were evaluated. The combination of proposed deepening and widening alternatives at certain depths has the potential to affect the stability of the existing north jetty (as shown in Figure 3-3).

In such a case, jetty stabilization for the north jetty would become a project cost. Geotechnical modeling determined that north jetty stabilization would be required at a project depth of 41 feet. This means, the cost of deepening alternatives from project depths of 41 to 43 feet would also include the cost of north jetty stabilization. Additional details regarding jetty stability analysis and the proposed sheet pile wall can be found in Engineering Appendix A.

Figure 3-3: Proposed Channel Template Potential Impacts to North Jetty



COMPARISON OF INTERMEDIATE ARRAY OF ALTERNATIVES

The intermediate array included the widening-only alterative (at existing project depth of 33 feet), and the widening footprint plus incremental depths from 34 to 43 feet. Rough order of magnitude costs for the intermediate array shown in Table 3-2 included jetty stabilization measures for project depths of 41 to 43 feet.

Table 3-2: Intermediate Array.[1]

Project (Depth)	Average Annual Benefits	Average Annual Costs	Net Benefits	BCR
No-Action	$0	$0	$0	0
Widening-Only	$4,116,905	$2,171,796	$1,945,109	1.90
34'+ Widening	$6,245,097	$2,171,903	$4,073,194	2.88
35'+ Widening	$6,900,701	$2,217,688	$4,683,014	3.11
36'+ Widening	$7,556,306	$2,264,137	$5,292,169	3.34
37'+ Widening	$8,211,911	$2,402,193	$5,809,718	3.42
38'+ Widening	$8,779,066	$2,635,478	$6,143,587	3.33
39'+ Widening	$9,346,221	$2,962,377	$6,383,844	3.15
40'+ Widening	$9,768,940	$3,244,471	$6,524,469	3.01
41'+ Widening	$10,191,659	$3,916,886	$6,274,773	2.60
42'+ Widening	$10,530,963	$4,348,164	$6,182,798	2.42
43'+ Widening	$10,870,267	$4,686,761	$6,183,506	2.32

EVALUATION OF THE INTERMEDIATE ARRAY OF ALTERNATIVES

Table 3-2 shows that the 40-foot depth had the highest net benefits, with the 39-foot depth having the next highest net benefits. Additionally, these two depths had net benefits within 1%

[1] FY12 costs were used at a discount rate of 3.75% over 50 years.

of one another. Therefore, 1 foot above and 1 foot below those two depths were taken as the boundaries. The end result was that project depths of 38-41 feet became the final array of depths to be evaluated.

3.8 FINAL ARRAY OF ALTERNATIVES

In order to determine the sensitivity of the four alternatives with respect to each other, another level of detailed evaluation was performed including more refined cost estimates and economic modeling[2] for the depths of 38 to 41 feet. Costs for stabilization of the north jetty were included for the 41-foot depth alternative. Note that the no-action plan is always considered.

COMPARISON OF THE FINAL ARRAY OF ALTERNATIVES

Table 3-3 shows that the refinement in cost and economic modeling slightly broadened the range of the net benefits between the alternatives. This analysis shows that the 40-foot alternative has the highest net benefits. The 39-foot alternative is within 3% of the 40-foot alternative, but the net benefits for the 38-foot and 41-foot alternatives, respectively, are each more significantly lower than both the 39-foot and 40 foot alternatives.

ER 1105-2-100 (Appendix G, Exhibit G-1) states the following: "Identification of the NED plan is to be based on consideration of the most effective plans for providing different levels of output or service. Where two cost effective plans produce no significantly different levels of net benefits, the less costly plan is to be the National Economic Development (NED) plan, even though the level of outputs may be less."

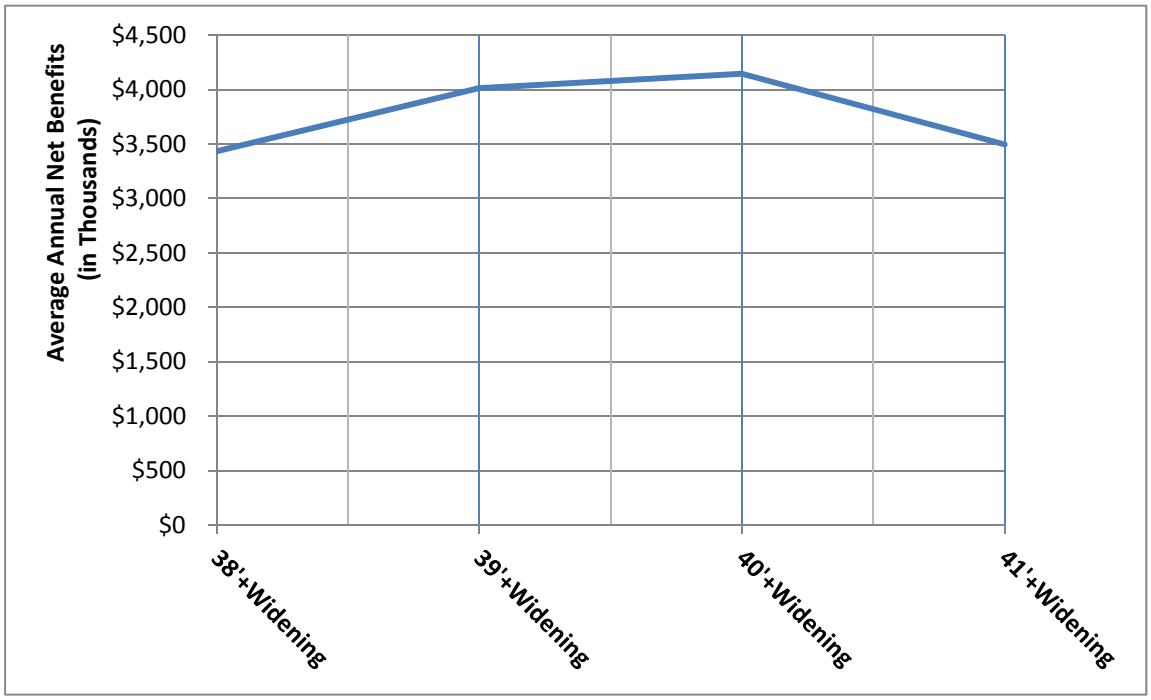
Table 3-3: Final Array.

Project (Depth)	Average Annual Benefits	Average Annual Costs	Average Annual Net Benefits	BCR
No-Action	$0	$0	$0	0
38'+Widening	$6,416,498	$2,982,771	$3,433,727	2.15
39'+Widening	$7,325,811	$3,311,091	$4,014,720	2.21
40'+Widening	$7,746,616	$3,599,861	$4,146,755	2.15
41'+Widening	$7,793,759	$4,297,090	$3,496,669	1.81

Figure 3-4 shows the average annual net benefits graphically for the final array, which shows the small increase from 39 ft to 40 ft, followed by a steeper drop off at 41 ft. This further shows the rationale for why the level of output, or benefits, for the 39 ft alternative is considered not to be significantly different than the 40 ft alternative.

[2] In this round, the costs were estimated at a greater level of detail with more information, and the economic model for each alternative was run with more iterations, making the benefits more refined. Notes: FY12 costs were used and annualized at a discount rate of 3.75% over 50 years.

Figure 3-4: Average Annual Net Benefits for Final Array.



PLAN FORMULATION EVALUATION

This section evaluates the final array and indicates how each alternative contributed to the planning objectives, avoided planning constraints, and met the Planning and Guidance (P&G) criteria of completeness, effectiveness, efficiency, and acceptability. Table 3-5 at the end of this chapter displays each category in detail. The 39-foot deepening and widening, and the 40-foot deepening plus widening alternatives most fully meet all objectives, constraints, and criteria.

SELECTION OF THE PLAN

Table 3-3 shows that the 39-foot alternative produces just 3% lower net benefits than the 40-foot alternative, and is also the less costly plan of the two alternatives. Therefore, when the guidance referenced above from ER 1105-2-100 is applied, the 39-foot deepening plus widening alternative becomes the National Economic Development (NED) plan. The benefit to cost (B:C) ratio is also the highest of the four alternatives, at 2.21 to 1.

Project Depth

The alternatives are based on the project depth of the inner channel. Project depth is the authorized depth to which the Federal government maintains channels and basins. All channel depths indicated in this report and EIS are project depth of the inner channel unless otherwise specified.

For each project depth, however, other depths are associated and should be taken into consideration during plan formulation as shown in Table 3-4.

For example, the entrance channel and inner channel have requirements for squat and underkeel clearance for safety. Additionally, during construction, the Federal government will dredge channels and basins to an additional two feet of required overdepth and one foot of allowable overdepth.

Table 3-4: Sailing Draft, Project Depth and Contract Depth.

Vessel Sailing Draft	UnderKeel Clearance Inner	Underkeel Clearance Entrance	Project Depth Inner	Project Depth Entrance	Contract Req'd Overdepth Both	Contract Allow Overdepth Both	Contract Depth Inner	Contract Depth Entrance
30	3	5	33	35	2	1	36	38
31	3	5	34	36	2	1	37	39
32	3	5	35	37	2	1	38	40
33	3	5	36	38	2	1	39	41
34	3	5	37	39	2	1	40	42
35	3	5	38	40	2	1	41	43
36	3	5	39	41	2	1	42	44
37	3	5	40	42	2	1	43	45
38	3	5	41	43	2	1	44	46
39	3	6	42	45	2	1	45	48
40	3	6	43	46	2	1	46	49

3.9 ENVIRONMENTAL MINIMIZATION AND AVOIDANCE EFFORTS

Conservation measures were a major focus during the plan formulation phase for the proposed project. Efforts to reduce impacts to habitats were fruitful during the plan formulation phase of this study, and it is the goal of this project to continue reduction of impacts to habitats throughout the construction phase.

Avoiding and minimization of potential impact areas significantly decreased the risk of indirect effects on managed and protected species. Likewise, a great deal of consideration was given to the utilization of rock removal methods to decrease the likelihood of an incidental take, injury, and behavioral modification of protected species, during construction.

The Four Federal Accounts

The Federal process incorporates four accounts to facilitate evaluation and display of effects of alternative plans. The four accounts are national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE). The Federal Objective is to determine the project alternative with maximum net benefits while protecting or minimizing impacts to the environment.

NED: The national economic development account displays changes in the economic value of the national output of goods and services. This account is required for navigation projects.

EQ: The environmental quality account displays non-monetary effects on significant natural and cultural resources.

RED: The regional economic development account registers changes in the distribution of regional economic activity that result from each alternative plan.

OSE: The other social effects account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

If rock removal is not achievable through excavation with dredge equipment, then other rock removal methods, limited to only those areas where excavation cannot be accomplished by dredging, will need to be pursued as discussed in Section 4.5 (Chapter 4) of this report.

The USACE believes that blasting (rock pre-treatment), if ultimately needed, is actually the least environmentally damaging method for removing the rock from within the project. If needed, each blast would last no longer than five (5) seconds in duration, and may even be as short as two (2) seconds each. Additionally, the blasts are confined in the rock substrate. Boreholes are drilled into the rock below, the blasting charge is set, and then the chain of explosives is detonated. Because the blasts are confined within the rock structure, the distance of the blast effects is reduced as compared to an unconfined blast.

For this reason, options not involving blasting could possibly be more detrimental to populations and individuals of protected species. One alternative option instead of blasting was the use of a punchbarge/piledriver to break rock. However, it was determined that the punchbarge, which would work for 12-hour periods, strikes the rock approximately once every 60-seconds. This constant pounding would serve to disrupt animal behavior in the area. Using the punchbarge would also extend the length of the project, thus increasing any potential impacts to all fish and wildlife resources in the area. In addition, the punch barge would negatively impact the surrounding community due to noise and vibrations.

More details on this discussion are outlined in Chapter 4.

SUMMARY OF ACCOUNTS FOR THE NATIONAL ECONOMIC DEVELOPMENT PLAN

The Federal objective is to determine the project alternative with the maximum net benefits while protecting or minimizing impacts to the environment. Under the National Economic Development (NED) account, which measures benefits of the recommended plan, the 39-foot plus widening alternative demonstrates the second highest net benefits of $4,014,720, and the highest B:C ratio of 2.21 to 1 (when compared to the other alternatives and prior to the Cost and Schedule Risk Analysis refinements, as shown in Table 3-3.

The 39-foot plus widening alternative, which was reduced during the plan formulation process (see Figure 3-2), was optimized to

minimize environmental impacts under the EQ account. Environmental impacts are more fully described in Chapter 5.

The Palm Beach area economy, under the RED account, will most likely experience regional economic benefits from the implementation of this project. It is estimated that 15.3 jobs will be created for every $1 million expenditure, and that 1430 jobs will be positively impacted from project construction expenditures. See Socio-Economic Appendix C for the details of this analysis.

The OSE account includes safety, which will be improved for the harbor pilots through the widened channel, especially by allowing a greater margin of error for vessels entering the entrance channel against the strong gulf stream, while transiting through the jetties, and at the transition area where the channel currently has a sharp transition from 400 ft to 300 ft, from the entrance channel to the inner channel. This account also includes the effects of the project on the homeowners in the region. The opinions of homeowners have been noted in the report and are located in pertinent correspondence, Appendix E, Attachment 1.

3.10 DEVELOPMENT OF IMPROVED ADVANCE MAINTENANCE PLAN

The improved advance maintenance plan described below is recommended for the existing project, even if the feasibility study's National Economic Development (NED) plan is never built. Therefore, it is not included in the plan formulation process for the recommended plan which was described earlier in this chapter. The improved maintenance plan is included in this feasibility study, rather than through the operation and maintenance program, due to the presence of rock.

Please reference Figure ES -3 (Executive Summary) to see the new overall components of the improved advance maintenance plan, compared to the existing features. Figure 3-5 below shows the features which were modeled. The discussion below summarizes the rationale, modeling, and results. More details on the modeling itself can be found in Hydrodynamic Modeling Attachment A of Engineering Appendix A.

One of the objectives of this feasibility study is to maintain or improve operations and maintenance dredging intervals within the Federal channel.

Advance maintenance features reduce the frequency of dredging. The strategy is not to reduce the volume of material required to be dredged, but rather, for more material to be trapped in the settling basin or under the channel, rather than the channel itself. This allows for cost savings by reducing the number of maintenance dredging events, while providing an operational channel for longer periods of time.

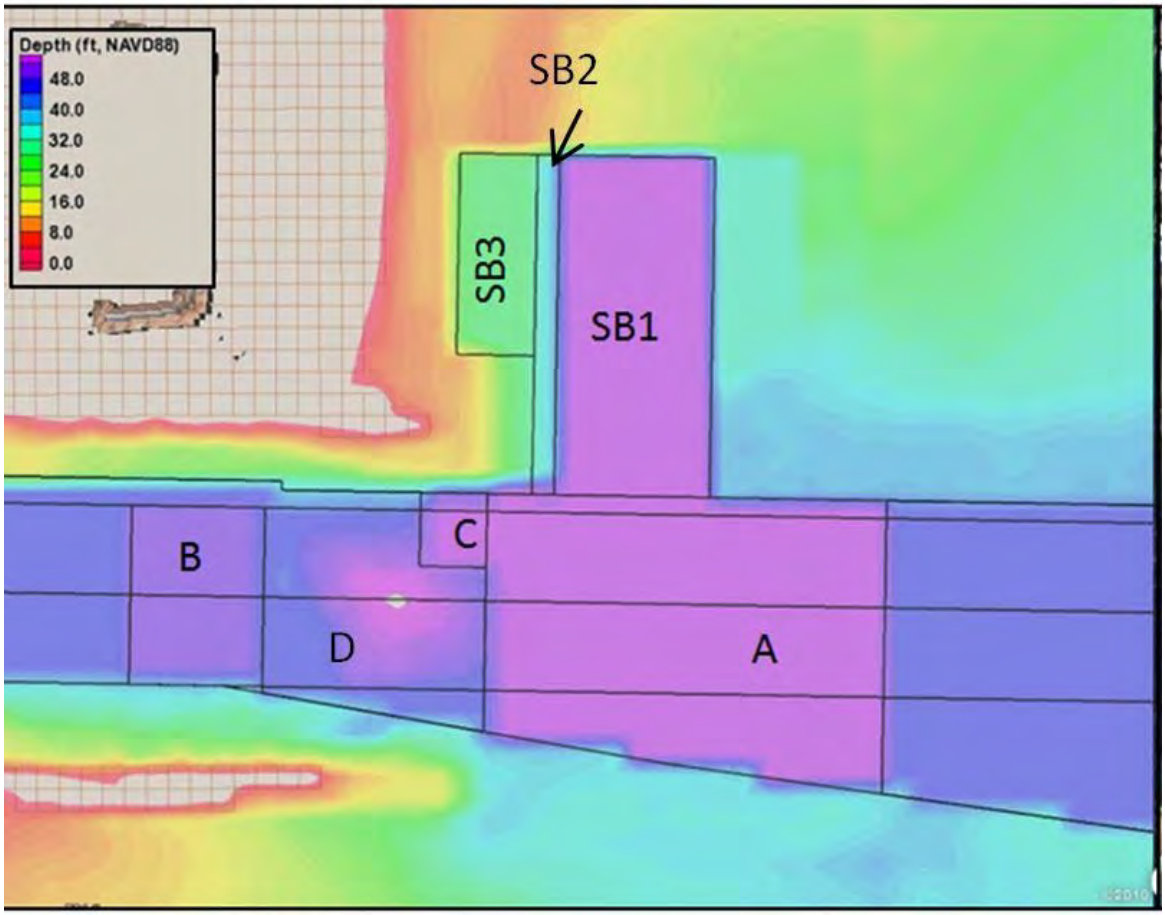
Lake Worth Inlet is historically a very high shoaling channel, requiring dredging 2 times/year to maintain existing project depths. Historically, there have been two ways of reducing

maintenance: an existing/extended settling basin and 2 feet of advance maintenance in the entrance channel (35 feet + 2 feet Mean Lower Low Water (MLLW)).

The Final Palm Beach Advance Maintenance Approval Package, approved December 2011, authorized an additional 2 feet of advance maintenance in the entrance channel (39 feet + 2 feet MLLW) from STA 30+00 to 47+00, as well as an expanded settling basin footprint west of the existing settling basin. This plan improved operation and maintenance dredging to 1 time/year with a smaller event every other year.

New modeling during the feasibility study, using advanced capabilities that were previously not available, showed ways to further decrease the frequency of O&M dredging.

Figure 3-5: Improved Advance Maintenance Plan Modeling.



Settling Basin: First, the configuration of the expanded settling basin (SB) was modeled with the addition SB2, as well as a small outward notch (SB3) to the west which would catch sediment before it entered the channel. This is a crucial piece of the improvement. Then, areas within the settling basin were modeled with varying depths ranging from 26 to 51 feet, starting with the deepest depth in SB1 and gently sloping into shallower depths in SB2 (34 feet) and the most shallow depth in SB3 (26 feet).

Entrance channel: The improved advance maintenance areas are located in the same footprint as the previously authorized footprint, with the exception of a small addition in the southern flare of the new widening footprint. The main difference is deeper depths. The area was split into two areas of varying depths. Advance maintenance zone (AMZ) A and AMZ C both were both modeled at 51 feet and AMZ B and AMZ D were modeled at 47 feet. AMZ D was later combined with AMZ B to form a larger AMZ B. AMZ C is an important part of this plan, due to the vast amount of sand that has been shown to shoal around the north jetty head. The proximity of this area to the north jetty as a result of the 40 foot widener of the recommended widening footprint, coupled with the advance maintenance depths, necessitates sheetpile stabilization for the north jetty for a 200-foot length from STA 38_75 to 40+75. The south jetty remains unaffected.

Both of the settling basin measures, as well as the advance maintenance measures in the entrance channel, termed through the remainder of the report as the improved advance maintenance plan, were found to decrease O&M frequency to 1 time/2 years. This results in cost savings over the period of analysis of 50 years as well as fewer disturbances to the environmental and community for each event. Final details on the improved advance maintenance plan are discussed in Chapter 4, Recommended Plan.

3.11 NATIONAL ECONOMIC DEVELOPMENT PLAN WITH AND WITHOUT IMPROVED ADVANCE MAINTENANCE PLAN

As stated earlier, the improved advance maintenance plan is recommended with or without the NED plan of 39-foot deepening plus widening, and stands alone on its own merit and benefits. Therefore the improved advance maintenance plan is an additive benefit to the selected plan. For the purposes of demonstrating this, the 39-foot deepening plus widening project is shown with and without the improved advance maintenance plan, in Tables 3-5 and 3-6.

The summary table below shows the economic benefits and costs for the 39-foot deepening plus widening project without the improved advance maintenance plan. Table 3-6 shows the NED plan economic costs and benefits when the advance maintenance plan is added. The costs are increased, but the net benefits also increase and the benefit to cost ratio (BCR) remains well over 1.0 to 1, at 2.0 to 1.0. It is important to note that the tables shown below show costs and benefits, and BCRs at a refined level of detail and different discount rate, and therefore they slightly differ from what is shown in the final array for the 39-foot deepening plus widening alternative.

Table 3-5: Summary of NED Plan Net Benefits and Benefit-cost Ratio without Improved Advance Maintenance Plan.

Project (Depth)	39'+Widening
Sum of Present-Value Benefits	$ 166,220,000
Total Costs with IDC	$ 81,800,000
Annualized Cost Savings (Benefits)	$ 7,090,000
Annualized Costs incl. O&M	$ 3,600,000
AA Net NED Benefits	$ 3,490,000
BCR	2.0

Notes: Annualized at 3.5% over 50 years. Numbers rounded to nearest $10,000.

Table 3-6. Summary of NED Plan Net Benefits and Benefit-cost Ratio including Improved Advance Maintenance Plan.

Project (Depth)	39'+Widening
Sum of Present-Value Benefits	$ 166,220,000
Total Costs with IDC	$ 92,930,000
Annualized Transportation Cost Savings (Benefits)	$ 7,090,000
Annualized Advanced Maintenance Cost Savings (Benefits)	$ 850,000
Total Average Annual Benefits	$ 7,940,000
Total Average Annual Costs	$ 3,960,000
AA Net NED Benefits	$ 3,980,000
BCR	2.0

Notes: Annualized at 3.5% over 50 years. Dollar amounts rounded to nearest $10,000.

Table 3-5: Plan Formulation Evaluation for Final Array

1. Alternatives	No Action	38 ft + Widening	39 ft + widening	40 ft + Widening	41 ft + Widening
2. Impact Assessment (4 Accounts)					
A. National Economic Development (NED)	O - Would not produce any additional benefits to the nation	P - 2 of the 4 highest net benefits, but did not maximize net benefits	F - Maximized net benefits (within 3% of 40 ft alt)	F - Maximized net benefits (within 3% of 39 ft alt)	P - 2 of the 4 highest net benefits, but did not maximize net benefits
B. Environmental Quality (EQ)	F - No impacts to the natural environment	P - Widening footprint, which is the cause for impact, is the same for each alt. Mitigation would be done for impacted areas that could not be avoided. Deepening incrementally by a foot has negligible environmental impacts.	P - Widening footprint, which is the cause for impact, is the same for each alt. Mitigation would be done for impacted areas that could not be avoided. Deepening incrementally by a foot has negligible environmental impacts.	P - Widening footprint, which is the cause for impact, is the same for each alt. Mitigation would be done for impacted areas that could not be avoided. Deepening incrementally by a foot has negligible environmental impacts.	P - Widening footprint, which is the cause for impact, is the same for each alt. Mitigation would be done for impacted areas that could not be avoided. Deepening incrementally by a foot has negligible environmental impacts.
C. Regional Economic Development (RED)	O - Would not produce any additional benefits to the region	P - Expected to be partially met for each alternative.	P - Expected to be partially met for each alternative.	P - Expected to be partially met for each alternative.	P - Expected to be partially met for each alternative.
D. Other Social Effects (OSE)	O - Would not produce any other incidental benefits	P - Widening footprint, which is shared by each alternative, has the biggest effect on improving safety.	P - Widening footprint, which is shared by each alternative, has the biggest effect on improving safety.	P - Widening footprint, which is shared by each alternative, has the biggest effect on improving safety.	P - Widening footprint, which is shared by each alternative, has the biggest effect on improving safety.
3. Plan Evaluation					
A. Contribution to Planning Objectives					
(1) Reduces transportation costs from light loading, tidal delays, or other commercial navigation issues due to insufficient depths in the MTB & from the entrance channel to the inner channel	O - There are high existing transportation costs.	P - Net AAEQ transportation costs savings are $3,433,727.	F - Net AAEQ transportation costs savings are $4,014,720.	F - Net AAEQ transportation costs savings are $4,146,755.	P - AAEQ transportation costs savings are $3,496,669.
(2) Reduces navigation concerns & improve vessel safety in the harbor related to insufficient widths	O - Maneuverability and safety concerns in harbor in existing conditions	F - Widening footrprint same for all alts and offers sufficient widths to address safety and maneuverability	F - Widening footprint same for all alts and offers sufficient widths to address safety and maneuverability	F - Widening footprint same for all alts and offers sufficient widths to address safety and maneuverability	F - Widening footprint same for all alts and offers sufficient widths to address safety and maneuverability
(3) Maintains or improves O&M event intervals for the Federal channel (December 2011 approved plan)	P - Existing conditions for dredging intervals is 1 time every 1 year.	F - Improved Advance Maintenance is same for all alternatives and would reduce frequency to 1 time every 2 yrs.	F - Improved Advance Maintenance is same for all alternatives and would reduce frequency to 1 time every 2 yrs.	F - Improved Advance Maintenance is same for all alternatives and would reduce frequency to 1 time every 2 yrs.	F - Improved Advance Maintenance is same for all alternatives and would reduce frequency to 1 time every 2 yrs.
B. Response to Planning Constraints					
(1) Avoid/minimize potential impacts to manatees & grassbeds	F - No impacts in existing condition	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates
(2) Avoid/minimize impacts to environment (seagrass, hardbottom, & softbottom resources)	F - No impacts in existing condition	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates	F - Widening impact the same for all alts and avoids first, then mitigates
(3) Avoid adverse impacts of shoreline erosion in proximity to Lake Worth Inlet	F - Shoreline erosion mitigated for	F - Shoreline erosion effects negligible	F - Shoreline erosion effects negligible	F - Shoreline erosion effects negligible	F - Shoreline erosion effects negligible
C. Response to Evaluation Criteria					
(1) Completeness	O - Not considered complete because it does not provide investments or actions to ensure realization to meet the planning objectives	F - Considered to fully meet the objective since costs represent the full rationale and include the necessary means to meet the planning objectives.	F - Considered to fully meet the objective since costs represent the full rationale and include the necessary means to meet the planning objectives.	F - Considered to fully meet the objective since costs represent the full rationale and include the necessary means to meet the planning objectives.	F - Considered to fully meet the objective since costs represent the full rationale and include the necessary means to meet the planning objectives.
(2) Effectiveness	O - Not effective in meeting planning objectives	P - Partially effective since it does contribute to the planning objectives, but not as fully as the 39 ft and 40 ft alternatives	F - Provides a solution which most fully meet the planning objectives.	F - Provides a solution which most fully meet the planning objectives.	P - Partially effective since it does contribute to the planning objectives, but not as fully as the 39 ft and 40 ft alternatives
(3) Efficiency	O - Not efficient in meeting the planning objectives	P - partially efficient since it is 2 of the 4 most cost effective alternatives, but not as fully as the 39 ft and 40 ft alternatives.	F - One of the two most cost effective alternatives which most fully meet the planning objectives	F - One of the two most cost effective alternatives which most fully meet the planning objectives	P - partially efficient since it is 2 of the 4 most cost effective alternatives, but not as fully as the 39 ft and 40 ft alternatives.
(4) Acceptability	P - Currently accepted as the status quo and is compatibility with existing laws, regulations, and public policies; however, it does not achieve full acceptability since there are problems which the port, harbor pilots do not deem as satisfactory with its workability and viability	F - Is consistent with existing laws, regulations, and public policies, and are supported by the port, harbor pilots, and state and federal environmental agencies, and well as provide incidental benefits of sand and safety to the community.	F - Is consistent with existing laws, regulations, and public policies, and are supported by the port, harbor pilots, and state and federal environmental agencies, and well as provide incidental benefits of sand and safety to the community.	F - Is consistent with existing laws, regulations, and public policies, and are supported by the port, harbor pilots, and state and federal environmental agencies, and well as provide incidental benefits of sand and safety to the community.	F - Is consistent with existing laws, regulations, and public policies, and are supported by the port, harbor pilots, and state and federal environmental agencies, and well as provide incidental benefits of sand and safety to the community.

F-Fully meets objective; P-Partially meets objective; O-Does not meet objective

MOLASSES TANKER, SLIP 2

4.0 RECOMMENDED PLAN

LAKE WORTH INLET

Palm Beach Harbor

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4 RECOMMENDED PLAN

This chapter discusses the details of the recommended plan, which was determined by plan formulation methods described in Chapter 3. The details of the recommended plan discussed in this chapter include material quantities and classifications, operations and maintenance (including the improved advance maintenance plan and associated north jetty stabilization), dredged material placement, cost and benefits, and risk and uncertainty.

4.1 OVERVIEW OF THE RECOMMENDED PLAN

Refer to Figure ES-4 located in the Executive Summary. The reference map located at the end of this report, entitled REF-4, can also be folded out to show the recommended plan and used as a reference throughout this chapter.

No locally preferred plan (LPP) has been identified. Therefore, the recommended plan is the National Economic Development Plan (NED) Plan, and is identified as the **39-foot depth with widening footprint** alternative. The recommended plan includes:

- the addition of a new channel flare on the south side of the Entrance Channel,
- a widening of the Entrance Channel by 40 feet and 60 feet (varies) to the north,
- widening of Inner Harbor Cuts 1 and 2 to provide for a minimum channel width of 450 feet,
- a 150-foot expansion of the Southern (Main) Turning Basin to the south, and
- an expansion of the Southern (Main) Turning Basin on the north side to remove a notch currently encroaching into the basin.
- Improved maintenance plan consisting of expanded settling basin, advance maintenance, and associated north jetty stabilization

The channel would be deepened to a project depth of 39 feet Mean Lower Low Water (MLLW) plus an additional 2 feet of required overdepth and 1 foot of allowable overdepth. The recommended plan includes an improved advance maintenance plan, inclusive of sheet pile on the north jetty, for stabilization due to the recommended plan's widening and deepening in combination with the improved advance maintenance plan. As stated earlier, the improved advance maintenance plan is recommended with or without the 39-foot selected project, and stands alone on its own merit and benefits. Therefore the improved advance maintenance plan produces additive benefits to the recommended plan, and is proposed in conjunction with the recommended plan and is reflected in the total project cost. Details pertaining to both the recommended plan, including mitigation, and the improved advance maintenance plan are described in the sections below throughout this chapter.

4.2 MATERIAL QUANTITIES AND CLASSIFICATIONS

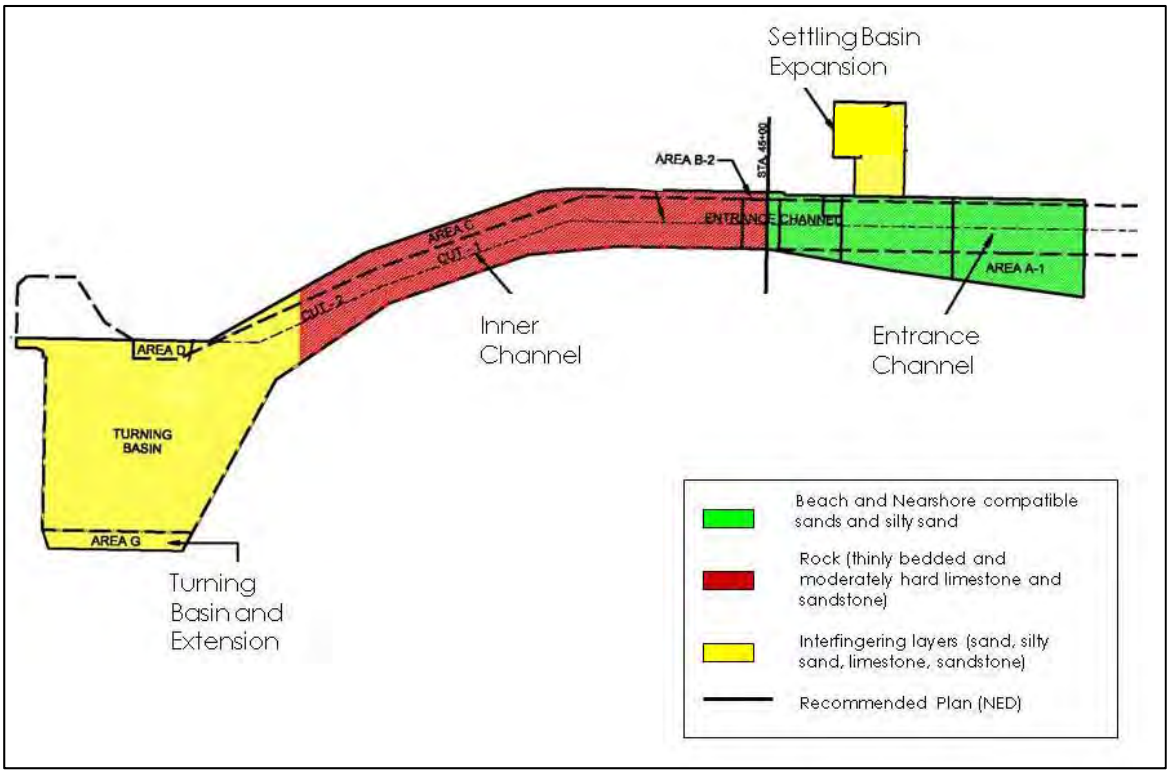
The recommended plan would dredge a total of approximately 2 million cubic yards (cy) of material. Of that total amount, approximately 1.4 million cubic yards material would be placed

in the Ocean Dredged Material Disposal Site (ODMDS); roughly 125,440 cubic yards of material would be used for seagrass mitigation; and roughly 450,000 cubic yards of sand would be placed in the nearshore south of the inlet. The breakdown of material is shown in Table 4-1, and the classification of material by location in the channel is shown in Figure 4-1.

Table 4-1: Project Features and Quantities.

ITEM	QUANTITY (CY)	PLACEMENT	CLASSIFICATION
DREDGING VOLUMES			
Entrance Channel to STA 45+00	285,404	nearshore	Sand and Silty Sands
Entrance Channel (west of STA 45+00)	145,767	ODMDS	Rock, Interfingering Layers
Inner Harbor	910,129	ODMDS	Rock, Interfingering Layers
Inner Harbor	125,440	Seagrass Mitigation	Sand and Silty Sands
Advance Maintenance	172,700	nearshore	Sand and Silty Sands
Advance Maintenance	12,000	ODMDS	Rock, Interfingering Layers
Settling Basin Expansion	258,000	ODMDS	Rock, Interfingering Layers
TOTAL DREDGING QUANTITIES	**1,897,750**		
HARDBOTTOM MITIGATION CONSTRUCTION			
Provide and place limestone boulders	25,100	Artificial Reef	Quarried Limestone
NORTH JETTY STABILIZATION			
PZC25 Sheetpile	200 LF, pile length = 63.5 feet		

Figure 4-1: Material Classification.



4.3 MITIGATION

Impacts caused by the total project include losses of 4.5 acres of seagrass habitat and 4.9 acres of low relief hardbottom habitat, for which mitigation will be required where new construction dredging is proposed. Since the exact amount of mitigation will not be known until Planning Engineering and Design (PED), when a final resource survey can be completed and mitigation amounts based on functional value can be calculated, an estimate of mitigation cost was prepared at the feasibility level. This estimate was determined by researching mitigation required in other Jacksonville District Civil Works projects, as well as mitigation required in permits issued by Jacksonville District Regulatory Division for hardbottoms.

Based on research of other projects in Jacksonville District, an average multiplier of 2.3 times the acreage of impact (4.9) was used to calculate estimated mitigation acreage needs for hardbottoms during the Feasibility Phase. The estimate of hardbottom mitigation acreage (11.25 acres) is conservative and expected to be reduced during PED upon completion of a final resource survey and functional value calculations.

The HEA model was used to calculate the impacts to seagrasses and resulted in a mitigation acreage of 11.25, which about 2.5 times the area of impact (4.5 acres). This is also comparable to mitigation requirements in other SAJ civil works projects and regulatory permits.

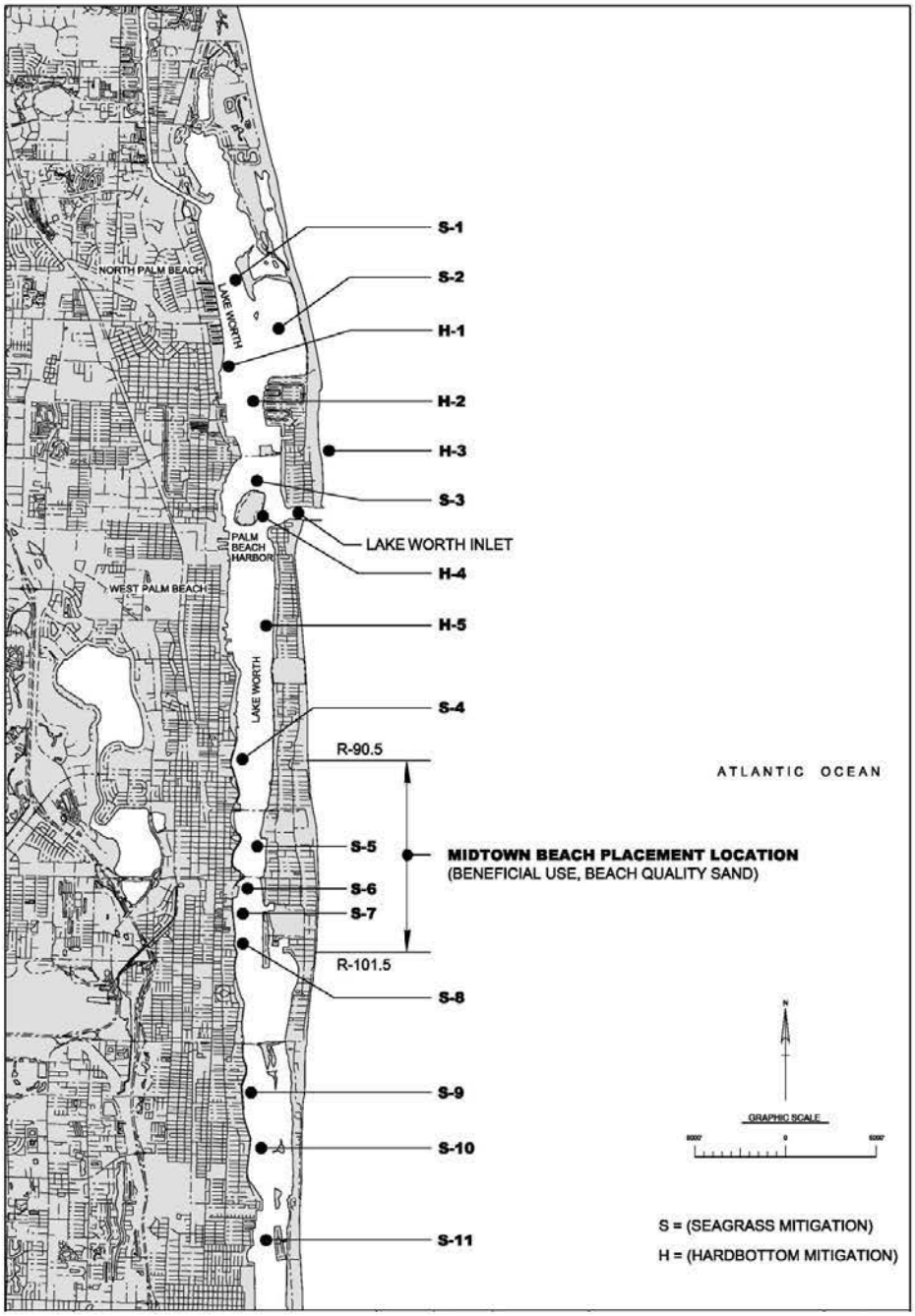
In addition, state and Federal agencies have supported these multipliers in past Jacksonville District projects and the multipliers discussed above represent a reasonable conservative estimate for mitigation. Calculations are included in the Mitigation Plan, Attachment 3 of Appendix D.

All potential sites that are under consideration are shown in Figure 4-2.[1] Turtle Cove and Little Lake Worth were originally considered but were strongly opposed by local residents during the public review period and will not be considered for further evaluation within this study. For the remaining sites, not all sites will be needed, and one or more could be used depending on capacity. It is possible that some of these sites may no longer be available at the time of construction. For this reason, sites will be reassessed in more detail in the PED (pre-construction, engineering, and design) phase closer to construction.

Reference the Mitigation Plan, Attachment 3, in Environmental Appendix D, for more details on the specific mitigation information and the Cost Effectiveness/Incremental Cost Analysis (CEICA) for Mitigation, Attachment 4, in Environmental Appendix D, for a cost effectiveness analysis.

[1] A cost effective, incremental cost analysis (CEICA) was performed to find the most cost-effective locations for mitigation. The Mid-Town area was not a consideration for mitigation; rather, it is shown for the purposes of beneficial use sites.

Figure 4-2: Potential Mitigation Sites or Beneficial Use Sites.



4.3.1 SEAGRASS MITIGATION SITES

The proposed mitigation area for seagrass impacts would be a submerged borrow hole. Roughly 125,440 cubic yards of dredged material is estimated as necessary to fill the dredged hole to surrounding elevations for seagrass establishment. Any dredged material placed to serve as mitigation fill would follow all Federal and State regulatory requirements. Features that are preferable for success include:

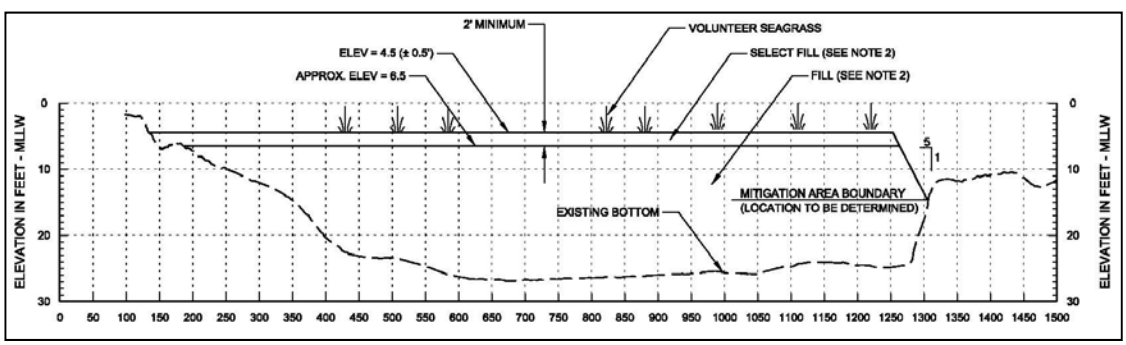
- Whether it has sites within the hole that can be restored to seagrass over a sufficient area to achieve the desired amount of mitigation
- If it experiences a relatively calm but well-circulated tidal current and little or no daily perturbations from boating activities, and
- If it can be a good candidate for cost-effective hauling or pumping of borrow material from the project site

SEAGRASS MITIGATION DESIGN

To achieve mitigation success, the following steps will be implemented:

1. Fill unvegetated areas with native material (dredged material) to the base fill elevation or to the elevation at which seagrass communities will grow to restore topography for climax community seagrasses (target elevation) (Figure 4-3).
2. Utilize dredged material of a consistency that will allow for settling and achievement of stable slopes and for support of the maximum possible surface area of fine capping fill material.
3. Using finer capping fill material, create a stabilized surface treatment of required acreage to achieve an elevation and substrate composition suitable for recruitment of seagrasses.
4. Design the site to maximize recruitment from adjacent seagrass beds but also incorporate strategic planting to achieve recovery if it does not occur naturally through recruitment within the desired timeframe.

Figure 4-3: Seagrass Mitigation.



4.3.2 HARDBOTTOM MITIGATION SITES

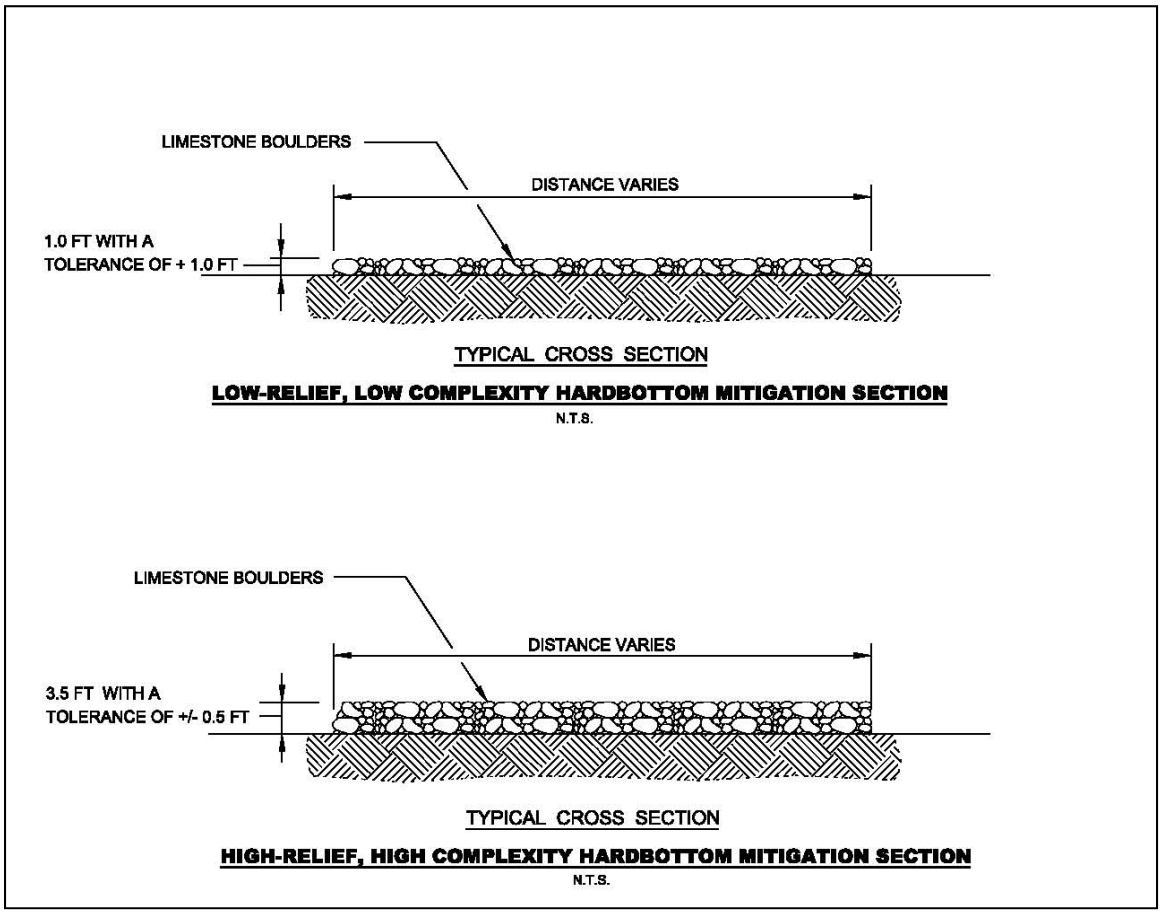
The USACE has the option to conduct mitigation prior to construction or concurrent with construction. A good candidate for mitigation could include the following features:

- Already has some artificial hardbottom located within the boundaries, which would allow for quicker colonization of artificial hardbottom material, as well as allow for easier monitoring since it is adjacent to a county mitigation site that is currently monitored.
- Water depths are similar to the depths of low relief hardbottoms impacted by the proposed project (8-12 feet).

HARDBOTTOM MITIGATION DESIGN

Purchased quarried native limestone (25,100 cubic yards) is currently included in the project cost hardbottom construction estimate; however, rock excavated from the entrance channel during the project, pre-fabricated materials, or recycled material will be assessed during the pre-construction engineering and design (PED) phase. The material will be used in the mitigation construction to mimic the orientation of typical natural hardbottoms (Figure 4-4). This hardbottom design will have a vertical relief of 3 to 4 feet and could be placed in “pods” or modules to provide the maximum structural complexity and to provide refuge for cryptic and reclusive species. As interstitial sand patches associated with hardbottom habitat are thought to be important in the ecological function of the hardbottom habitat, the hardbottom footprint will be 20 by 40 feet with space between modules consisting of mainly sand. Natural limestone provides an ideal substrate for the establishment of a fouling community and colonization by the common hardbottom community species.

Figure 4-4: Hardbottom Mitigation.



4.4 CONSTRUCTION

For cost-estimating purposes, it is anticipated that a mechanical dredge (barge mounted backhoe) and scow barges would be used for construction of the inner harbor and settling basin, since it is likely that this equipment could dredge though the intermittent layers of rock that occur in this area. It is assumed that a hydraulic pipeline dredge would be used to dredge the entrance channel where beach quality material exists, since this equipment could easily dredge and place the material on the nearshore.

Barges would take the project material to the seagrass mitigation site for the base fill during construction, and then capping would take place with barge or pipeline.

Rock will be placed by crane and barge to ensure proper placement within the hardbottom mitigation site. Although quarried limestone has been estimated in the cost for hard bottom mitigation, other types of hard bottom mitigation materials, such as rock from the project, pre-fabricated structures, or recycled structures, will be revisited during the pre-construction, engineering, and design (PED) phase in the value engineering process and will be coordinated with agencies for acceptability and evaluated for cost effectiveness.

4.5 DREDGING METHODS

In general, USACE does not specify types of equipment and construction methods within its specifications due to the requirements of Federal acquisition regulations implementing the Competition in Contracting Act, that require Federal agencies to limit how specifications are written to prevent limiting competition among contractors. The contractor selected by USACE will determine most efficient construction methodology of the project, in their professional opinion, and submit that as part of a proposal to USACE. USACE can, and does, specify the intended results of construction through detailed plans and specifications. Generic information regarding several construction techniques is discussed below.

4.5.1 DREDGING TECHNIQUES

The 39-foot deepening plus widening alternative is the recommended plan. Notwithstanding the uncertainty inherent in the bidding and construction process (see below paragraphs), certain assumptions can be made regarding methods that may be needed to complete construction. Dredged material would most likely be excavated using either a hydraulic cutterhead dredge or mechanical excavator with some of the material pretreated using some method to break the rock prior to dredging, such as confined underwater blasting using explosives. Geotechnical data indicate that the majority of the material to be dredged may be able to be removed without rock pre-treatment (although additional core borings will provide more specific information regarding positions of massive hardened materials during the PED phase of the project).

The specifications will limit the extent of rock pre-treatment to only those areas where excavation cannot be accomplished by dredging equipment without a pre-treatment technique. Equipment capable of dredging rock without rock pre-treatment includes a hydraulic pipeline dredge with a rock cutterhead or certain types of clamshell and backhoe dredges. Use of small or inappropriate dredges will be discouraged through the use of minimum monthly production standards or other language within the project specifications. The contractor may employ the use of more than one dredge at a given time; this possibility will be left open in the project specifications.

Construction phasing is based on USACE estimates for dredging durations and element costs, and provides the plan for contract phases per fiscal year. The number of contracts required to complete this project is a function of the funding stream, the contractor's proposal, construction methods, equipment availability, and construction window compliance. These factors may require multiple contracts. Available data is insufficient at this time to dictate the precise number of contracts that may be required, therefore a single continuing contract is assumed. This will allow the contractor to group like items, meet Port implementation schedules, have flexibility with component construction due to weather or environmental conditions, and reduce mobilization and demobilization costs. The USACE estimates project construction may take up to 1000 days (Reference project schedule in Appendix B, Cost Engineering and Risk Analysis Appendix). This is based on a conservative estimate for funding of the project, on a piecemeal basis. It is assumed that if required funding is received in a timely manner, the overall project phasing could be expedited. If construction is initiated in 2015 under these assumptions, it could be completed by 2018.

REQUIRED, ALLOWABLE, AND OVER-CUT BEYOND PROJECT DEPTH OR WIDTH

The Plans and Specifications for new work, or construction dredging, normally require dredging beyond the project depth and/or width. For this project, the two purposes of the "required" additional dredging are to remove rock/consolidated material at the bottom of the channel in order to provide an area below the project depth such that maintenance dredging equipment will be capable of removing shoal material down to the project depth in the future and to account for rapid shoaling between dredging cycles (reduce the frequency of dredging required to maintain the project depth for navigation in high shoaling areas which is referred to as advanced maintenance). An additional 2 feet of required overdepth for consolidated materials is applied throughout the entire project footprint and an additional 4 to 8 feet of required overdepth for the improved advance maintenance is applied to those areas shown on Plate 10 of Appendix A, Engineering and Figure ES-4 in the executive summary.

In addition, the dredging contractor is allowed to go beyond the required depth. This "overdepth grade" accounts for the inherent variability and inaccuracy of dredging equipment (normally ± two feet). In addition, the dredge operator may practice over-cutting. An "over-cut" along the sides of the channel) where substrates are unconsolidated materials, like sand and silts) may be employed in anticipation of movement of material down the sides of the channel. Over-cut throughout the channel bottom may be the result of furrowing or pitting by the dredging equipment (the suction dredge's cutterhead, the hopper dredge's drag arms, or the clamshell dredge's bucket). Figure 4-5 and Figure 4-6 illustrate these concepts.

Figure 4-5: Diagram of Overcut in Dredged Channel Cross-Section.

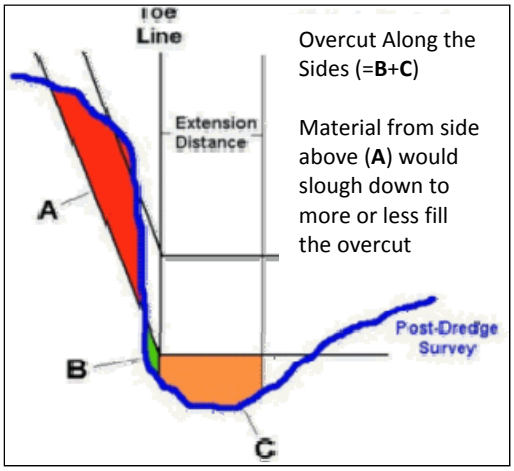
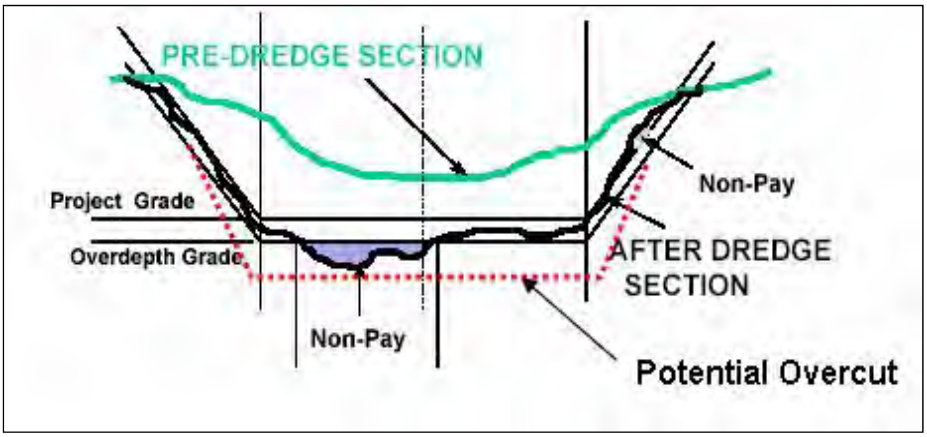


Figure 4-6: **Typical Cross-Section Showing Project Grade Relative to Overdepth Grade.**



In addition, some mixing and churning of material below the channel bottom may occur (especially with a large cutterhead). Generally, the larger the piece of dredging equipment, the greater the potential for over-cut and mixing of material below the "allowable" channel bottom. Some of this material may become mixed in with the dredged material. If the characteristics of the material in the over-cut and mixing profile differ from that above it, the character of the dredged material may be altered. The quantity and/or quality for disposal or placement may be substantially changed depending on the extent of over-depth and over-cut.

POST-DREDGING OPERATIONS

Since dredging equipment does not typically result in a perfectly smooth and even channel bottom, a drag bar, chain, or other item may be drug along the channel bottom to smooth down high spots and fill in low spots. This finishing technique also reduces the need for additional dredging to remove any high spots that may have been missed by the dredging equipment. It may be more cost-effective to use a drag bar or other leveling device (and possibly less hazardous to sea turtles) than to conduct additional hopper dredging

4.5.2 POTENTIAL MATERIAL REMOVAL METHODS

Dredging equipment uses either hydraulic or mechanical means to transport material from the substrate to the surface. Hydraulic dredges use water to pump the dredged material as slurry to the surface and mechanical dredges use some form of bucket to excavate and raise the material from the channel bottom. The most common hydraulic dredges include suction, cutter-suction, and hopper dredges. The most common mechanical dredges in the U.S. include clamshells, backhoes, and marine excavator dredges. Public Law 100-329 requires dredges working on U.S. government projects have U.S. built hulls, which can limit the options for equipment types, if a new type of dredge is developed overseas, until that new technology is adopted by a U.S. dredge-building company.

Various project elements influence the selection of the dredge type and size. These factors include the type of material to be dredged (rock, clay, sand, silt, or combination); the water depth; the dredge cut thickness, length, and width; the sea or wave conditions; vessel traffic conditions; environmental restrictions; contaminants; other operating restrictions; and the

required completion time. All of these factors impact dredge production and as a result, costs. Multiple dredges of the same or different types may be used on projects where conditions vary between dredging location or to expedite the work.

The following discussion of dredges and their associated impacts will be limited to potential dredging equipment suitable for the Lake Worth Inlet expansion project, based on historic review of expansion operations at similar projects, as well as the expert opinion of USACE construction and operations staff. The key project elements for this project include the following:

- Much of the material is sand with thin lenses of soft rock (see Geotehnical Attachment C of Engineering Appendix A).
- Significant environmental resources, including hardbottoms and sea grass, are located adjacent to and within the project footprint.
- To date, no contaminated material has been identified in the project footprint that will be dredged.

HYDRAULIC DREDGING

Hydraulic dredges mix dredged material into a sediment-water slurry and pump the mixture from the bottom surface to a temporary location such as a barge or re-handling site, or to a permanent location such as a confined or unconfined upland or aquatic site. The advantage of hydraulic dredges is that less turbidity is generated (re-suspended sediments) at the dredge than with mechanical dredges. The disadvantage of hydraulic dredges is that a large quantity of water is added to the dredged material and this excess water must be dealt with at the disposal location. Examples of hydraulic dredges include hopper dredges and cutterhead dredges. Hydraulic dredges may be used on portions of the Lake Worth Inlet project.

HOPPER DREDGE

Hopper dredges are self-propelled ocean-going vessels that hydraulically lift dredged material from the bottom surface and deposit it into an open hopper within the ship. The draghead(s) operates like a vacuum cleaner being dragged along the bottom. When the hopper is full, the dredge transits to a disposal location and releases the dredged material into an underwater disposal site by opening doors on the hopper bottom or in some cases the vessel is designed to split open longitudinally. Hopper dredges can also be designed to hydraulically pump the material from the hopper to an upland location. This is often used for beach nourishment projects. Hopper dredges are not efficient in removing treated (broken) or untreated rock; however, this equipment could be used to remove unconsolidated overburden material or accumulated maintenance material above the rock, especially in the entrance channel. Since hopper dredges are self-propelled, they are more maneuverable than dredges that rely upon tugs. However, they require numerous passes over the same area to remove the required material; they are inefficient in small confined dredging areas and are most effective in removing sand and other unconsolidated materials. Animations and video of hopper dredge operations can be located online at http://el.erdc.usace.army.mil/dots/trip.html.

A hopper dredge could be used to remove unconsolidated overburden material from the entrance channel. However, only a small volume of this material is present, which may reduce the efficiency of this method. Environmental impacts from hopper dredges include localized suspended sediment along the bottom around the draghead and fine-grained sediment turbidity plumes from hopper overflow. This could impact both water quality and the hardbottom communities adjacent to the channel. The turbidity can be reduced or eliminated by restricting the amount of hopper overflow time, eliminating hopper overflow, or directing the hopper overflow toward the channel bottom through tubes. Suspended sediment is expected to settle quickly because overburden in the entrance channel is mostly sand.

Hopper dredges are also known to take threatened and endangered sea turtles resting on the bottom of entrance channels and in sand borrow areas. The National Marine Fisheries Services (NMFS), in a November 2003 biological opinion for the use of hopper dredges in the Gulf of Mexico, makes the following statement:

"The construction and maintenance of Federal navigation channels have been identified as a source of turtle mortality since turtle takes were first documented during hopper dredging operations in Canaveral Channel, Florida, in 1980… Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore sand mining areas, move relatively rapidly and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving turtle."

As a result of these findings, the South Atlantic Division of USACE (which includes the Jacksonville District) completed a regional consultation for the use of all types of dredges throughout the southeast Atlantic from the Virginia-North Carolina state line to Key West, Florida. This consultation resulted in a regional biological opinion (referred to as the "SARBO") for the use of hopper dredges in USACE-maintained entrance channels and borrow areas and provided for protective measures. USACE was required to reduce the likelihood of turtle entrainment. A project-specific biological assessment has been developed for the Port Everglades project that includes the use of a hopper dredge as a construction technique, which incorporates the terms and conditions of the SARBO (South Atlantic Regional Biological Opinion) as part of the proposed action (Pertinent Correspondence Appendix E, Attachment 1).

PIPELINE AND CUTTER SUCTION DREDGE

Large cutter-suction dredges or cutterhead dredges, are mounted on barges. The cutter suction head resembles an eggbeater with teeth. It mobilizes the dredged material as it rotates. The mobilized material is hydraulically moved into the suction pipe for transport. The cutter suction head is located at the end of a ladder structure that raises and lowers it to and from the bottom surface. The cutter suction dredge moves by means of a series of anchors, wires, and spuds. The cutter suction dredges as it moves across the dredge area in an arc as the dredge barge swings on the anchor wires. One corner of the dredge barge is held in place by a spud and the dredge rotates around that spud. The dredge requires workboat or tug assistance to move the anchors and a tug is required to move the dredge to and from a location. Some cutter-suction dredges have spud carriages that allow the dredge

to be moved forward without the assistance of tugs (Figure 14). The discharge pipeline connects the cutter suction dredge to the disposal area. The dredged material is hydraulically pumped from the bottom, through the dredge, and through the discharge pipeline to the disposal location. This is generally an upland site, but can be a barge for transport to a remote location or an in-water site. Dredge pumps are located on the barge with additional pump(s) often located on the ladder, especially for deep water dredging projects. Booster pumps can also be added along the discharge pipeline to move the material greater distances. Cutter-suction dredges are limited to dredging depths within reach of the ladder.

Depending upon their design and the hardness of the material to be removed, cutterhead dredges may be used to remove blasted or untreated rock and unconsolidated material. Cutterhead dredges are more limited than hopper dredges to the sea state condition (size of waves) they can work in and for a cutterhead dredge to work in open ocean conditions, it must be ocean certified by the U.S.Coast Guard (USCG).

A large cutterhead dredge could be used for at least portions of the deepening project. Some pretreatment (cracking of the rock prior to dredging) may be required for portions of the rock. Disposal options include direct placement of the dredged material in mitigation sites or transport by barges to the Ocean Dredged Material Disposal Site (ODMDS). Disposal of dredged material is discussed within Section 4.8 of this report.

Potential environmental impacts from cutterhead dredges include localized suspended sediment along the bottom around the cutterhead and fine-grained sediment turbidity plumes from barge overflow or pipeline leaks. Overflow and leaks can be reduced or eliminated by restricting the amount of overflow time, eliminating barge overflow, and performing regular inspections of the pipeline. Locating barges the furthest possible distance from resources can further reduce environmental impacts. If booster pumps are used, noise impacts may increase.

Anchors are placed to both sides of the cutterhead dredge to provide the ability to swing the dredge. The anchors are placed using a crane on a workboat. Implementation of an anchoring and vessel operation plan to effectively minimize anchor and cable impacts to hardbottom habitat would occur through the Request for Proposal (RFP) process and would include incentives to encourage potential contractors to avoid hardbottom impacts. The evaluation criteria in the RFP would consider the technical aspects of the contractor's proposal as the most significant factor. As a result, the vessel operational and anchoring plan that best avoids or reduces impacts to reefs would receive the highest evaluation and the incentives that follow. Possible suggestions, provided ultimately by resource agency staff, dredging firms, and other consultants, that may appear in contractor proposals for evaluation during the RFP process include

- use of surge buoys along the anchor cable to help lift it up off the reef areas during dredging operations to minimize the area impacted by the anchor cable
- restricted anchor placement, which restricts placement of the anchors for the cutter-suction dredge to within the channel edge limits. That method reduces impacts but almost doubles dredging time since only half of the channel can effectively be dredged at a time.

Video clips of how cutterhead dredges operate are located on the following website: http://el.erdc.usace.army.mil/dots/trip.html.

MECHANICAL DREDGING

Mechanical dredges are classified by how the bucket is connected to the dredge. The three standard classifications are structurally connected (backhoe), wire rope connected (clamshell), and chain and structurally connected (bucket ladder). The advantage of mechanical dredging systems is that very little water is added to the dredged material by the dredging process and the dredging unit is not used to transport the dredged material. This is important when the disposal location is remote from the dredging site. The disadvantage is that mechanical dredges require sufficient dredge cut thickness to fill the bucket to be efficient and greater re-suspended sediment is possible when the bucket impacts the bottom and as fine-grained sediment washes from the bucket as it travels through the water column to the surface. Clamshell or backhoe marine excavators may be used on portions of the Lake Worth Inlet project.

CLAMSHELL DREDGE

Clamshell dredges are the most common of the mechanical dredges. Clamshell dredges use a number of different bucket types for mud, gravel, unconsolidated rock, or boulders. The clamshell dredging operation cycle is to lower the bucket in open position to the bottom surface, close bucket penetrating material with weight of bucket, raise bucket above hopper level, swing, dump, swing and repeat. The length of the wire to lower the bucket limits the dredging depth and production depends upon the bucket size, dredging depth, and type of material. The dredged material is placed in a scow or on a barge for transport to the disposal site. Clamshell dredges are able to work in confined areas, can pick up large particles, and are less sensitive to sea (wave) conditions than other dredges. However, their capacity is low and they are unable to dig in firm or consolidated materials, such as rock. Clamshell dredges may be used to remove the unconsolidated overburden in Port Everglades. The dredge requires a tug to move it to and from a location. Potential clamshell dredging environmental impacts in unconsolidated sediments include resuspension of sediments when the clamshell hits the bottom and as material washes from the bucket as it rises through the water column. Operational controls such as reducing the bucket speed as it drops to the bottom and as it rises through the water column can reduce impacts, as can use of a closed bucket system. An animation showing the operation of a clamshell is located online at http://el.erdc.usace.army.mil/dots/trip.html.

Clamshell dredges have commonly been used in areas where manatees are known to congregate, and on rare occasions, manatees have been anecdotally documented as being attracted to water dripping off of the clamshell bucket. To ensure that clamshell dredges do not adversely impact manatees, USACE implements standard protection conditions when a clamshell dredge is proposed during a project in addition to the standard manatee protection requirements. These protections include the following standard language in the USACE environmental specifications:

"Manatee Monitoring (Clamshell Only): During clamshell dredging operations, a dedicated observer shall monitor for the presence of manatees. The dedicated observer shall have experience in manatee observation and be equipped with polarized sunglasses to aid in observing. Nighttime lighting of waters within and adjacent to the work area shall be illuminated, using shielded or low-pressure sodium-type lights, to a degree that allows the dedicated observer to sight any manatee on the surface within 200 feet of the operation. The dredge operator shall gravity-release the clamshell bucket only at the water surface, and only after confirmation that there are no manatees within the safety distance identified in the standard construction conditions."

Report Submission: The Contractor shall maintain a log detailing sightings, collisions, or injuries to manatees occurring during the contract period. The data shall be recorded on forms provided by the Contracting Officer (sample Daily Manatee Reporting Log is on the first web site indicated in paragraph CONSTRUCTION FORMS AND DETAILS below). All data in original form shall be forwarded directly to Chief Environmental Branch, P. O. Box 4970, Jacksonville, Florida, 32232-0019, within 10 days of collection and copies of the data shall be supplied to the Contracting Officer. Following project completion, a report summarizing the above incidents and sightings shall be submitted to the appropriate FWS and FWC offices.

Special Operating Conditions:

(1) All vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels shall follow routes of deep water whenever possible. Boats used to transport personnel shall be shallow-draft vessels, preferably of the light-displacement category, where navigational safety permits. Mooring bumpers shall be placed on all barges, tugs, and similar large vessels wherever and whenever there is a potential for manatees to be crushed between two moored vessels. The bumpers shall provide a minimum stand-off distance of four feet.

(2) If a manatee(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by the Contractor to ensure protection of the manatee. These precautions shall include the operation of all moving equipment no closer than 50 feet of a manatee. If a manatee is closer than 50 feet to moving equipment or the project area, the equipment shall be shut down and all construction activities shall cease within the waterway to ensure protection of the manatee. Construction activities shall not resume until the manatee has departed the project area.

The full set of Master Environmental Specifications utilized by USACE is located online at http://www.saj.usace.army.mil/Divisions/Engineering/DOCS/CADD/docsect/01%2057%2020.pdf. Animation showing how a clamshell operates is located on the following website - http://el.erdc.usace.army.mil/dots/trip.html.

BACKHOE MARINE EXCAVATOR

A backhoe dredge is a *back-acting* excavating machine that is usually mounted on pontoons or a barge. The backhoe digs toward the dredge with the bucket penetrating from the top

of the cut face. The operation cycle is similar to the clamshell dredge, as are the factors affecting production. Backhoe marine excavators have accurate positioning ability and are able to excavate firm or consolidated materials. However, they are susceptible to swells and have low to moderate production. Backhoe marine excavators could be used to excavate unconsolidated overburden, fractured rock, and possibly some unfractured rock. The dredging depth for backhoe marine excavators is limited to the reach of the excavator arm. The dredge also requires a tug to move to and from a location.

Backhoe marine excavators' potential dredging environmental impacts in unconsolidated sediment are similar to those of a clamshell dredge, as are the operation controls to reduce that impact. The key is slowing the movement of the bucket through the water. Environmental impacts can be significantly less for a backhoe marine excavator dredge removing fractured (blasted) rock as the volume of fine-grained sediment is significantly less in fractured rock than unconsolidated sediment and as a result the potential for sediment resuspension is reduced. The same operational controls can be applied to fractured rock as unconsolidated sediment, basically slowing the bucket's speed in the water.

Both types of mechanical dredges require transport barges to move the dredged material from the dredge to the disposal site. The type and size of barges will depend upon the distance to the disposal site and the production rate of the dredge. Barges are less expensive than dredges, therefore, the operation is generally designed so that the dredge is always working and does not experience down time waiting for a barge to be available to load. Barges or bottom dump scows may be used to transport dredged material to the ODMDS for disposal. Details concerning dredged material disposal are located in Section 4.8 of this report.

Potential barge environmental impacts could occur as the barge is loaded if material is allowed to spill over the sides, during transport if the barge leaks material, and during disposal if the material escapes from the disposal area. Operational controls eliminate spilling material during loading by monitoring the dredge operator to make sure that the dredge bucket swings completely over the barge prior to opening the bucket. Requiring barges in good repair with new seals minimizes leaking during transport, and monitoring changes in draft throughout the transport allows for determination of leaking scows for each and every load of material being transported to the disposal site. Hauling rock is often damaging to transport barges; so intermediate inspection and repairs may be required during the project to maintain the barges in good working condition. Seals may require replacement. Operating in compliance with the Site Management and Monitoring plan prepared by U.S. Environmental Protection Agency (USEPA) for the ODMDS would minimize the environmental impacts during disposal. The barges would be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor disposal activity.

4.5.3 ALTERNATIVES TO DREDGING HARD ROCK

ROCK PRE-TREATMENT TECHNIQUES

Pre-treatment techniques are used to break up consolidated, massive materials (i.e. rock) prior to removal of the material by a dredge. Such factors as location, rock hardness, cost, and amount of surface requiring treatment are to be taken into account when determining which method is most suitable and practicable for a given project.

The USACE has investigated methods to pre-treat rock without blasting using a punch barge/hydrohammer (also called spudding). Spudding is the process of fracturing the rock by dropping an array of chisels or spuds on to the rock, causing a fracture. A hydrohammer is a jackhammer mounted on a backhoe. A dredge (hydraulic or mechanical) then follows and excavates the rock. Spudding is a slow process and can be relatively expensive. The punch barge works for twelve hour periods, striking the rock below approximately every 30 to 60 seconds. The primary environmental impact of spudding is noise and vibration. The constant pounding would serve to disrupt marine mammal behavior in the area as well as impact other marine species that may be in the area. Using the punch barge would also extend the length of the project temporally due to the lower production with harder materials, thus temporally increasing potential impacts to all fish and wildlife resources in the area. Use of the punch barge at Port Everglades was unsuccessful in 1981 due to hardness of the rock. In addition, the operation was very noisy and the vibration of the chisel on the bottom caused impacts to nearby structures.

DREDGE MATERIAL TRANSPORT VESSELS

Three vessel types could be used to transport dredged material to an approved disposal area. These vessels include a split hull barge, bottom dump barge, and flat top barge. A split hull barge has two hulls connected with hinges at the front and back. This allows the hulls to swing apart, opening at the bottom to allow dredged material to fall from the barge. This provides a rapid disposal of dredged material within a small area. The rapid descent of material through the water column reduces the potential for resuspension of sediments into the water column during disposal. Such a barge may be used for ODMDS disposal.

A bottom dump barge has doors on the bottom of the hopper which open at the disposal site to allow the dredged material to fall to the bottom. This type of barge has slower disposal than split hull dump barges and material spreads over a larger area. This barge may be used for ODMDS disposal.

Dredged materials are placed in the bottom dump and split hull barges using either a pipeline, a bucket or backhoe dredge, where one is loaded at a time or via a device called a “spider-barge” which allows two barges to be in different states of loading (one being loaded, one settles, and a third transits to and from the disposal site) and is a much more efficient system for loading barges.

A flat top barge transports dredged material stacked on a barge deck and must be unloaded mechanically at the disposal site. As a result, disposal time is slow but it is possible to drain dredged material with filters prior to disposal. This type of barge generally has a shallower draft requirement than the other two barge types and may be used for construction of mitigation sites during final filling stages or when access is limited by depth of water.

4.6 OPERATION AND MAINTENANCE

The U.S. Coast Guard (USCG) is responsible for providing and maintaining navigation aids. Since there will only be a slight realignment of the Entrance Channel centerline (20-foot northerly shift), the Palm Beach Harbor Pilots have requested that there be no relocation of the Range Markers from their current positions. The channel widening and turning basin expansion will create the need to relocate certain buoys; however, this relocation is considered minor and incidental by the USCG and therefore there will be no cost to the project for their physical relocation. A relatively small amount of cost is identified in the cost estimate to cover miscellaneous administrative costs for coordination with the USCG during and post construction.

Mitigation and monitoring would be the responsibility of the Federal government until deemed successful by the resource agencies as defined in conditions described within the applicable Florida Department of Environmental Protection (FDEP) permit when issued. Typical durations for mitigation area maintenance in this geographical area is five years. The Federal government is responsible for operation and maintenance of the navigation improvements proposed in this report upon completion of the construction contract.

4.7 IMPROVED ADVANCE MAINTENANCE PLAN

Please refer to the reference map at the end of the report entitled REF-4 for the following discussion and Figure ES-4 in the executive summary.

Bottom Line: The model showed that the improved advance maintenance plan (including settling basin expansion and additional advance maintenance in the entrance channel) recommended in this report is needed for the existing conditions. It is needed even *without* the recommended project.

The December 2011 advance maintenance approval package (2011 Advance Maintenance Plan) recommended the following plan for the operation and maintenance (O&M) program to reduce dredging to 1 time/year, and was constructed in the fall of 2012:

- Settling Basin (SB): Construct the primary basin (SB1) to -37 feet Mean Lower Low Water (MLLW) (35 feet + 2 feet)

- Entrance channel: Dredge the entire existing channel from Station 30+00 to Station 47+00 to -41 feet MLLW (39 feet required plus 2 feet allowable overdepth).

During this feasibility study, the advance maintenance plan for the existing project was assessed with an advanced model and the following modifications are recommended to reduce dredging to 1 time/2 years (Reference Figure ES-4):

- Settling Basin (SB): First, SB2 and a small outward notch (SB3) would be added to the settling basin to the west which would catch sediment before it entered the channel. This is a crucial piece of the improvement. Then, areas within the settling basin were would have varying depths ranging from 26 to 51 feet, starting with the deepest depth in SB1 and gently sloping into shallower depths in SB2 (34 feet) and the most shallow depth in SB3 (26 feet). Area SB4 was not modeled but is currently part of the existing advance maintenance plan which will be carried forward to be included in the improved advance maintenance plan.

- Entrance channel: The improved advance maintenance zones (AMZ) are located in the same footprint as the previously

Improvements after the 2011 Advance Maintenance Package

These modifications would have been the proposed plan for the "Advance Maintenance Approval Package, Dec. 2011", had the Coastal Modeling System (CMS) been available at that time to model to today's level of accuracy 10 years ago. The prior analysis used GENESIS shoreline change and volume transport to size the settling basin. Genesis is not intended for use near inlets but was the best available at the time.

This 2011 analysis used the CMS which can more accurately predict the sediment transport. This model includes waves, currents, sediment transport, and bed changes. It was developed specifically for looking at waves, hydrodynamics and sediment transport at inlets.

Hydrodynamics Attachment A, in Engineering Appendix A, demonstrates the model results, and Economics Appendix C shows that the modified advance maintenance recommendation will reduce the frequency of dredging to 1 time every 2 years and will save the program $850,000 on average annually, over the next 50 years as well as causing reduced disturbance to the environment and community in comparison to current operation and maintenance dredging practice.

authorized footprint, with the exception of the new triangular area in AMZ A, which is in the recommended plan's widening footprint – the difference is additional maintenance depths. The area would be split into two areas of varying depths. AMZ A and AMZ C both would be dredged to 51 feet and AMZ B would be dredged to 47 feet.

This improved advance maintenance plan is recommended for the existing project, even if the recommended plan is never built, and would normally be incorporated into existing maintenance and funded by the O&M program. However, the O&M program is not authorized to initially fund and construct areas that contain rock.[2] Therefore, this improved maintenance plan is submitted for approval with this feasibility study and this project will fund initial construction of this improved advance maintenance plan, with the intent that future maintenance of those areas, after they no longer contain rock, will be funded out of the O&M program.

As a result of the improved advance maintenance plan, O&M events will change from dredging approximately 117,500 cubic yards of sand every year on average to approximately 240,000 cubic yards of sand every two years (there will be a 2,500 cubic yard per year increase in shoaling from the project). All material from O&M events is anticipated to be sand and will continue to be placed south of the inlet, on the beach or in the nearshore. The overall estimate is 24 maintenance dredging events (reduced from 50) over the 50-year project life. This reduced frequency of dredging will result in an an average annual equivalent savings of savings of $850,000 (using FY 14 price levels at an FY14 discount rate of 3.5% over 50 years). More information on the shoaling estimates can be found in Engineering Appendix A, Hydrodynamic Attachment A. Refer to Socio-Economic Appendix C for information on the cost savings as a result of the improved advance maintenance plan.

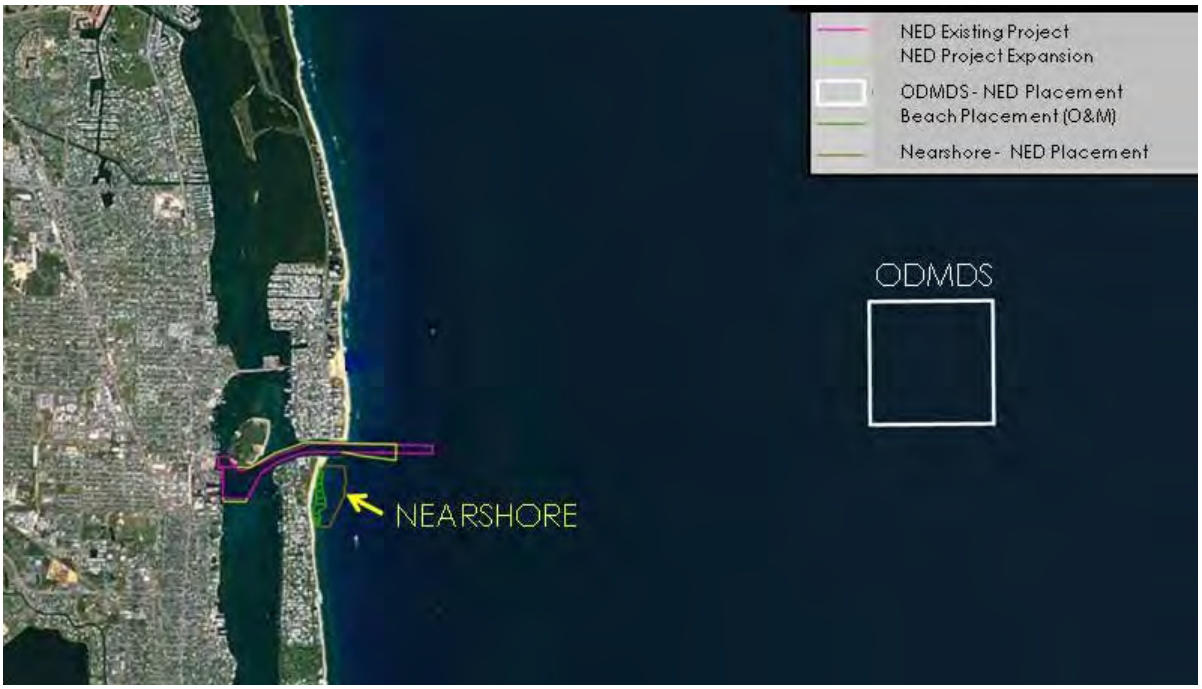
[2] ER 1130-2-520, dated 29 November 1996, page 8-1, specifically prohibits the dredging of advance maintenance in rock under the O&M program: "Advance maintenance involving removal of rock Is not authorized under the Operation and Maintenance, General appropriation."

4.8 DREDGED MATERIAL PLACEMENT

It is anticipated that all sandy material (approximately 450,000 cubic yards) would be placed in the nearshore placement area, located below the mean low water line. Approximately 125,500 cubic yards of material would be used to fill one or more hole(s) to mitigate for seagrass losses. The remainder of the material, approximately 1.4 million cubic yards of material dredged during initial construction would be placed at the Palm Beach Ocean Dredged Material Disposal Site (ODMDS). See Figure 4-7 for the overall placement plan. All operation and maintenance (O&M) material is anticipated to continue to be placed on the beach or in the nearshore south of the inlet from R-76 to R-79.

The USACE will, to the greatest extent practicable, place beach quality dredged material within the authorized beach and/or near shore templates per the current design and restrictions provided by all applicable laws, regulations, policy, and guidance.

Figure 4-7: Dredged Material Placement Plan.



NEARSHORE PLACEMENT

Near shore quality sand (up to 20% silt) would be placed in the near shore (below the Mean High Water (MHW) line out to the -17 foot contour) along the coast south of the inlet between FDEP range monuments R-76 to R-79, filling landward to seaward. This is a least-cost placement option and also allows beneficial use of the material for recreation and wildlife, which is an incidental benefit. As stated in Chapter 2, fill material would comply with Florida Department of Environmental Protection (FDEP) requirements pursuant to the Florida Administrative Code (FAC) subsection 62B-41.005(15).

OCEAN DREDGED MATERIAL DISPOSAL SITE (ODMDS) PLACEMENT

The 2004 Site Management and Monitoring Plan (SMMP)[3] states the following: "The capacity of the Palm Beach Harbor ODMDS has not been determined. Modeling conducted by the Coastal Engineering Research Center (CERC) was conducted for a single project volume up to 500,000 cubic yards. Therefore, use of the ODMDS will be restricted to 500,000 cubic yards of dredged material per project. Projects in excess of 500,000 cubic yards of dredged material will require additional capacity studies prior to utilization of the ODMDS."

During USACE coordination with U.S Environmental Protection Agency (USEPA) throughout this feasibility study , USEPA noted that the original purpose of the ODMDS was for maintenance material, and that the estimated 1.4 million cubic yards which would be dredged and placed in the ODMDS for the recommended plan is beyond the intent of the ODMDS design. As a result, per conversations with USEPA, USACE will conduct a modeling study to look at the distribution of the proposed material (rock and sediments) to determine the resulting footprint on the seafloor and associated mounding, and the results will be known prior to pre-construction, engineering, and design (PED) phase. There is more than enough actual vertical capacity at this site, which is 1 nmi^2 in approximately 525-625 feet of water, and which has only been used once to date for approximately 3,500 cubic yards of dredged material. USEPA's concern is whether the material will fit within the horizontal footprint when placed, rather than if there is enough vertical capacity.

Should materials exceed the ODMDS footprint, site expansion could be determined necessary. Based on the existing site configuration and conditions at the Palm Beach ODMDS and the amount of proposed dredged material from the recommended plan, it is not likely (low risk) that an ODMDS expansion would be necessary for this site. See the Discussion in Section 4.10 Risk and Uncertainty for more discussion of low risk.

In addition, prior to solicitation of the construction contract and subsequent disposal in the ODMDS, the USACE will assess the dredged material to determine if it meets the Ocean Dumping Criteria in 40CFR226, in accordance with the 2009 Palm Beach ODMDS SMMP.

POTENTIAL FOR OTHER BENEFICAL USES OF DREDGED MATERIAL

The placement of beach quality material from R-76 to R-79 (above the Mean High Water (MHW) line to vegetation) south of the inlet is currently being done for operation and maintenance material and will likely continue to be done in the future, through temporary easements obtained by the Town of Palm Beach and paid for by the Town of Palm Beach through a separate tri-party agreement between the Town of Palm Beach, Port of Palm Beach and Palm Beach County. However, placing material above the MHW line for a new project would incur large real estate costs, which would not make it a least-cost placement option. Therefore, this option is not considered to be part of the recommended plan. The USACE will coordinate with state and local regulatory agencies and this option may be reevaluated.

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[3] The SMMP was updated in 2009 with revisions, but this requirement was transferred with the update.

Other opportunities exist in the project vicinity such as filling anoxic deepwater holes in Lake Worth Inlet Lagoon, creation of habitat for submerged aquatic vegetation such as seagrasses and/or placement at the Mid-Town beach placement area, shown in Figure 4-2. It is not anticipated that these alternative forms of disposal will result in any cost savings to the project; however, if cost increases are considered small and if there is a non-federal interest in paying for any increased cost difference, these alternatives are preferable and could be further developed and incorporated into the project during the PED.

4.9 DETAILED COST ESTIMATES

4.9.1 PROJECT COSTS AND COST SHARING

The cost was estimated using MII[4]. Table 4-2 addresses USACE cost sharing guidelines. The estimate used for the cost sharing table shown in Table 4-3 is based on the "constant dollar basis" (second column) on the Total Project Cost Summary (TPCS) spreadsheet (Appendix B, Cost Engineering and Risk Analysis), which includes 0.5% escalation to program year 2014 at effective price level 1 Oct 13. The Total Project Cost represents the most refined level of cost detail, with added contingency, which was determined through the Cost and Schedule Risk Analysis (CSRA). More details on the cost estimate can be found in Appendix B, Cost Engineering and Risk Analysis, as can details of cost assumptions, and risks that factored into the contingency.

The cost estimate below reflects all project features, including the advance maintenance plan. There are no local facility costs associated with the project cost, since the Port of Palm Beach is in the process of improving the Slip 3 bulkhead and deepening Slip 3, as an existing/future without-project condition. Environmental windows for manatees and turtle nesting factored heavily into construction windows and construction sequencing. Cost assumptions for mitigation conservatively assumed 11.25 acres of seagrass creation, and 11.25 acres of hardbottom creation, along with risk contingencies. The Cost Effective Incremental Cost Analysis (CEICA), located in Environmental Appendix D, Attachment 4, provides an analysis of cost effectiveness for seagrass and hardbottom mitigation, which were subsequently used in the cost estimate.

The total project cost, with added contingency, and including the cost of aids to navigation, is estimated at $88,556 ,000.

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[4] MII is the second generation of the Micro-Computer Aided Cost Estimating System (MCACES). It is a detailed cost estimating software application that was developed in conjunction with Project Time & Cost, Inc. (PT&C). MII is one of several modules of an integrated suite of cost engineering tools called Tri-Service Automated Cost Engineering Systems (TRACES). It interfaces with other PC based support modules and databases used by the Tri-Service Cost Engineering community. MII provides an integrated cost estimating system (software and databases) that meets the U.S. Army Corps of Engineers (USACE) requirements for preparing cost estimates.

Table 4-2: Cost Share Guidelines.

Feature	Federal Cost %1	Non-Federal Cost % 1
General Nav. Features (GNF)	· 90% from 0' to 20'	· 10% from 0' to 20'
	· 75% from 20' to 45'	· 25% from 20' to 45'
	· 50% 46'and deeper	· 50% 46' and deeper
Mitigation	· 75%	· 25%
GNF's costs for this project include: mobilization, all dredging costs, and all disposal area construction costs.		
Navigation Aids	· 100%	· 0%
Operation and Maintenance		
GNF	· 100% except cost share 50% costs for maint. > 45 feet	· 0% except cost share 50% for maint. > 45 feet
(1) The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF over a period of 30 years, at an interest rate determined pursuant to Section 106 of WRDA 86. The value of LERR shall be credited toward the additional 10% payment.		

Table 4-3: Total Project Cost and Cost Sharing, 39-foot project (RECOMMENDED PLAN).[1]

WBS Number	General Navigation Feature (GNF)	Project cost	23% Contingency (CSRA)	Total Project Cost	Federal Share	Non-federal Share
12	Mob, Demob, Mech& Pipeline (w/ seagrass mit)	$50,863,000	$11,698,000	$62,561,000	$46,920,750	$15,640,250
6	Hardbottom Mitigation	$10,708,000	$2,463,000	$13,171,000	$9,878,250	$3,292,750
30	PED	$2,111,000	$486,000	$2,597,000	$1,947,750	$649,250
31	Construction Management	$5,087,000	$1,167,000	$6,254,000	$4,690,500	$1,563,500
10	Sheetpile wall (north jetty)	$2,135,000	$491,000	$2,627,000	$1,970,250	$656,750
6	5 yr monitoring	$1,049,000	$241,000	$1,290,000	$967,500	$322,500
	Subtotal Construction of GNF[2]	**$71,953,000**	**$16,546,000**	**$88,499,000**	**$66,374,000**	**$22,125,000**
1	RE Admin[3]	$25,000	$7,000	$32,000	$19,000	$13,000
	Total Project First Cost	**$71,978,000**	**$16,553,000**	**$88,531,000**	**$66,393,000**	**$22,138,000**
12	Aids to Navigation[4]	$20,000	$5,000	$25,000	$25,000	
	Credit for non-federal LERR[5]				$13,000	-$13,000
	10% GNF non-federal[6]				-$8,849,900	$8,849,900
	Total Project Cost	**$71,998,000**	**$16,558,000**	**$88,556,000**	**$57,581,000**	**$30,975,000**

[1]Cost is based on Project First cost (constant dollar basis) on Total Project Cost Summary spreadsheet, which includes 0.5% escalation to program year 2014 at effective price level 1 Oct 13 (Cost Appendix, page 34).

[2]75% Federal/25% non-federal including the cost of the improved advance maintenance plan.

[3]RE Admin costs. There are no actual lands and damages but per USACE regulations, RE admin costs will be placed in the 01 account. Additional RE costs will be cost shared according to the GNF. Escalation from the TPCS accounts for some numerical differences.

[4]Navigation Aids - 100% Federal (U.S. Coast Guard cost, not USACE cost)

[5]LERR Adjustment credit of 01 account (non-fed) not to exceed 10% of GNF.

[6]Project cost sharing also includes the Sponsor paying an additional 10% of the construction of GNF over a period of 30 years. The value of LERR will be credited toward the additional 10%.

4.9.2 ECONOMIC COSTS AND BENEFITS

Table 4-4, below, shows the economic summary for the recommended plan. The total cost varies slightly from the total cost in Table 4-3 since USACE regulations require the economic analysis to use the "Estimated Cost" (first column) on the Total Project Cost Summary spreadsheet (Appendix B, Cost Engineering and Risk Analysis), which does not include escalation. Additionally, the information in this table varies from the information presented in Chapter 3 in the final array for several reasons. First the improved advance maintenance plan costs as well as the improved advance maintenance plan cost savings benefits were included in the below final analysis (and were not included in the Chapter 3 final array analysis). Additionally, this table shows a refinement in total project cost, to include a risk based contingency which is periodically updated as new information becomes available, and a refined model analysis in the economic HarborSym model. The benefit to cost ratio is justified (over 1.0) at 2.0 to 1. More details on this analysis can be found in Socio-Economic Appendix C.

Table 4-4: Summary of Recommended plan Net Benefits and BCR.[5]

Project (Depth)	39'+Widening
Sum of Present-Value Benefits	$ 166,220,000
Total Costs with IDC	$ 92,930,000
Annualized Transportation Cost Savings (Benefits)	$ 7,090,000
Annualized Advanced Maintenance Cost Savings (Benefits)	$ 850,000
Total Average Annual Benefits	$ 7,940,000
Total Average Annual Costs	$ 3,960,000
AA Net NED Benefits	$ 3,980,000
BCR (x:1)	2.0

Notes: Net benefits were annualized at 3.5% discount rate, over 50 years. Costs are in FY14 Price Levels. Dollar amounts rounded to nearest $10,000. BCR rounded to nearest 0.1. Benefits are based on 100-iteration model runs. Interest during construction estimated based on mid-month uniform payments, broken down by contract. Jetty stabilization costs and advanced maintenance cost savings were included.

[5] The summary reflects the FY14 3.5% discount rate, annualized over 50 years. Benefits are based on 100 iteration model runs. Interest during construction estimated based on mid-month uniform payments. Improved advance maintenance costs and associated jetty stabilization costs were included.

INTEREST DURING CONSTRUCTION

Interest during construction (IDC) accounts for the opportunity cost of expended funds before the benefits of the project are available and is included among the economic costs that comprise the recommended plan project costs. The amount of the pre-base year cost equivalent adjustments depends on the interest rate; the construction schedule, which determines the point in time at which costs occur; and the magnitude of the costs to be adjusted. Pre-construction, Engineering, and Design (PED) costs are included in the IDC as well as construction costs and durations. The IDC calculation includes 732 days for PED plus 989 work days for construction activities.

4.9.3 FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES

The sponsor's financial certification has been provided and is located in Pertinent Correspondence Appendix E, Attachment 2.

4.9.4 VIEW OF NON-FEDERAL SPONSOR

The Port of Palm Beach supports the proposed expansion of the Federal Project at Palm Beach Harbor. The channel and inlet was last improved over fifty years ago. But as the Port's business has grown, its current condition limits its ability to target new opportunities. The proposed deeper and wider project will be utilized immediately by our current vessel fleet while allowing our customers to attract larger, more efficient vessels to transport cargo for our community, state, and nation. The currently proposed project is the best prospect to provide a long-term solution for restrictions, and the proposed advance maintenance plan should be sufficient to provide the Federally authorized channel dimensions for a longer period of time. Beneficial use of dredged material is critically important to our community. The placement of any sandy material on the beach or close nearshore and use of dredged material for restoration of Lake Worth Lagoon is very welcome.

4.9.5 LERRS SUMMARY

The following discussion summarizes the Real Estate Appendix F, which can be referenced for more details.

REAL ESTATE REQUIREMENTS

The lands required for the deepening of the project are submerged and within the navigable waters of the United States. These lands are available by navigation servitude.

The lands required for the widening of the project are submerged and within the navigable waters of the United States. These lands are available by navigation servitude.

The lands required for the ODMDS and nearshore placement areas are submerged and within the navigable waters of the United States. These lands are available by navigation servitude.

The proposed mitigation lands required for the seagrass replacement and hardbottom re-creation are submerged and within the navigable waters of the United States. These lands are available by navigation servitude.

Port of Palm Beach, the project sponsor, as well as the State of Florida, have conveyed the preference for beach compatible dredged material excavated from the inlet be placed on the beach, both above and below the mean high water (MHW) line. Upland beach placement (above the MHW line) is not a part of the recommended plan and all costs, including administrative costs, will be paid for solely by the project sponsor. Since these beach disposal easements are not part of the recommended plan or project, the project sponsor will not receive any credit for the land costs or administrative costs.

Port of Palm Beach, the project sponsor, in conjunction with the Town of Palm Beach, Florida, have acquired 23 temporary construction easements as part of the existing Palm Beach Harbor Maintenance Dredging Beach Placement Project. The easements are to expire May of 2015. The easements extend from approximately R-76.5, 2,500 feet to R-79. These parcels have been certified for the Palm Beach Harbor Navigation Project. The easement allows the Federal Government/USACE to nourish, renourish, protect, operate and to perform any other work necessary and incident to the maintenance between the MHWL and vegetation. The existing easements, as well as an additional 20 parcels, (located between R-76 through R-81), are in the process of being extended or acquired for continued disposal placement. All lands seaward of the MHW line is owned by the State of Florida and should be included within the Joint Coastal Permit (JCP). During PED phase if the template within the area described above is filled to capacity then an additional placement area at Mid-Town Beach between R-90.4 through R-101.4 may be used. The material will be placed below the MHW line and no easements will be required. All construction easements from private owners would be acquired and funded solely by the project sponsor or other local interests. This includes all administrative costs. These lands will be certified by the project sponsor prior to project construction if necessary.

Staging and work areas will be within the lands below the designated MHW line or on previously provided construction easements for the Palm Beach Harbor Project. These lands will be certified for this project prior to advertisement

Federal fee and easement properties located at or near the south jetty acquired for the Palm Beach Harbor Project will be used temporarily for construction purposes. A pipeline from the inlet to the nearshore placement area will require the use of Tract Nos. A-102 (fee) and 108E-5 (perpetual right-of-way easement). No acquisition is required for the use of these lands.

SUMMARY OF PROJECT REAL ESTATE COSTS

There are no real estate costs for this project, other than administrative costs during pre-construction, engineering and design (PED) for coordination. These costs amount to $32,000, inclusive of contingency ($19,000 Federal; $13,000 non-Federal). These costs are not for lands and damages but per USACE regulations, they have been placed in the 01 Account in the total project cost spreadsheet (TPCS), located in Appendix B Cost Engineering and Risk Analysis, and in the cost sharing analysis, shown earlier in the chapter in Table 4-3.

4.10 RISK AND UNCERTAINTY

Engineering Regulation 1105-2-100 directs planners to identify areas of risk and uncertainty in their analysis and describe them clearly, so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans. During the beginning of the feasibility phase, a risk register was developed and each aspect of the project was evaluated for risk, and a rating was given of high, medium or low. Throughout the study, risk ratings were upgraded or downgraded depending on new information, and new items were added as needed. The areas of risk that still remain important are as follows.

Economics. For the economics portion of the study, risk and uncertainty is always present in the future projections. No growth rate projection will ever be 100% accurate, and the true ups and downs of business cycles cannot be accurately forecast through a linear or exponential growth rate. Linear or steady compound growth rates (exponential growth) are meant only to be representative of projected tonnage that is expected to transit through the port over longer periods. Using smoother curves as estimates for actual tonnage acts to normalize peaks and valleys in future business cycles. In reality, future tonnage will likely exceed the forecast in some years, and fall short of the forecast in others. A “most-likely” steady growth rate will account for both of these occurrences over the long run because the positive and negative differences from the estimated to actual tonnage will eventually cancel each other out. Risk and uncertainty is also present in the fluctuation of the Federal interest rate, in changes in vessel operating costs, and in unforeseen changes and paradigm shifts. Sensitivity analyses were done for each of the major commodity forecasts to mitigate risk as much as possible. All topics described above can be found in more detail in the Socio-Economic Appendix C.

Engineering. There is currently some risk and uncertainty regarding the geotechnical properties of the proposed dredged material; in some areas where there have been fewer core borings, it is unknown how dense the rock may be in certain areas. However, this risk is considered low and more detailed core borings, originally scheduled for PED, are currently underway to fully understand geotechnical properties prior to construction. The sheetpile wall for the jetty stabilization measure has only been designed to a level necessary for the feasibility study and there could be some risk in the sheetpile quantity estimates until the sheetpile wall is fully designed during the pre-construction, engineering, and design (PED) phase. This is considered low risk, as the jetty feature is less than 3% of the total project cost and any potential refinements to the design will remain relatively small, with respect to the total project.

The need for expansion of the Palm Beach Ocean Dredged Material Disposal Site (ODMDS) is considered a low (unlikely) risk. There is more than enough actual vertical capacity at this site, which is 1 nmi^2 in approximately 525-625 feet of water, and which has only been used once to date for approximately 3,500 cubic yards of dredged material. U.S. Environmental Protection Agency's (USEPA) concern is whether the material will fit within the horizontal footprint when placed, rather than if there is enough vertical capacity. Results from a past modeling study for Miami Harbor can be used as a precedent. Miami Harbor modeled placement of 6,000,000 cubic yards of dredged material (as compared to 1,500,000 cubic yards in Lake Worth) in the Miami ODMDS, a 1nmi^2 area (same as Lake Worth) with material that contained similar percents of rock as proposed Lake Worth Inlet material. Results showed that the material would fit in the Miami ODMDS footprint, with no need to expand. Based on this analysis at the Miami ODMDS, USACE does not expect that the proposed dredged material from the Lake Worth Inlet construction would result in a need to expand this ocean disposal site. However, if the modeling study does indicate that the expansion of the Palm Beach ODMDS is necessary (if modeling shows material will fall outside of the footprint), the course of action would be to expand the existing site or designate a site with sufficient capacity. This would be at least a 2 year process and would require additional funding. This risk was mitigated by identifying the risk and starting early to complete the modeling. This modeling study is scheduled to be complete prior to the PED phase. Scenarios below outline the USACE plan (A) and back-up plan (B) for using the Palm Beach ODMDS. USACE plan and back-up scenario are as follows:

A. Disposal modeling shows that proposed LWI dredged material does not exceed boundaries of existing Palm Beach ODMDS. Site can be used by USACE.

B. Disposal modeling shows that proposed LWI dredged material does exceed boundaries of existing Palm Beach ODMDS. A larger site would be required. Per the Marine Protection, Research, and Sanctuaries Act (MPRSA), "In any case in which the use of a designated site is not feasible, the Secretary (USACE) may, with the concurrence of the Administrator (USEPA), select an alternative site." Should USEPA not designate a disposal site with sufficient capacity for proposed material from Lake Worth Inlet construction under Section 102 of the MPRSA, Section 103(b) of MPRSA authorizes USACE, with USEPA concurrence, to select a site for one time disposal of dredged material in ocean waters. USACE could select to expand the existing Palm Beach ODMDS or select an alternative site of sufficient size to contain the proposed material. USACE would be required to evaluate the proposed disposal site under the criteria and factors in MPRSA Section 102(a) including a study to determine effects of dumping on marine ecosystems.

Environmental. The final mitigation amount is expected to be the same or less than what is being estimated. Since the exact amount of mitigation will not be known until Planning Engineering and Design (PED), when a final resource survey can be completed and mitigation amounts based on functional value can be calculated, an estimate of mitigation cost was prepared at the feasibility level. This estimate was determined by researching mitigation required in other Jacksonville District Civil Works projects, as well as mitigation required in permits issued by Jacksonville District Regulatory Division for hardbottoms. In addition, state and Federal agencies have supported these multipliers in past Jacksonville District projects and the multipliers discussed above represent a reasonable conservative estimate for mitigation.

Mitigation itself is considered low risk and will be performed as in-kind mitigation. Risks during construction to threatened and endangered species were minimized in the proposed plan and cost estimate by avoiding seasons of peak activity and incorporating other management methods such as observers.

Each of the above factors, as well as a thorough analysis of each project element, were incorporated into the Cost and Schedule Risk Assessment (CSRA) process, where the purpose of the CSRA is to develop a more statistically based project contingency. Therefore, areas of specific risk and uncertainty for cost and schedule were translated into higher contingencies which were then applied to the total project cost. Some of the risk and uncertainty will continue to decrease in the plans and specifications phase, as more information is known, thus lowering project contingency. More information on CSRA can be found in Appendix B, Cost Engineering and Risk Analysis.

JOHNSON'S SEAGRASS (*Halophila johnsonii*)

5.0 Effects of the Recommended Plan

LAKE WORTH INLET

Palm Beach Harbor

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5 EFFECTS OF THE RECOMMENDED PLAN

This chapter explains how the Recommended Plan, described in Chapter 4, will affect all elements of the surrounding environment, and describes a "future with-project" condition to directly compare to the baseline (existing) and "future without-project" conditions as described in Chapter 2. Chapter 5 mirrors the relevant resources first presented in Chapter 2 and presents the predicted effects of the Recommended Plan on the human environment.

For ease of comparison of the "future with-project" to the "future without-project", a table of "future without-project" conditions is provided as a foldout at the end of this chapter and can remain open as a constant reference for each item of comparison. A table for the economics environment only is provided first on page 5-35, followed by a table on page 5-36 which includes: the navigation environment, the built environment, and the natural environment. A table of the recommended plan compared to all elements is shown on page 5-37. All of the environments are evaluated through the National Environmental Policy Act (NEPA).

5.1 GENERAL SETTING

Neither the future without-project condition (no action alternative) nor the future with-project condition (Recommended Plan) would change the current general setting within the project area.

5.2 ECONOMIC ENVIRONMENT

Transportation cost savings will result primarily from the use of larger vessels, more efficient use of large vessels that are currently transiting the harbor, reduced vessel calls, and reduced congestion in the harbor.

5.2.1 OVERVIEW – COMMODITIES

FUTURE WITH-PROJECT CONDITIONS

For the purposes of this study, all vessel movements were assumed to have the same destination, and harbor with and without the project. This means that the commodity tonnages forecast to be transited through Palm Beach Harbor are assumed to move with or without the proposed improvements. There will be no expected shift in destination, mode of transportation, or any induced movement of cargo due to the proposed navigation improvements. However, for some petroleum products there will be a shift in origin from the U.S. Gulf Coast to East Coast of South America and the Caribbean. The future with-project commodity forecast is shown in Table 5-1.

Table 5-1: Future with-project Commodity Forecast.

	2017	2027	2037	2047	2057	2067	CAGR (2017-2067)	Benefitting Commodity?
Sugar (Shipments)	790	790	790	790	790	790	0.00%	No
Molasses (Shipments)	265	265	265	265	265	265	0.00%	Yes
Liquid Petroleum Products (Receipts)	232	251	272	295	320	347	0.80%	Yes (only diesel)
Asphalt (Receipts)	76	95	119	149	186	186	1.81%	Yes
Cement & Concrete (Receipts)	97	122	154	194	244	308	2.35%	Yes
Containerized Cargo (Both Directions)	999	1,343	1,805	1,805	1,805	1,805	1.19%	No
Non-Containerized General Cargo (Both Directions)	122	135	148	163	179	197	0.96%	Yes (only for largest vessels)
Total	2,581	3,000	3,552	3,660	3,789	3,897	0.83%	

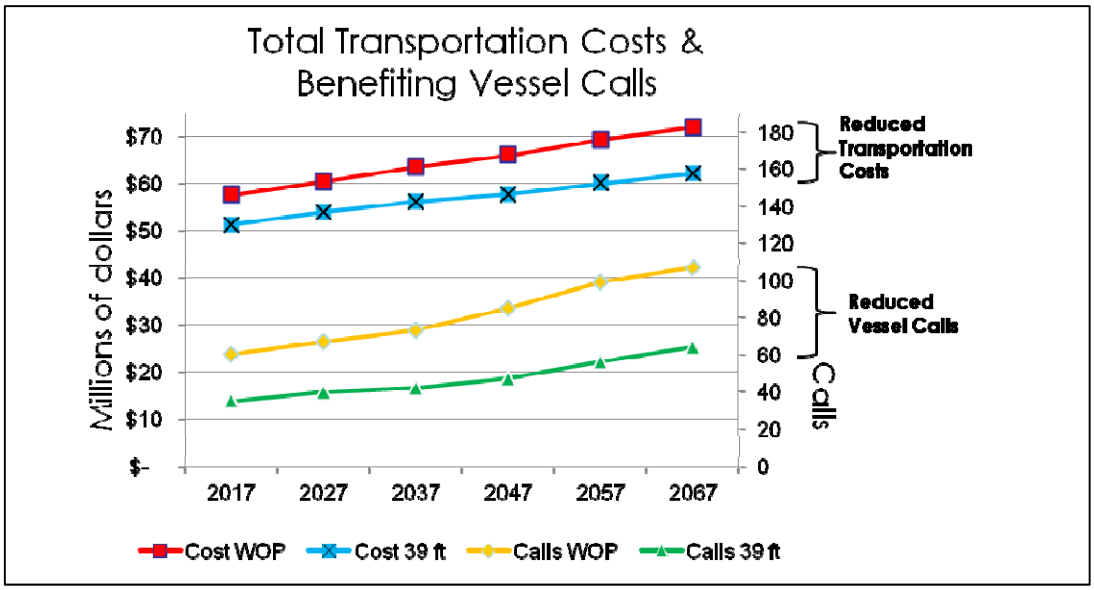
Notes: Values shown in thousands of metric tons. Liquid Petroleum includes residual fuel oil and distillate fuel oil (diesel). Non-containerized general cargo includes break-bulk, project cargo, and Ro-Ro. The "Benefitting Commodity?" column displays whether or not the commodity movements will benefit from channel deepening. CAGR = Compound annual growth rate.

5.2.2 OVERVIEW – FLEET

FUTURE WITH-PROJECT CONDITIONS

VESSEL CALLS: Compared to the future without-project condition, one main difference will be the number of vessel calls. The future-with-project vessel calls were projected by applying the forecasted commodity tonnage for each commodity type to a fleet distribution that minimizes total transportation costs by utilizing the most efficient mix of vessel sizes that take full advantage of increased channel width and depth in the future with-project conditions. The future with-project total transportation cost reductions, as well as reduced vessel calls, for the benefiting vessel classes are shown for the 39-foot project in Figure 5-1, below. In the following subsections, the assumptions and caveats behind each of the vessel fleet predictions are detailed.

Figure 5-1: Total Transportation Costs and Benefiting Vessel Calls (with-project Condition).



VESSEL SIZE: Currently, the largest self-propelled vessels that can fully load will be limited to the 30,000 to 35,000 dead weight tons (DWT) range. With a deeper channel, larger vessels upwards of 60,000 DWT could operate into the Port near full capacity with the result of carrying additional cargo on fewer dry bulk and liquid bulk vessels, thus reducing the amount of vessel calls. A deeper channel would also result in more cargo transiting on self-propelled tanker vessels for imports of diesel and asphalt (shifting from domestic barge).

Depending on future with-project channel depth, dry bulk and tanker vessels are expected to call between approximately 50,000 and 60,000 DWT. Under with-project conditions there will be a shift from domestic tug and vessel to self-propelled tanker vessels for liquid petroleum bulk movements.

5.2.3 MAJOR COMMODITIES

LIQUID PETROLEUM

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: Liquid Petroleum includes fuel oil and diesel. The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: In the with-project condition, a transition from tanker barges to self-propelled tanker vessels would be likely for diesel because of the economies of scale offered by bringing in larger vessels due to a more navigable channel with more room for maneuvering vessels.

SUGAR AND MOLASSES

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: Sugar would continue to move by domestic tug and barge in both the without-project and with-project conditions because of national price supports for US sugar production, and therefore will not be affected by channel improvements. In a future with-project condition, molasses tanker size would generally increase with a deeper channel and their use of tugs would likely decrease with a wider channel.

CEMENT AND ASPHALT

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: In the future with-project scenario, cement carriers would likely be larger vessels approaching 60,000 DWT, which would draw deeper drafts, and, if the channel were wider, they might use tug assistance less frequently. The main advantage of using larger vessels would be a transportation cost savings in the form of fewer shipments to move a similar amount of goods. In addition, the larger channel dimensions would relieve some of the sailing restrictions to which large bulk vessels must currently adhere.

As asphalt receipts are expected to rise steadily, in the future with-project condition a transition of fleet to larger self-propelled tanker vessels from tanker barge would be likely because of economies of scale and benefits from fewer vessel movements, and fewer tugs used. However, the amount of asphalt that can be moved through the Port is not only constrained by demand from the hinterland, but also by the available storage facilities at the Port. The on-dock storage capacity limitation for asphalt receipts only limits the volume that can be received in a single shipment - it does not limit the total throughput capacity at the port. This single shipment tonnage limitation was taken into account in the vessel movements and commodity transfers that were simulated in HarborSym model. As demand increases into the future, the turnover rate of the storage tanks will increase to accommodate the additional throughput.

CRUISE SHIPS AND PASSENGERS

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: Under with-project conditions, the current constraints under high wind condition restriction would be lifted. A longer cruise vessel may be likely to call as well. The day-cruise vessel would be the same in the with- and without-project conditions. The *Bahamas Celebration* would be able to make a straight back departure out of Slip 1. This would in turn have indirect benefits to allow cargo vessels to access Berth 6 (opposite Berths 2-3 in Slip 1) when the cruise ship is present.

CONTAINERIZED CARGO

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: The fleet forecast in the with-project condition will not change from the without-project forecast.

NON-CONTAINERIZED GENERAL CARGO AND SPECIALTY SHIPMENTS

FUTURE WITH-PROJECT CONDITIONS: COMMODITY AND FLEET

Commodity: The commodity forecast in the with-project condition will not change from the without-project forecast.

Fleet: With a deeper and wider channel in the with-project condition, vessels of this type will be larger and more able to more fully load to their design drafts with other types of cargo before calling Palm Beach to load or unload specialty cargo.

5.3 NAVIGATION ENVIRONMENT

5.3.1 TIDES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The proposed project would not significantly affect tides.

5.3.2 CURRENTS

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The proposed project would not significantly affect currents.

5.3.3 SEA LEVEL RISE

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The total regional sea level rise predicted by the three scenarios (baseline, intermediate, and high) at the end of the 50 year life of the project were projected to be 0.39, 0.83 ft, and 2.24 ft, respectively, and will not have a significant impact on the performance of the Palm Beach Harbor project. Potential impacts of rising sea level include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. A positive potential impact of sea level rise on the project is a reduction in required maintenance due to increased depth in the channel.

In general, regional sea level rise will not affect the function of the project alternatives or the overall safety of the design vessel. While there is expected to be a small increase in tidal surge and penetration for all three scenarios, the structural aspects of the project will be either unaffected or can be easily adapted to accommodate the change.

Seagrasses are found in the Intracoastal waterway and Lake Worth Lagoon vicinity in water depths up to 12 feet. Proposed mitigation for impacts to current seagrass beds would more than likely survive with the proposed sea level rise scenarios within their current range adjacent to the project area. As a result, it is expected that the seagrass beds would continue to exist, although photosynthetic efficiency may decrease with increasing depth.

5.3.4 STORM SURGE

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The difference in storm surge elevations (0.328 ft) between the with-project and without-project condition is a minor increase compared to actual storm surge water level (10 feet) during the 100 year storm event. Therefore no significant impact of the recommended project to storm surge is anticipated.

5.3.5 NAVIGATION RESTRICTIONS

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

When the restrictions mentioned in Table 2-2 are relaxed or alleviated in the future with-project condition it will also benefit other commercial traffic and recreational boaters. Proposed improvements will allow currently-restricted commercial shipping to have a wider call window, which will likely increase the chance or ability for ships to call 24 hours per day, reducing overall channel congestion. The increased channel availability should indirectly benefit recreational boater traffic as well, because their chance to encounter a commercial vessel moving in the harbor and entrance channel should be decreased.

Performing the proposed work would result in safer navigation conditions. Vessel traffic within Palm Beach Harbor and its inlet channel could be temporarily disrupted due to dredging activities. Notices to mariners would be coordinated and issued prior to dredging activities as per U.S. Coast Guard regulations. It is the intention of the USACE to maintain a safe environment for recreational and commercial vessels through Operations and Maintenance dredging of Palm Beach Harbor while complying with U.S. Coast Guard regulations.

5.4 BUILT ENVIRONMENT

5.4.1 EXISTING FEDERAL PROJECT

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The existing project would be modified to include the following dimensions, shown below in Table 5-2. Figure ES-4, or the comparative foldout reference map located at the end of this report, entitled REF-4, should be referred to for the full widening footprint changes.

Table 5-2: With-project Dimensions

Feature	Authorized Depth (feet)	Width (feet)	Length (miles)
Entrance Channel	41	440 to 460 ft (varies)	0.8
Inner Channel	39	Minimum of 450 ft	0.3
Main (South) Turning Basin	39	1200 (diameter), extended 150 ft to the south	

5.4.2 OPERATIONS AND MAINTENANCE

ADVANCE MAINTENANCE AND SETTLING BASIN

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The maintenance features, to include adding a westward notch to the settling basin and additional advance maintenance in the settling basin and the entrance channel (shown in Figure ES-4 and the reference map at the end of this report, entitled REF-4) would be authorized with the project. It is anticipated the additional area in the settling basin and recommended advance maintenance features in the entrance channel would allow for fewer disruptions to navigation traffic due to fewer dredging events as well as shorter durations of navigation restrictions due to shoaling. Future sandy shoaled material which would be trapped in the settling basin and advance maintenance channel, with O&M estimated at approximately 240,000 cubic yards every 2 years, would be dredged and placed on the beach or in the nearshore south of the inlet from R76 to R-79.

5.4.3 DREDGED MATERIAL PLACEMENT

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

NEARSHORE PLACEMENT

Approximately 450,000 cubic yards of sandy material meeting beach quality criteria (up to 10% silt) or nearshore quality criteria (up to 20% silt) would be placed in the nearshore. As identified in previous National Environmental Policy Act (NEPA) documents and DEP Permit Number 0216012-007-JC, nearshore placement of dredged material would be below the MHW line immediately south of the jetty, landward to the -17-foot contour, between DEP reference monuments R-76 and R-79 (Sections 2 and 3, Township 43 South, Range 43 East). All activities are within Palm Beach County, Lake Worth Lagoon (Atlantic Intracoastal Waterway), or the Atlantic Ocean, Class III Waters, not Outstanding Florida Waters. Placement of material in the nearshore as described above has been evaluated in previous Palm Beach Harbor NEPA documents and the effects are incorporated by reference into this EIS.

OCEAN DREDGED MATERIAL DISPOSAL SITE (ODMDS) PLACEMENT

Approximately 1.4 million cubic yards of material would be placed in the ODMDS. The USACE will coordinate with the EPA Region 4 Ocean Dumping Program Coordinator if the ODMDS is required for construction. The USACE will assess the dredged material to determine if it meets the Ocean Dumping Criteria in 40CFR226 and the disposal will be conducted in accordance with the Palm Beach Harbor ODMDS Site Management and Monitoring Plan (May 2009).

Although the ODMDS was given an initial capacity limit of 500,000 cubic yards per event, modeling is scheduled to take place as a first step toward allowing a larger capacity limit. The USACE has begun, and will continue, to coordinate with the EPA Ocean Dumping Program Coordinator for Region 4 for use of the ODMDS as needed for the Recommended Plan. More information is detailed in Section 4.8 and Section 4.10 (Chapter 4).

OTHER BENEFICIAL USE SITES

Dredged material could also be placed on the beach between DEP reference monuments R-78 and R-81, above the mean high water (MHW) line. Local interests strongly support the placement of beach compatible material on the beaches. The placement of dredged material on the beaches would not occur from May 1 through October 31 due to nesting of sea turtles. If needed, material would be placed in the nearshore during this timeframe. Mid-Town Beach could be used for placement, if a non-federal entity is willing to pay the incremental cost difference. The Mid-Town beach fill template is located between DEP reference monuments R-90.4 and R-101.4.

5.4.4 PORT FACILITIES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The Port is moving forward with a contract to make bulkhead and deepening improvements in Slip 3 to obtain immediate benefits, even in absence of a Federal project.

5.4.5 NORTH AND SOUTH JETTIES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Geotechnical analysis shows that the south jetty will not be affected as a result of the widening and deepening portion of the recommended plan, as discussed in Chapter 3. The south jetty will also not be affected by the improved advance maintenance plan, as described in Chapter 4. The north jetty slope stability would not be impacted as a result of the widening and deepening portion of the recommended plan itself, but it would be impacted as a result of the widening and deepening project in combination with the improved advance maintenance plan. However, the sheet pile wall which is proposed as a part of the improved advance maintenance plan will stabilize the north jetty.

5.4.6 SAND TRANSFER PLANT

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The sand transfer plant will continue to pump 160,000 cubic yards of sand per year and may undergo future maintenance when necessary. There is a pipeline within the harbor right of way, but the pipeline is located well beneath the bottom of the channel and will not be affected by the deepening of this project.

5.4.7 PEANUT ISLAND

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

It is not intended, nor expected, that this project would affect the physical attributes, economic benefits, recreational enjoyment by the community, and wildlife habitat associated with Peanut Island. According to the hydrodynamic model, no significant increase in velocity is indicated around Peanut Island nor are significant increases in wave heights, currents or wave energy expected around Peanut Island. Recreational navigation within the vicinity could be temporarily disrupted due to dredging activities, similar to disruptions that occur due to normal operation and maintenance (O&M) dredging activities. Performing the proposed work would result in safer navigation conditions for all vessel traffic. It is the intention of the USACE to maintain a safe environment for recreational and

commercial vessels through the proposed deepening of Lake Worth Inlet/Palm Beach Harbor while complying with U.S. Coast Guard regulations.

5.5 NATURAL ENVIRONMENT

5.5.1 VEGETATION

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Construction of the recommended plan would permanently remove approximately 4.5 acres of seagrass communities. The beds are primarily concentrated in Areas G, C, and D. In general, seagrass habitat loss results in loss of refugia and foraging habitat for many marine species, including both protected and managed species. Removal of seagrasses also affects the ecosystem by impeding important processes and functions such as sediment stabilization, nutrient cycling, and oxygen production. Mitigation for impacts to seagrasses resulting from the Recommended Plan are discussed in Section 4.3 and presented in full detail within the Mitigation Plan included as Attachment 3, Environmental Appendix D. Mitigation compensation for seagrasses will be required and is not expected to exceed 11.25 acres of beneficial dredge material placement based on conservative calculations completed by USACE using the HEA model. This model is available upon request.

Deepening shallow water habitats beyond 10-13 feet (3-4 meters) is likely to impede post-dredging recolonization (Kenworthy 2000, Hammerstrom et al. 2006). This effect would be most noticeable in the proposed larger turning basin (Area G).

5.5.2 THREATENED AND ENDANGERED SPECIES

The USACE has reviewed the biological, status, threats and distribution information presented in this assessment and believes that the following species have the potential be in or near the action area and thus may be affected by the proposed project: green turtle, loggerhead turtle, Kemp's ridley turtle, Hawksbill sea turtle, leatherback turtle, west indian manatee, humpback whale, sperm whale, Johnson’s seagrass, and smalltooth sawfish.

The USACE has determined the Recommended Plan may adversely affect Johnson’s seagras within the action areas due to the following adverse impacts : direct effect of blasting and dredging activities as well as indirect effects. The proposed project may affect, but is not likely to adversely affect; the green turtle, loggerhead turtle, Kemp's Ridley turtle, Hawksbill turtle, leatherback turtle, west indian manatee, humpback whale, sperm whale, and smalltooth sawfish. Please see the Biological Assessment in Pertinent Correspondence Appendix E (Endangered Species Act (ESA) Consultation), provided to National Marine

Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for further detail on all species discussed below.

SEA TURTLES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Construction activities within the beach placement areas may affect sea turtle nesting success. Visual surveys for escarpments along the beach fill area and landward of any nearshore placement would be made immediately after completion of the placement of dredged material. All scarps would be leveled or the beach profile would be reconfigured to minimize scarp formation. In addition, in order to minimize this impact, the following measure would be implemented:

No beach placement of dredged material would occur from May 1 through October 31, the primary sea turtle nesting season. If beach placement activities were to occur outside of this time frame but still within potential sea turtle nesting (March 1 to May 1 and November 1 to November 30), sea turtle monitoring and relocation would be performed in accordance with the Biological Opinion (BO) of the USFWS for this project.

In the event that a hopper dredge is used, the conditions stated by the NMFS in the 1998 South Atlantic Regional Biological Opinion (SARBO) for the use of this type of dredge would be implemented.

WHALES (HUMPBACK AND SPERM)

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Of the six species of endangered whales that may be found seasonally in the waters offshore southeastern Florida, the USACE believes that only the sperm and humpback whales may be adversely affected by activities associated with the proposed action. These effects would be a result of acoustic harassment. The blue, fin, northern right and sei whales are not discussed in detail because they are unlikely to be within the vicinity of the project. Additional information on blue, fin and sei whales can be found in Waring *et al*. (1999). Due to the rarity of sightings of these four whale species near the project area, the USACE believes that any effects to them by the project are discountable. Please see the Biological Assessment in Pertinent Correspondence Appendix E provided to NMFS and USFWS for further detail on blasting impacts and conservation measures to be implemented to reduce acoustic harassment. Development of conservation measures involved consideration of past practices and operations, anecdotal observations, and the most current scientific data. The discussion below summarizes the development of the conservation measures, which, although developed for marine mammals (including whales, manatee, and dolphins), will also be utilized to protect such species as sea turtles and smalltooth sawfish.

To achieve the deepening of the Lake Worth Inlet, pretreatment of the rock areas may be required. Blasting is anticipated to be required for some, or all, of the deepening and extension of the channel, where standard construction methods are unsuccessful. Current geotechnical investigations have shown the majority of rock to be inside the harbor in the

turning basin, not in the entrance channel. The work may be completed in the following manner:

- Contour dredging with either bucket, hydraulic or excavator dredges to remove material that can be dredged conventionally and determine what areas require blasting.
- Pre-treating (blasting) the remaining above grade rock, drilling and blasting the "Site Specific" areas where rock could not be conventionally removed by the dredges.
- Excavating with bucket, hydraulic or excavator dredges to remove the pre-treated rock areas to grade.

All drilling and blasting will be conducted in strict accordance with local, state and federal safety procedures. Marine Wildlife Protection, Protection of Existing Structures, and Blasting Programs would be coordinated with federal and state agencies. Based upon industry standards and USACE, Safety & Health Regulations, the blasting program may consist of the following:

The weight of explosives to be used in each blast will be limited to the lowest poundage of explosives that can adequately break the rock. The blasting would consist of up to 3 blasts per day, preparing for removal of approximately 1500 cubic yards per blast.

The following safety conditions are standard in conducting underwater blasting:

- Drill patterns are restricted to a minimum of 8 ft separation from a loaded hole.
- Hours of blasting are restricted from 2 hours after sunrise to 1 hour before sunset to allow for adequate observation of the project area for protected species.
- Selection of explosive products and their practical application method must address vibration and air blast (overpressure) control for protection of existing structures and marine wildlife.
- Loaded blast holes will be individually delayed to reduce the maximum pounds per delay at point detonation, which in turn will reduce the mortality radius.
- The blast design will consider matching the energy in the “work effort” of the borehole to the rock mass or target for minimizing excess energy vented into the water column or hydraulic shock.

Further detail, including additional conservation measures, is included in the BA provided to the NMFS and is included in Pertinent Correspondence Appendix E, Attachment 1.

JOHNSON’S SEAGRASS

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Dredging will result in the removal of approximately 4.5 acres of seagrass beds where *H. johnsonii* is the sole constituent or associate of other seagrass species in the areas surrounding the turning basin. This impact will include the direct removal of *H. johnsonii.* Changes in bottom depth through deepening and widening efforts within the Port are expected to make resulting habitats unsuitable for re-colonization of *H. johnsonii*. In addition, areas of Johnson’s seagrass adjacent to construction activities may be temporarily

affected by increased turbidity and lower water clarity during construction. Therefore, the proposed project may adversely affect Johnson's seagrass within the action area as discussed in the Biological Assessment found in Pertinent Correspondence, Appendix E.

Mitigation for project impacts is discussed in Section 4.3 and is presented in full detail within the Mitigation Plan (Appendix D, Attachment 3). Mitigation compensation for seagrasses will be required and is not expected to exceed 11.25 acres of beneficial dredge material placement based on conservative calculations completed by USACE using the HEA model. This model is available upon request.

WEST INDIAN MANATEE

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

During the colder months, high numbers of manatees aggregate at the Florida Power and Light Riviera Plant south of Area G. The Riviera Plant discharges warm water during the colder months when ambient water temperatures drop to less than 61 degrees Fahrenheit. During the 2009-10 winter survey, the Riviera Plant had 581 manatees and 554 during the 2010-11 winter survey (Reynolds 2011). Deepening and widening the channels in Lake Worth Inlet is not expected to result in any change of use by manatees. Though some foraging acreage would be lost in Areas D and G, mitigation for seagrass impacts would be completed. Changes to manatee/vessel interactions within the harbor are expected to be insignificant as a direct result of the expansion project.

Protective measures would be taken to ensure the safety of manatees when waterborne workboats are used, including having an observer(s) aboard the dredging equipment to maintain a watch for manatees during dredging operations and during the dredge transit to and from the disposal site. To make the contractor and his personnel aware of the potential presence of this species in the project area, their endangered status, and the need for precautionary measures, the contract specifications would include the following standard manatee protection clauses:

- The contractor would instruct all personnel associated with construction activities about the potential presence of manatees in the area and the need to avoid collisions with them.

- If a manatee were sighted within 100 yards of the project area, all appropriate precautions would be implemented by the contractor to ensure protection of the manatee. These precautions would include the operation of all moving equipment no closer than 50 feet of a manatee. If a manatee were closer than 50 feet to moving equipment or the project area, the equipment would be shut down and all construction activities would cease to ensure protection of the manatee. Construction activities would not resume until the manatee had departed the project area.

- All vessels associated with the project would operate at 'no wake' speeds at all times while in shallow waters or channels where the draft of the boat provides less than three feet

clearance from the bottom. Boats used to transport personnel would be shallow draft vessels, preferably of the light-displacement category, where navigational safety permits. Vessels transporting personnel between the landing and any workboat would follow routes of deep water to the greatest possible extent. Shore crews would use upland road access if available.

- All personnel would be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Endangered Species Act and the Marine Mammal Protection Act.

Utilization of blasting as a technique to remove rock may have an effect on manatees in the area of any blasts fired. The project area is an important area for manatees, particularly in winter, and manatees are commonly seen transiting along the Intracoastal Waterway (IWW). It is likely that any effect on manatees outside a proposed safety radius will be in the form of an auditory Temporary Threshold Shift (TTS). Both the pressure and noise associated with blasting can injure marine mammals. Conservation measures for marine mammals, described above for whales, will also be implemented for protection of manatees. These effects are further discussed in the Biological Assessment (BA) provided to NMFS and included in Pertinent Correspondence Appendix E. In addition to reducing the pressure wave by confining the blasts in rock, by putting in place a series of protective zones around the blast array and monitoring the area for the presence of protected species, including the Florida manatee, the USACE does not believe that any manatee will be injured or killed by the blasting activities.

SMALLTOOTH SAWFISH

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The smalltooth sawfish may be affected by dredging nearshore areas in channels that are currently suitable habitats (areas of sand and/or mud bottoms less than 30 feet in depth) and by blasting if there is an animal present in the blast zone at time of detonations. As stated in Chapter 2 in the corresponding section, it is unlikely for this species to be found within the project area.

PIPING PLOVER

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Surveys for piping plovers would be completed prior to and during construction activities. Surveys would begin on April 1 or 45 days prior to construction commencement, whichever is later, and be conducted daily throughout the construction period as stated in the December 2012 letter from the USFWS. Though the current beach placement location is adjacent to an inlet, piping plovers have not been observed during previous dredging placement activities. If piping plover were documented during surveys, the USFWS would be provided the survey data and report. The Recommended Plan, or future with-project condition, is not expected to affect the piping plover.

5.5.3 FISH AND WILDLIFE RESOURCES[1]

MIGRATORY BIRDS

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Surveys for shorebirds and other migratory bird species would be completed prior to construction activities. Surveys would begin on April 1 or ten days prior to construction commencement, whichever is later, and be conducted daily throughout the construction period.

No adverse effects on migratory birds are anticipated. However, if any construction were performed from April 1 to August 31, the USACE's standard migratory bird protection conditions would be implemented. If migratory bird nests were identified, all specifications within the Migratory Bird Protection Plan would be followed.

BOTTLENOSE DOLPHIN

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Other than the effects of confined blasting, the remaining construction activities associated with the expansion of Lake Worth Inlet would result in no additional effect on the bottlenose dolphins in the vicinity because these animals, which transit through the port, are familiar with large vessels operating in a largely urban waterway.

The use of blasting to expand Lake Worth Inlet may have an effect on dolphins that are in close proximity to any blasts fired to crack rock. If dolphins are within the project area during construction activities, it is likely that any effect on dolphins outside of the proposed safety radius will be in the form of a Temporary Threshold Shift (TTS). Both the pressure and noise associated with blasting can injure marine mammals.

As with manatees, direct impacts on dolphins due to blasting activities in the project area include alteration of behavior. For example, daily movements and/or seasonal migrations of dolphins may be impeded or altered. Although incidental take would not result from sound/noise outside of the Danger Zone, disturbances of this nature (alteration of behavior/movements) are considered harassment under Marine Mammals Protection Act (MMPA).

However, to ensure that the project was being very conservative in estimation of effects to listed species, the USACE assumed that the proposed action may harass dolphins by causing a TTS. As a result of this assumption, the USACE will submit a request for an Incidental Harassment Authorization (IHA) from the NMFS during the PE&D portion of the project. Section 101 (a)(5) of the MMPA allows the incidental (but not intentional) taking of marine mammals upon request if the taking will (1) have a negligible impact on the species or stock(s); and (2) not have an immitigable adverse impact on the availability of the species or

[1] Other than threatened and endangered species

stock(s) for subsistence uses. The USACE concludes that causing a TTS in an individual dolphin near a confined blast meets these criteria.

5.5.4 HARDBOTTOM HABITAT

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Widening of the channel and turning basin would result in the direct removal of approximately 5 acres of hardbottom habitat in Areas C, D, and G. Benthic communities in the impact area are comprised of mainly sponge and hydroid species. Direct habitat loss to previously unimpacted hardbottom assemblages associated with dredging would be permanent. This hardbottom provides habitat for many sea turtle, fish, and invertebrate species. The areas to be impacted and their functional value are discussed in Section 2.5.5 of this report and in the Habitat Equivalency Analysis (HEA) found in the Mitigation Plan Appendix D, Attachment 3.

Mitigation for project impacts is discussed in Section 4.3 and presented in full detail within the Mitigation Plan (Appendix D, Attachment 3). Approximately 5 acres of hard bottoms are expected to be impacted due to the Recommended Plan. ; mitigation compensation for hardbottom will be required and is not expected to exceed 11.25 acres of artificial reef creation based on conservative calculations completed by USACE using the HEA model. This model is available upon request.

5.5.5 ESSENTIAL FISH HABITAT

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The recommended plan would impact Essential Fish Habitat (EFH) including removal of seagrass and hardbottom habitat. EFH present in the project footprint include the habitats and acreages noted in the detailed EFH Assessment located in the Environmental Appendix D, Attachment 6. Permanent impacts to EFH include the seagrass and hardbottoms in Areas C, D, and G. Temporal impacts to hardbottoms would occur due to the widening of the channel in Area B, but these species would recolonize the new channel walls within approximately one year. Impacts to EFH have been coordinated with NMFS for this project.

5.5.6 COASTAL BARRIER RESOURCES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

There will be no impacts to coastal barrier resources under the No Action alternative or the recommended plan.

5.5.7 WATER QUALITY

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

A State Water Quality Certificate would be obtained under Section 401 of the Clean Water Act prior to construction and state water quality standards would be met during construction. The recommended plan would cause temporary increases in turbidity where dredging is taking place; however, it is not anticipated that dredging will improve or degrade existing water quality conditions in the port area in the long-term. The State of Florida water quality regulations require that water quality standards not be violated during dredging operations. The standards state that turbidity outside the mixing zone shall not exceed 29 Nephelometric Turbidity Units (NTU) above background. Various protective measures and monitoring programs would be conducted during construction to ensure compliance with state water quality standards. Should turbidity exceed state water quality standards during construction, as determined by monitoring, the contractor would be required to cease operations until a return to background conditions.

The USACE has determined that although no filling of jurisdictional wetlands will occur as a part of the proposed action, a Section 404(b) determination was conducted for this EIS and is included in Environmental Appendix D, Attachment 1 due to the use of dredged materials for mitigation purposes. Impacts associated with disposal activities at the EPA designated ODMDS have been reviewed and addressed in EPA's 2004 EIS for the designation of the Palm Beach Harbor ODMDS. The USACE was a cooperating agency on the designation EIS, and hereby incorporates those analyses into this EIS (EPA, 2004).

A survey of the Lake Worth Inlet area for municipal water supply well fields shows wells located no closer than one mile from the Port of Palm Beach. Palm Beach County's public water supply is mainly sourced by the surficial aquifer system through wells extending approximately 150 feet underground. Salt water intrusion into different portions of the surficial aquifer system is thought to be due to residual salt water. The SFWMD and USGS monitor many wellfields within Palm Beach County and well number PB-652A is the closest well to the study area.

A wellfield is the area surrounding a permitted well where greater than 100,000 gallons of potable water per day is pumped out of the ground. The Port of Palm Beach and Lake Worth Lagoon/Lake Worth Inlet, is one mile northeast from a Zone 4 Wellfield Zone of Protection and over 1.5 miles southeast from a Zone 2 Wellfield Zone of Protection.

Deepening Lake Worth Inlet may have some impact on the location of the freshwater/ saline water interface in the immediate vicinity of the Inlet; however, the nearest municipal water supply well field is greater than one mile from the Inlet. It is unlikely that deepening Lake Worth Inlet would impact groundwater quality significantly.

Deepening Lake Worth Inlet might result in periodic increases in water salinity to eastern portions of the drainage canal network that are directly connected to the Lake Worth Inlet and Lake Worth Lagoon area; however, the impact to water supplies is expected to be

minimal because the closest canal point is 2.5 miles north of the project area. It is more likely that the projected gradual increase in sea level rise will result in more impact to groundwater salinity than deepening of Lake Worth Inlet since the zone of impact from sea level rise is the entire coastline and tidal portion of the drainage canal network rather than a limited portion of the area effected by the proposed deepening.

Deepening the Lake Worth Inlet entrance should not have an impact on the freshwater/saltwater interface within the surficial aquifer because the fresh groundwater does not extend eastward of the Palm Beach County shoreline at any depth within the surficial aquifer. Deepening the entrance channel may cause a slight increase in conductivity in the vicinity of the inlet, but this is unlikely to have any measurable effect to onshore groundwater quality conditions given that the new channel depth would not change either the on-shore groundwater surface elevation or the mean sea level which together control the location of the saltwater interface.

In conclusion, the deepening of Lake Worth Inlet is likely to result in minimal impacts to groundwater quality in the immediate vicinity. Saltwater intrusion could worsen as a result of sea level rise (a future without-project condition), with more ocean water leaking into surficial aquifers. No substantial impact to water supplies is expected to occur as a result of this project.

5.5.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

There are no known sources of hazardous, toxic, or radioactive wastes in the dredging area. Sediments and materials for the areas to be excavated during construction have been evaluated to be sandy material, with no indication of contaminants. However, the site would be remediated in the event contaminants were unexpectedly found during construction of the advance maintenance features. Material may require additional evaluation prior to construction before the material may be placed in the ODMDS.

5.5.9 AIR QUALITY

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Direct emissions from the proposed dredging of Lake Worth Inlet and Palm Beach Harbor would be confined to exhaust emissions of labor transport equipment (land and water vehicles), and construction equipment (dredge, barge, tugs, etc.). As described in Chapter 2 in the corresponding section, pollutants considered in this air quality assessment are sulfur oxides (SOx), volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon dioxide (CO), PM10, and PM2.5. Volatile organic compounds, sulfur oxides, and nitrogen oxides are precursors to ozone generation. These criteria pollutants are generated by the activities (e.g., construction and mobile source operations) associated with the proposed alternative.

Further, the Contractor shall be required to comply with applicable air pollution standards of the State of Florida (Florida Statute, Chapter 403 and others and Chapters 200 series of the FAC) Commonwealth Territorial and all Federal emission and performance laws and standards, including the U.S. Environmental Protection Agency's Ambient Air Quality Standards.

Pursuant to the General Conformity Rule of the Federal Clean Air Act (CAA) as promulgated by the EPA, a Federal agency must make a General Conformity Determination for all Federal actions in non-attainment or maintenance areas where the total of direct and indirect emissions of a non-attainment pollutant or its precursors exceed levels established by the regulations. Short term impacts from dredge emissions and other construction equipment associated with the Recommended Plan would not significantly impact air quality. No air quality permits would be required. The project is located within an attainment area and therefore the EPA's general conformity rule to implement Section 176(c) of the CAA does not apply and a conformity statement should not be required. The criteria pollutants, including ozone, are estimated herein for planning purposes only. Current air quality monitoring data is available online from Palm Beach County at http://www.pbchd.com/env/airqual/env_air_quality.html.

Growth projections showed an increased use of the Port with or without the widening and deepening project. However, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The project allows for a shift from smaller, less efficient ships, to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls consistent with national trends detailed in the IWR 2012. Therefore, it is expected emissions as a result of ships calling on the Port would decrease.

Emission Sources: The marine emission sources such as dredges and the associated support equipment, was derived from EPA's extensive compilation of air emission factors for various types of equipment (Compilation of Air Emission Factors, AP-42, 5th Edition, USEPA 1995). The latest EPA technical report for developing load factors and emission factors for large compression-ignition marine diesel engines is given in the *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data*; EPA 420-R-00-002, published February 2000. The technical report is a compilation of engine and fuel usage test data from various types of marine vessels, including bulk carriers, container ships, dredges, tanker vessels, and tugboats. This report was employed in the determination of the load factors and emission factors for the various types of marine equipment that would be operational during construction of the proposed Lake Worth Inlet recommended plan. The marine emission factors can be found in Table 5-3 below.

Equipment Use Parameters: This Environmental Impact Statement (EIS) estimates air pollution emissions from construction operations for the recommended plan. In estimating the project's potential marine emissions, a marine equipment list (dredges and support equipment) including individual engine specifications [horsepower (hp)] was developed. The marine operations are comprised of the following equipment: one hydraulic dredge (1,256

hp), two mechanical dredges (1,256 hp each), one work tugboat (250 hp), one crew/survey vessel (100 hp), one derrick (200 hp), one tow vessel (3000 hp), two spreaders/graders (250 hp each) and a two dump scows (250 hp each). Emission rates for each applicable criteria pollutant CO, NOx, PM2.5, PM10, SOx, and VOCs were calculated in tons per hour. Each sources' (engine) emission rate was derived from the following formula:

Emission Rate (tons/hr) = Engine Horsepower × Engine Load Factor × Emission Factor

The marine equipment's engine load factors were estimated from the USEPA technical report *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data* incorporating each source's suggested operating mode. A conservative time-averaged load factor of 75% of total power capacity was used for likely deployed vessels during dredging operations. The duration in months for construction of the recommended plan, including the breakwaters and seawalls, is approximately 33 months. The annual hours of operation were developed for each piece of marine equipment over the construction period. Potential criteria air pollutant quantities emitted were calculated based on the following formula:

Emission Amount (tons/year) = Emission Rate (tons/hour) × Working Hours (hours/year)

Table 5-3: Marine Emission Factors (EPA, 2000)

Marine Engine Emission Factors		
Pollutant	Emission Rate (g/kW-hr)	lb/hp-hr
PM	0.272	0.0004
NOx	10.805	0.0175
NO2	16.058	0.0260
SO2	1.832	0.0030
CO	1.676	0.0027
VOC	0.189	0.0003

Emission Results: The criteria air pollutants emissions presented in the tables below represent the estimated total of direct and indirect emissions that would occur during the Lake Worth Inlet, Palm Beach Harbor Recommended Plan construction for each project component.

Table 5-4: Estimated Emissions (tons) for Jetty Stabilization

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Crane	400	517	0.21	1.36	0.03	0.03	0.23	0.02
Work Tug	250	517	0.13	0.85	0.02	0.02	0.15	0.01
Crew/Surv	100	517	0.05	0.34	0.01	0.01	0.06	0.01
Derrick	200	517	0.10	0.68	0.02	0.02	0.12	0.01
Total			**0.50**	**3.23**	**0.07**	**0.07**	**0.55**	**0.06**

Table 5-5: Estimated Emissions (tons) for Pipeline Dredging

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge	1,256	272	0.35	2.24	0.05	0.05	0.38	0.04
Tow Vessel (Mobilization)	3,000	272	0.83	5.36	0.12	0.12	0.92	0.09
Spreader/Grader (1)	250	272	0.07	0.45	0.01	0.01	0.08	0.01
Spreader/Grader (2)	250	272	0.07	0.45	0.01	0.01	0.08	0.01
Total			**2.31**	**14.94**	**0.34**	**0.34**	**2.56**	**0.26**

Table 5-6: Estimated Emissions (tons) for Mechanical Dredging

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Dredge - 1	1,256	8,064	10.25	66.47	1.52	1.52	11.39	1.14
Dredge - 2	1,256	8,064	10.25	66.47	1.52	1.52	11.39	1.14
Work Tug	250	8,064	2.04	13.23	0.30	0.30	2.27	0.23
Crew/Surv	100	8,064	0.82	5.29	0.12	0.12	0.91	0.12
Derrick	200	8,064	1.63	10.58	0.24	0.24	1.81	0.18
Dump Scow - 1	250	8,064	2.04	13.23	0.30	0.30	2.27	0.23
Dump Scow - 2	250	8,064	2.04	13.23	0.30	0.30	2.27	0.23
Total			**29.08**	**188.50**	**4.31**	**4.31**	**32.31**	**3.26**

Table 5-7: Estimated Emissions (tons) for Seagrass Mitigation

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Crane	400	1,131	0.46	2.97	0.07	0.07	0.51	0.05
Work Tug	250	1,131	0.29	1.86	0.04	0.04	0.32	0.03
Crew/Surv	100	1,131	0.11	0.74	0.02	0.02	0.13	0.01
Derrick	200	1,131	0.23	1.48	0.03	0.03	0.25	0.03
Total			**1.09**	**7.05**	**0.16**	**0.16**	**1.21**	**0.12**

Table 5-8: Estimated Emissions (tons) for Hardbottom Mitigation

Equipment	Capacity (hp)	Annual (hrs)	Pollutants (tons/yr)					
			CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Crane	400	2,957	1.20	7.76	0.18	0.18	1.33	0.13
Work Tug	250	2,957	0.75	4.85	0.11	0.11	0.83	0.08
Crew/Surv	100	2,957	0.30	1.94	0.04	0.04	0.33	0.03
Derrick	200	2,957	0.60	3.88	0.09	0.09	0.67	0.07
Total			**2.84**	**18.43**	**0.42**	**0.42**	**3.16**	**0.32**

The criteria air pollutant emissions presented in Table 5-9 below represents the potential direct and indirect emission estimates occurring during the proposed Lake Worth Inlet, Palm Beach Harbor Recommended Plan construction.

Table 5-9: Total Estimated Emissions (tons) for All Project Components

Location	Duration (Months)	CO	No_x	$PM_{2.5}$	PM_{10}	SO_x	VOC
Jetty Stabilization	3.23	0.50	3.23	0.07	0.07	0.55	0.06
Pipeline Dredging	1.7	2.31	14.94	0.34	0.34	2.56	0.26
Mechanical Dredging	17.53	29.08	188.50	4.31	4.31	32.31	3.26
Seagrass Mitigation	3.37	1.09	7.05	0.16	0.16	1.21	0.12
Hardbottom Mitigation	8.8	2.84	18.43	0.42	0.42	3.16	0.32
Total		**35.82**	**232.15**	**5.31**	**5.31**	**39.80**	**4.01**

Carbon Dioxide Emissions: Carbon dioxide (CO_2) is emitted in a number of ways. It is emitted naturally through the carbon cycle and through human activities like the burning of fossil fuels. Natural sources of CO_2 occur within the carbon cycle where billions of tons of atmospheric CO_2 are removed from the atmosphere by oceans and growing plants, also known as 'sinks,' and are emitted back into the atmosphere annually through natural processes also known as 'sources.' When in balance, the total carbon dioxide emissions and removals from the entire carbon cycle are roughly equal. Since the Industrial Revolution in the 1700's, human activities, such as the burning of oil, coal and gas, and deforestation, have increased CO_2 concentrations in the atmosphere. In 2005, global atmospheric concentrations of CO2 were 35% higher than they were before the Industrial Revolution. As an important greenhouse gas, Carbon Dioxide (CO_2) emissions were also calculated for planning purposes.

Table **5-10** below shows this estimation.

Table 5-10: Carbon Dioxide (CO2) Emissions for All Project Components

Project Activity	Fuel Consumption (gal)	Emissions CO_2 (lbs)
Jetty Stabilization	110,677	2,457,029
Pipeline Dredging	58,191	1,291,840
Mechanical Dredging	600,166	13,323,685
Seagrass Mitigation	115,241	2,558,350
Hardbottom Mitigation	301,224	6,687,173
Total	**1,185,499**	**26,318,078**

CO_2 emissions from a gallon of diesel = 2,778 grams x 0.99 x (44/12) = 10,084 grams = 10.1 kg/gallon = 22.2 pounds/gallon. Note: These calculations and the supporting data have associated variation and uncertainty. EPA may use other values in certain circumstances, and in some cases it may be appropriate to use a range of values.

Carbon Dioxide emissions were calculated based on the Intergovernmental Panel on Climate Change (IPCC) guidelines for calculating emissions inventories. This requires that an oxidization factor be applied to the carbon content to account for a small portion of the fuel that is not oxidized into CO_2. For all oil and oil products, the oxidation factor used is 0.99 (99 percent of the carbon in fuel is eventually oxidized, while 1 percent remains un-oxidized).
The temporary increases in the project-related emissions are relatively minor compared to the existing point, nonpoint, and mobile source emissions in Palm Beach County. Effects from project emissions and other construction equipment associated with the Recommended Plan would not significantly affect air quality within the local air-shed. Short-term loadings of internal-combustion engine exhaust gasses are expected to be negligible, not posing a threat to workers, local populations, or the area's attainment status. As mobile and temporary sources, no air quality permit would be required for this project. Because the project is located within a designated attainment area, USEPA's general conformity rule Section 176 (c) of the CAA does not apply and a Conformity Determination Analysis would not be required.

Further, as cited within the Socio-Economic Appendix C, the vessel classes would take advantage of the additional depth in the with-project condition. Growth projections showed an increased use of the Port with or without the deepening project; however, the amount of cargo and liquid bulk on the vessels is expected to increase as the vessels add more cargo in response to the additional water depth available for use, allowing for more efficient use of the vessels. The project allows for a shift from smaller, less efficient ships to slightly larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls.

5.5.10 NOISE

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The urban setting of the Port produces noise not necessarily related to the operation of the Port. There is little to no noise produced as a result of vessel traffic except for the engine noise associated with vessel transit and tug operations. Port tariff restricts the blowing of whistles and horns by vessels while in Port, and the only intermittent whistle blowing are signals between tugs while assisting vessels in their movement within the Port.

Construction of the proposed expanded navigation channel and turning basin would result in a short term increase in noise over the existing background level. Construction equipment would be properly maintained to minimize the effects of the noise and the distance of the activity from residential areas would also reduce any noise impacts associated with construction. Excavation of hard rock formation may require special methods to ensure removal. Rock fracturing, or blasting, is being considered as a method.

Under the Marine Mammal Protection Act (MMPA), any activity that may result in causing Level B harassment must undergo a consultation with the appropriate agency. NMFS has promulgated regulations to obtain authorization under the MMPA for Level B harassment through a process called an "Incidental Harassment Authorization" (IHA). The IHA allows the activity to go forward with the unintentional harassment of non-ESA listed marine mammals in the project area (50 CFR 216).

The USACE has previously obtained IHAs for blasting pre-treatment activities associated with the Miami Harbor Phase II deepening project in 2005-2006, and currently has recently submitted an application for an IHA for the proposed deepening at Miami Harbor scheduled to begin early in 2013. The Port Everglades project will also gain this authorization before the project can advertise for contractors to submit proposals, accept a proposal or initiate construction. With the application for an IHA for Miami Harbor Phase II, the USACE believed, and NMFS concurred, that the blasting activities were likely to cause Level B harassment and that an IHA was warranted. As part of the 2005 renewal of the IHA for Miami Harbor, NMFS also concurred with the USACE determination that dredging activities themselves (operations of a cutterhead or clamshell dredge for that project) and the overall operations of dredges, tugs and scows were not likely to result in harassment of marine mammals in the project area and did not require an IHA (NMFS, 2005).

5.5.11 AESTHETIC RESOURCES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

Construction activities within the Palm Beach Harbor navigation channel would temporarily impact the aesthetics due to presence of the dredge equipment within the project area. This temporary impact would be similar to that of typical operations and maintenance dredging, but of longer duration (up to two years). Construction equipment including dredges, dredge pipes, survey vessels, construction vessels, scows, etc would be visible to

the public. Temporary aesthetic impacts due to construction of staging areas, access roads and the like may also occur. Aesthetic impacts due to work sites can be reduced through proper periodic site management measures such as prompt removal of trash and debris. Construction fences around work areas can provide a visual as well as safety barrier.

5.5.12 RECREATION RESOURCES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

There would be temporary impacts to recreational boating during construction of the Recommended Plan, similar to that of normal maintenance dredging. Construction of the Recommended Plan would be of longer duration (up to two years) than typical maintenance dredging, thereby impacting recreational boating for a longer period of time. Vessel traffic would also be temporarily disrupted due to construction activities. Both the nearshore placement area and the beach placement area would cause temporary impacts to recreational beach goers during placement of the dredged material. Mitigation areas discussed in this document would create additional opportunities for diving and snorkeling in the area.

5.5.13 CULTURAL RESOURCES AND HISTORIC PROPERTIES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

A determination that no historic properties would be affected by the proposed project has been made by the USACE and provided to the Florida State Historic Preservation Officer for their concurrence. In a letter dated November 20, 2013 (see Appendix E, Pertinent Correspondence) the SHPO concurred with this determination.

5.5.14 NATIVE AMERICANS

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

The Jacksonville District historic preservation staff holds an annual meeting with representatives of both the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida. The purpose of the meetings is to conduct consultation with the tribes in compliance with Section 106 of the National Historic Preservation Act. In the 2011 and 2012 meetings, the Lake Worth Inlet project was presented and discussed. We have determined that the project will not affect properties that are of concern to the tribes. The tribes did not have any further comment on our determination.

5.5.15 PUBLIC SAFETY

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

As discussed for the No Action Alternative, notices to mariners would be coordinated and issued prior to dredging activities as per U.S. Coast Guard regulations. Vessel traffic within

Palm Beach Harbor and its inlet channel could be temporarily disrupted due to dredging activities. Performing the proposed work would result in safer navigation conditions. It is the intention of the Corps to maintain a safe environment for recreational and commercial vessels through the proposed deepening of Lake Worth Inlet/Palm Beach Harbor while complying with U.S. Coast Guard regulations.

5.5.16 NATURAL OR DEPLETEABLE RESOURCES

FUTURE WITH-PROJECT CONDITIONS (RECOMMENDED PLAN)

No depleteable resources would be used other than fossil fuels to power equipment and produce materials or equipment for dredging, disposal site construction, and pipeline construction.

5.5.17 CUMULATIVE IMPACTS

This section discusses potential impacts resulting from other facilities, operations, and activities within the immediate project area that, in combination with potential impacts from the Recommended Plan, may contribute to cumulative impacts in the Recommended Plan's Region of Influence (ROI). Cumulative impacts are impacts on the environmental that result from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of the agency (Federal or non-federal) or person that undertakes such other actions (40 CFR Part 1508.7). For this EIS, the existing conditions of each alternative location as described in the affected environment sections earlier in this chapter reflect the cumulative effects of past and present actions. A description of regional development trends for each alternative location is provided to show the basic progression of how the baseline conditions were altered over time and how they may continue to change with or without the Proposed Action.

An inherent part of the cumulative effects analysis is the uncertainty surrounding actions that have not yet been fully developed. The CEQ regulations provide for the inclusion of uncertainties in the EIS analysis, and state that "(w)hen an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking" (40 CFR Part 1502.22). The CEQ regulations do not say that the analysis cannot be performed if the information is lacking. Consequently, the analysis contained in this section includes what could be reasonably anticipated to occur given the uncertainty created by the lack of detailed investigations to support all cause and effect linkages that may be associated with the Proposed Action.

Geographic and Temporal Limits of the Analysis: The geographic areas used for the scope of this analysis varies for each affected resource, For example, air quality is generally evaluated on a county by county basis by USEPA, so the cumulative effects for air quality would be evaluated by this bounding area. Marine resources, however, are affected only within the nearshore areas off of the Palm Beach County coastline and marine inshore waters. However, it would be extremely difficult to establish the effects resulting from all past projects throughout the County, so this cumulative assessment is limited to those actions within and adjacent to Palm Beach Harbor and Lake Worth Inlet.

PAST ACTIONS IN THE PROJECT AREA

Palm Beach Harbor was authorized as a Federal Navigation Project beginning in the 1930s. Expansion activities during the past fifty years include deepening the channels and turning basin to 25 feet (1945), extending the turning basin southward 550 feet (1950), deepening the channels to 35 and 33 feet and enlarging the turning basin (1960), maintenance of locally expanded turning basin to a depth of 25 feet (1986), and authorization for the Port of Palm Beach to deepen the northern side of existing basin from 25 to 33 feet (1992). Palm Beach Harbor has undergone numerous maintenance events in addition to the navigation improvements listed above. The USACE fully expects the Port of Palm Beach and Lake Worth Inlet to remain viable for many years and to continue undergoing maintenance and navigation improvements.

PRESENT ACTIONS IN THE PROJECT AREA

Aside from the proposed navigational improvements for Lake Worth Inlet, concurrent actions in the vicinity of the proposed project that may impact the environment include the completion of the expanded settling basin just north of the north jetty. Environmental effects of this advance maintenance feature were discussed in the January 2012 USACE Palm Beach Harbor Operations and Maintenance Activities Environmental Assessment (EA).

FUTURE ACTIONS IN THE PROJECT AREA

Future without-project actions will include the port's bulkhead improvements in slip 3, as well as deepening slip 3 to the recommended depth. The port continues to look for ways to expand and increase its efficiency. Operation and maintenance to remove shoaled areas and restore project depth facilitate safer navigation are ongoing events. In addition, the Florida Inland Navigation District (FIND) requested authorization through the USACE Regulatory Division to deepen approximately 0.67 miles of the Intracoastal Waterway in Lake Worth Lagoon, north of the Lake Worth Inlet project area. The USACE Regulatory Division estimated the FIND project would directly impact 5.82 acres of seagrass. Other documents which discuss potential actions in the project area include the Florida Department of Environmental Protection (DEP) Strategic Management Plan, and the Inlet Management Plan of Palm Beach.

SUMMARY OF CUMULATIVE EFFECTS ASSESSMENT

Due to efforts to avoid and minimize the environmental impact of each action within the project area and its vicinity, and due to mitigation actions that have been carried out for past projects, and that are likely to be carried out for any future actions, the USACE anticipates that any cumulative impacts due to past and future projects at Lake Worth Inlet/Palm Beach Harbor and within its vicinity are negligible and not significant. See Table 5-11.

Table 5-11: Summary of Cumulative Impacts.

Resources/Issues	Past Actions & Their Effects	Current Maintenance Dredging	Proposed Channel Widening and Deeping Features	Other Present and Reasonably Foreseeable Future Actions & Their Effects
Fish & Wildlife Resources	Stabilization of the inlet by building the north and south jetties allowed increased vessel traffic. Additional hard bottom habitat created along jetties.	Minimal impact on migratory birds with protective measures. Benthic organisms would be impacted during dredging events. Other wildlife temporarily displaced during beach placement.	Construction of new channel width and depth would temporarily impact the benthic community. Minimal impact on migratory birds with protective measures. Other wildlife temporarily displaced during beach placement.	Minimal impact on migratory birds with protective measures. Benthic organisms would be impacted during dredging events. Other wildlife temporarily displaced during beach placement.
Threatened & Endangered Species	Stabilization of the inlet due to the north and south jetties allowed increased vessel traffic.	Minimal effect with use of standard protection measures. Use of clamshell or cutterhead dredge would have minimal effect on sea turtles.	Minimal effect with use of standard protection measures. Use of clamshell or cutterhead dredge would have minimal effect on sea turtles.	Minimal effect with use of standard protection measures. Use of clamshell or cutterhead dredge would have minimal effect on sea turtles.
Essential Fish Habitat	Increased tidal flushing at inlet. No substantial effect on federally managed fish species.	No substantial effect on federally managed fish species with avoidance of resources outside the channels. Benthic organisms temporarily displaced due to dredging of channel and settling basin, but area recolonized after disturbance.	No substantial effect on federally managed fish species with avoidance of resources outside the channels. Benthic organisms temporarily displaced due to dredging, but recolonize area after disturbance.	No substantial effect on federally managed fish species with avoidance of resources outside the channels. Benthic organisms temporarily displaced due to dredging, but recolonize area after disturbance.
Water Quality	Temporary increase in turbidity with past dredging.	Temporary increase in turbidity with past dredging, no significant saltwater intrusion is expected.	Temporary increase in turbidity with past dredging, but less frequently with advance maintenance features, no significant saltwater intrusion is expected.	Temporary increase in turbidity during dredging, no significant saltwater intrusion is expected.

Resources/Issues	Past Actions & Their Effects	Current Maintenance Dredging	Proposed Channel Widening and Deeping Features	Other Present and Reasonably Foreseeable Future Actions & Their Effects
Economics	Construction of navigation channels and stabilization of inlet due to the north and south jetties created a significant positive economic stimulus.	Lake Worth Inlet/Palm Beach Harbor would continue to provide an economic stimulus to the region.	The advance maintenance features would reduce the frequency of maintenance dredging events thereby reducing the impacts to vessels in the navigation channel.	Lake Worth Inlet/Palm Beach Harbor would continue to provide an economic stimulus to the region.
Navigation	Stabilization of the inlet due to the north and south jetties allowed increased vessel traffic and additional recreational opportunities (boating).	Stabilization of the inlet due to the north and south jetties allowed increased vessel traffic and additional recreational opportunities (boating). Temporary impacts to vessel traffic due to annual dredging activities.	Stabilization of the inlet due to the north and south jetties allowed increased vessel traffic and additional recreational opportunities (boating). Temporary impacts to vessel traffic due to construction activities.	Stabilization of the inlet due to the north and south jetties allowed increased vessel traffic and additional recreational opportunities (boating). Temporary impacts to vessel traffic due to annual dredging activities.

5.5.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. Energy used during construction activities would be an irreversible loss. Irreversible loss of resources in certain areas due to widening and deepening of project elements would occur; however, it is proposed to mitigate for those unavoidable losses of sea grasses and hardbottoms within Areas D and G.

An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resources as they presently exist are lost for a period of time. Irretrievable resource impacts would occur such as the walls of the channel but organisms would be expected to recolonize after dredging. This temporal loss would be mitigated for as discussed within the Mitigation Plan Attachment 3, Environmental Appendix D.

5.5.19 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

There would be an unavoidable temporary increase in turbidity levels limited to the waters adjacent to the various construction activities. As previously stated, benthic organisms and common vegetation types within the project area would be temporarily lost due to construction but are expected to recover or be replaced through mitigation as described in Mitigation Plan Attachment 3, Environmental Appendix D.

5.5.20 LOCAL SHORT-TERM USES AND MAINTENANCE OR ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed deepening construction activity is typically of short duration. Adversely affected benthos would be expected to recover in approximately one year. However, benthic species in the direct footprint of the navigation channel may not achieve full recovery since dredging and sand placement occurs on a biennial basis. Most fish species and other motile organisms like crabs should be able to avoid the dredging equipment. Since the project area is limited in size, the long-term productivity of fish and other motile species should not be significantly affected.

5.5.21 INDIRECT EFFECTS

Deepening and widening of the project channel would benefit the shipping industry and local and statewide economies. This may contribute to increased development in adjacent areas.

5.5.22 COMPATIBILITY WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

The Draft Feasibility Report and Environmental Impact Statement were provided to the Florida State Clearinghouse, as well as Federal and local agencies and interested stakeholders to obtain comment and determine compatibility with Federal, state, and local objectives. All comments received were reviewed and incorporated, as appropriate, into the final FR/EIS. A Coastal Zone Management Consistency Determination was prepared as an appendix to the draft document for review by the State of Florida to determine if the project is consistent with the Florida Coastal Management Program. The Consistency Determination is included in the final FR/EIS (See Environmental Appendix D, Attachment 2) as well as the State of Florida's concurrence letter dated June 14, 2013 stating the project is consistent with the Florida Coastal Management Program (See Pertinent Correspondence Appendix E, Attachment 1)

5.5.23 CONFLICTS AND CONTROVERSY

The draft FR/EIS anticipated controversy regarding the level of impacts to natural resources and the means to mitigate for those impacts. During the public review of the draft FR/EIS, many stakeholders requested two locations (Turtle Cove and Little Lake Worth) for seagrass mitigation be removed from the mitigation plan. As a result of the received comments, the USACE removed these locations from consideration and the mitigation plan has been updated accordingly. The USACE has engaged regulatory/resource agencies via various coordination activities in order to alleviate conflicts and controversy, especially over impacts to seagrasses and manatee. The USACE fully supports the National Environmental Policy Act of 1969 and coordination processes directed towards its implementation. The draft FR/EIS also anticipated nearby landowners would be concerned over rock fracturing, or blasting, techniques. A few comments were received from stakeholders concerning blasting techniques, but discussion of blasting was included as part of the draft FR/EIS public presentation. An updated discussion of the potential for blasting is included in the final FR/EIS.

5.5.24 UNCERTAIN, UNIQUE, OR UNKNOWN RISKS

Some mitigation activities may involve uncertainty. For example, reestablishment of seagrasses involves risk of success. However, such risk was taken into account when the acreage of mitigation necessary for compensation was calculated (temporal loss and risk factors affect necessary mitigation), and monitoring will be conducted to ensure success. In addition, the USACE will partner with Palm Beach County Department of Environmental Resource Management (DERM) to complete required mitigation. Palm Beach County DERM has proven successful in previous mitigation and restoration projects within Lake Worth Lagoon. No cultural resources are known within the project footprint or immediately adjacent areas. The "unanticipated finds" clause will be in effect during dredging activities to ensure no cultural resources are impacted as a result of the project. The future rate of Relative Sea Level Rise at Lake Worth Inlet/Palm Beach Harbor is also uncertain and has been discussed in Chapters 2 and 5 as well as Engineering Appendix A in this document.

5.5.25 PRECEDENT AND PRINCIPLE FOR FUTURE ACTIONS

The proposed project is an integral part of the Port's Master/Vision Plan, and as such, land based improvements in infrastructure will be associated with the completion of the recommended plan. Notable future improvements include maintenance and expansion of Port facilities to fulfill intermodal transportation needs as well as maintenance and improvement of existing properties to maintain and expand cargo and passenger throughput. These improvements can be reviewed in the Port's Master Plan (Port of Palm Beach 2006).

5.5.26 ENVIRONMENTAL COMMITMENTS

The USACE and contractors commit to avoiding, minimizing or mitigating for adverse effects during construction activities by including the following commitments in the contract specifications:

1. Standard protective measures for manatees shall be required.

2. The USACE migratory bird protection conditions shall be implemented.

3. The work shall be performed in compliance with state water quality standards as outlined in the Water Quality Certificate, when issued.

4. 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, after receipt of such notice, inform the contracting officer of proposed corrective action and take such action as may be approved. If the contractor fails to comply promptly, the contracting officer would issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions would be granted or costs or damages allowed to the contractor for any such suspension.

5. Air emissions such as vehicular exhaust and dust shall be controlled.

6. The contractor would train his personnel in all phases of environmental protection. The training would include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities to insure adequate and continuous environmental pollution control. Quality control and supervisory personnel would be thoroughly trained in the proper use of monitoring devices and abatement equipment, and would be thoroughly knowledgeable of Federal, State, and local laws, regulations, and permits as listed in the Environmental Protection Plan submitted by the contractor.

7. The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract would be protected during the entire period of this contract. The contractor would confine his activities to areas defined by the drawings and specifications.

8. As stated in the standard contract specifications, the disposal of hazardous or solid wastes would be in compliance with Federal, state, and local laws. A spill prevention plan would also be required.

9. Mitigate as proposed and develop a monitoring plan for the mitigation areas.

10. Develop monitoring and protective measures for endangered, threatened, and protected species for impacts associated with blasting.

11. Abide by the Terms & Conditions in finalized endangered species consultations.

12. Incorporate, to the maximum extent practical and applicable, the best management practices detailed in *Best Management Practices for Construction, Dredge and Fill, and Other Activities Adjacent to Coral Reefs* (PBS&J, 2008), prepared by FDEP in partnership with USACE and other resource agencies under the U.S. Coral Reef Task Force. Best Management Practices specific to project construction will be developed during the PED phase of the project when the project specific plans and specifications are developed. While generalized BMPs can be cited and incorporated in the EIS, the project details needed for specific, effective BMPs are not developed for the project until the PED phase.

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Table 5-12: Future without project (no action) for Economic Environment

Overview - Commodity		Most commodities will experience some growth, with the exception of sugar and molasses.
Overview - Fleet		Number of vessel calls will increase, due to increase in most commodities and existing vessel fleet will remain too draft-constrained to carry them in fewer shipments. Tug assistance will continue to be needed.
Major Commodities		
Liquid Petroleum	Commodity	Growth of diesel and gasoline at 0.6%.
	Fleet	Fuel oil and diesel: Domestic tanker vessel with need for tug assistance.
Sugar and Molasses	Commodity	No growth.
	Fleet	Sugar: Domestic tanker vessel with a great need for tug assistance. Molasses: Self-propelled tanker vessel with a great need for tug assistance. Continue to be draft-constrained and maneuverability difficulties will continue due to width.
Cement	Commodity	Slow but constant over 30 years, returning to pre-recession years by 2015.
	Fleet	Self propelled bulk vessel with a great need for tug assistance. Continue to be draft-constrained and maneuverability difficulties will continue due to width.
Asphalt	Commodity	Slow but constant over 30 years, returning to pre-recession years by 2015.
	Fleet	Domestic tanker vessel with a need for tug assistance, and some small foreign flagged tanker vessels. Continue to be draft-constrained and maneuverability difficulties will continue due to width.
Cruise Ships	Commodity	The Bahamas Celebration could add a second vessel to route and double current passenger capacity. The restriction when winds are greater than 30 knots would not be lifted.
	Fleet	Vessels will be length-constrained due to sharp turn into entrance channel.
Containerized Cargo	Commodity	Post-recession number of container shipments will grow at 3%-3.9% due to demand for goods in Caribbean Islands.
	Fleet	Draft restrictions will limit the size of the vessels to the 1,350-1,500 TEU capacity range.
Non-containerized Cargo	Commodity	1.9% growth rate, based on historical
	Fleet	Draft and length-constrained for largest vessels.

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Table 5-13: Future without project (no action) for Navigation, Built, and Natural Environment

Navigation Environment	
Tides	There will be no significant changes.
Currents	There will be no significant changes.
Sea Level Rise	Future sea level rise rates are expected to 0.39 ft (baseline), 0.83 ft(intermediate) , and 2.24 ft (high).
Storm Surge	Storm surge will continue to be approximately 10 ft in the 100 year storm event.
Navigation restrictions	The amount of vessels will continue to increase in numbers, and will be restricted by light loading, tidal delays, and maneuvering difficulties. These will continue translate into transportation costs to the economy, navigation concerns and safety issues. Continuing maintenance dredging of Palm Beach Harbor as currently authorized would temporarily disrupt vessel traffic due to dredging activities.
Built Environment	
Existing Project	The federal project will remain designed to its current dimensions.
Operation and Maintenance	Additional features for improved advanced maintenance would be constructed for the existing project. Due to the rock that would be dredged, the improved features would be submitted in a new approval plan. Maintenance dredging would continue to occur.
Dredged Material	ODMDS; Nearshore; Peanut Island; Other beneficial use (Beach, Mid-town, dredged holes).
Port Facilities	Port will continue to look for ways to expand. The port has contracts in place to deepen Slip 3 and make improvements to Slip 3 bulkheads. Cruise terminal may service a second, smaller day cruise vessel.
North Jetty	The north jetty will continue to perform its function and may undergo maintenance as needed.
South Jetty	The south jetty will have an inadequate factor of safety until it is further inspected and evaluated for appropriate maintenance needs in the O&M program.
Sand Transfer Plant	The sand transfer plant will continue to pump 160,000 cy of sand per year to the discharge points south of the inlet and it may undergo future maintenance as necessary.
Peanut Island	Peanut Island will continue to be enjoyed by the community for a variety of recreational activities and will continue to provide habitat for wildlife as it does in the existing condition.
Natural Environment	
Vegetation	No direct impacts to vegetation are expected. Seagrass beds adjacent to the existing project limits would be subject to turbidity and sedimentation generated by passing vessels. This turbidity and sedimentation is expected to be greater than current as additional vessels are expected to call in the future.
T&E Species	Effects to protected species discussed in the future are expected to be the same as existing.
Fish and Wildlife	There will be no significant changes
Hardbottom	With continued maintenance of the Federal project, it is expected that temporal impacts to hard bottom communities would continue as described in previous NEPA documents
EFH	Current Federal channel would continue to be dredged and cause temporal impacts to EFH that may have developed as a result of shoaling within the channel. Species potentially found in the project area would not be expected to change.
Coastal Barrier	There are no CBRA units in or near the project area.
Water Quality	Temporary increases in turbidity along and adjacent to the beach disposal site as well as at the dredge sites during maintenance dredging activities.
HTRW	There are no known sources of hazardous, toxic, or radioactive wastes in the dredging area.
Air Quality	Status quo for air quality being maintained, when specifically addressing vessel fleet impacts to air quality
Noise	Short term increase in noise over the existing background level (significant increase in ambient noise levels) due to maintenance dredging.
Aesthetic	Maintenance dredging activities within the Palm Beach Harbor navigation channel would temporarily impact the aesthetics of the area due to presence of dredge equipment
Recreation	Temporary impacts to beach and recreational boating due to maintenance dredging.
Cultural	No impacts from maintenance dredging.
Public Safety	Temporary disruption of recreational vessels and beach recreation during maintenance dredging.

Table 5-14: Future Without-project (no action) compared to Future With-Project (Recommended Plan)

Navigation Environment	Future without-project (no action) for Navigation, Built, and Natural Environment	Recommended Plan
Tides	There will be no significant changes.	The proposed project would not significantly affect tides
Currents	There will be no significant changes.	The proposed project would not significantly affect currents
Sea Level Rise	Future sea level rise rates are expected to 0.39 ft (baseline), 0.83 ft(intermediate) , and 2.24 ft (high).	Future sea level rise rates are expected to 0.39 ft (baseline), 0.83 ft(intermediate) , and 2.24 ft (high).
Storm Surge	Storm surge will continue to be approximately 10 feet in the 100 year storm event.	Storm surge will be increased by 0.328 feet.
Navigation restrictions	The amount of vessels will continue to increase in numbers, and will be restricted by light loading, tidal delays, and maneuvering difficulties. These will continue translate into transportation costs to the economy, navigation concerns and safety issues. Continuing maintenance dredging of Palm Beach Harbor as currently authorized would temporarily disrupt vessel traffic due to dredging activities.	Performing the proposed work would result in safer navigation conditions. Vessel traffic within Palm Beach Harbor and its inlet channel could be temporarily disrupted due to dredging activities.
Built Environment		
Existing Project	The federal project will remain designed to its current dimensions.	The existing project would be modified to include the following dimensions, shown below in Table 5-2.
O&M	Additional features for improved advanced maintenance would be constructed for the existing project. Due to the rock that would be dredged, the improved features would be submitted in a new approval plan. Maintenance dredging would continue to occur.	It is anticipated the additional area in the settling basin and recommended advance maintenance features in the entrance channel would allow for fewer disruptions to navigation traffic due to fewer dredging events as well as shorter durations of navigation restrictions due to shoaling.
Dredged Material	ODMDS; Nearshore; Peanut Island; Other beneficial use (Beach, Mid-town, dredged holes).	ODMDS; Nearshore; Peanut Island; Other beneficial use (Beach, Mid-town, dredged holes).
Port Facilities	Port will continue to look for ways to expand. The port has contracts in place to deepen Slip 3 and make improvements Slip 3 bulkheads. Cruise terminal may service a second, smaller day cruise vessel.	The Port will move forward with its improvements in anticipation of the additional growth that will come along with the Federal project expansion.
North Jetty	The north jetty will continue to perform its function and may undergo maintenance as needed.	The north jetty slope stability would be impacted as a result of the improved advance maintenance plan's deeper depths in conjunction with the recommended plan , but the sheet pile wall, included as part of the overall recommended plan, will stabilize the jetty.
South Jetty	The south jetty will have an inadequate factor of safety until it is further inspected and evaluated for appropriate maintenance needs in the O&M program.	There will be no change in the south jetty as a result of the project.
Sand Transfer Plant	The sand transfer plant will continue to pump 160,000 cy of sand per year to the discharge points south of the inlet and it may undergo future maintenance as necessary.	The sand transfer plant will continue to pump 160,000 cy of sand per year and may undergo future maintenance when necessary.
Peanut Island	Peanut Island will continue to be enjoyed by the community for a variety of recreational activities and will continue to provide habitat for wildlife as it does in the existing condition.	It is not intended, nor expected, that this project would affect the physical attributes, economic benefits, recreational enjoyment by the community, and wildlife habitat associated with Peanut Island.
Natural Environment		
Vegetation	No direct impacts to vegetation are expected. Seagrass beds adjacent to the existing project limits would be subject to turbidity and sedimentation generated by passing vessels. This turbidity and sedimentation is expected to be greater than current as additional vessels are expected to call in the future.	Construction of the recommended plan would permanently remove approximately 4.5 acres of seagrass communities.
T&E Species	Effects to protected species discussed in the future are expected to be the same as existing.	The Recommended Plan may adversely affect Johnson's seagrass within the action areas due to the following adverse impacts : direct effect of blasting and dredging activities as well as indirect effects. The proposed project may affect, but is not likely to adversely affect; the green turtle, loggerhead turtle, Kemp's Ridley turtle, Hawksbill turtle, leatherback turtle, west Indian manatee, humpback whale, sperm whale, and smalltooth sawfish.
Fish and Wildlife	There will be no significant changes	Temporary impacts are expected during construction, but no significant long term impacts are expected.
Hardbottom	With continued maintenance of the Federal project, it is expected that temporal impacts to hard bottom communities would continue as described in previous NEPA documents	Widening of the channel and turning basin would result in the direct removal of approximately 5 acres of hardbottom habitat in Areas C, D, and G. Benthic communities in the impact area are comprised of mainly sponge and hydroid species. Direct habitat loss to previously unimpacted hardbottom assemblages associated with dredging would be permanent.
EFH	Current Federal channel would continue to be dredged and cause temporal impacts to EFH that may have developed as a result of shoaling within the channel. Species potentially found in the project area would not be expected to change.	The recommended plan would impact EFH including removal of seagrass and hardbottom habitat. Permanent impacts to EFH include the seagrass and hardbottoms in Areas C, D, and G. Temporal impacts to hardbottoms would occur due to the widening of the channel in Area B, but these species would recolonize the new channel walls within approximately one year.
Coastal Barrier	There are no CBRA units in or near the project area.	There are no CBRA units in or near the project area.
Water Quality	Temporary increases in turbidity along and adjacent to the beach disposal site as well as at the dredge sites during maintenance dredging activities.	The recommended plan would cause temporary increases in turbidity where dredging is taking place; however, it is not anticipated that dredging will improve or degrade existing water quality conditions in the port area in the long-term.
HTRW	There are no known sources of hazardous, toxic, or radioactive wastes in the dredging area.	There are no known sources of hazardous, toxic, or radioactive wastes in the dredging area.
Air Quality	Status quo for air quality being maintained, when specifically addressing vessel fleet impacts to air quality	The project allows for a shift from smaller, less efficient ships; to larger, more efficient ships carrying more cargo without increasing the overall number of vessel calls. No significant impacts to air quality are expected.
Noise	Short term increase in noise over the existing background level (significant increase in ambient noise levels) due to maintenance dredging.	Construction of the proposed expanded navigation channel and turning basin would result in a short term increase in noise over the existing background level.
Aesthetic	Maintenance dredging activities within the Palm Beach Harbor navigation channel would temporarily impact the aesthetics of the area due to presence of dredge equipment	Construction activities within the Palm Beach Harbor navigation channel would temporarily impact the aesthetics due to presence of the dredge equipment within the project area. This temporary impact would be similar to that of typical operations and maintenance dredging, but of longer duration (up to two years).
Recreation	Temporary impacts to beach and recreational boating due to maintenance dredging.	There would be temporary impacts to recreational boating during construction of the Recommended Plan, similar to that of normal maintenance dredging. Construction of the Recommended Plan would be of longer duration (up to two years) than typical maintenance dredging; thereby impacting recreational boating for a longer period of time. Vessel traffic would also be temporarily disrupted due to construction activities.
Cultural	No impacts from maintenance dredging.	A determination that no historic properties would be affected by the proposed project
Public Safety	Temporary disruption of recreational vessels and beach recreation during maintenance dredging.	Vessel traffic within Palm Beach Harbor and its inlet channel could be temporarily disrupted due to dredging activities. Performing the proposed work would result in safer navigation conditions.

6.0 ENVIRONMENTAL COMPLIANCE

LAKE WORTH INLET

Palm Beach Harbor

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6 ENVIRONMENTAL COMPLIANCE

This chapter shows the study coordination of the recommended (NED) plan is in compliance with all environmental requirements and the process has been shared with the public at the required intervals, through the National Environmental Policy Act (NEPA). Additionally, it shows how the recommended plan meets USACE environmental operating principles.

6.1 SCOPING AND ISSUES – NEPA PUBLIC MEETINGS

In accordance with the NEPA, an information letter was sent to interested parties on December 6, 2007. A Notice of Intent (NOI) was published in the Federal Register (Volume 72, No 239: Pages 70825-70826) December 13, 2007 to advertise the intent of USACE to write an Environmental Impact Statement. A public meeting was held January 9, 2008 at the Port of Palm Beach to discuss the proposed project. Written comments from Federal, state, and local governmental agencies, various private and non-profit organizations, and individuals are included in Pertinent Correspondence Appendix E, Attachment 1 along with the official responses from USACE.

Federal agencies invited to attend meetings and provide comments throughout the scoping and public involvement process included the USACE, U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS). State agencies included the Florida Department of Environmental Protection (FDEP), Florida Fish and Wildlife Conservation Commission (FFWCC), State Historic Preservation Office (SHPO), and the Florida Department of Transportation (FDOT).

The Notice of Availability (NOA) of the Draft Feasibility Report and Environmental Impact Statement (FR/EIS) was published in the Federal Register (Volume 78, No 76: Page 23558) April 19, 2013 to initiate the 45 day public review comment period. A public meeting was held May 9, 2013 at the Port of Palm Beach to present the tentatively selected plan described in the Draft FR/EIS. Comments received during at the public meeting and during the public review period are included in the Appendix E, Pertinent Correspondence. Comments and USACE responses are summarized in a table at the start of the Correspondence Appendix.

6.2 COOPERATNG AGENCIES

Agencies were invited to participate in the study as cooperating agencies under NEPA by letter dated February 22, 2008. NOAA NMFS accepted with limited participation; USFWS and Palm Beach County Department of Environmental Resources Management declined; and FDEP Bureau of Beaches and Coastal Systems and FFWCC both declined the invitation. Copies of correspondence regarding being a cooperating agency under NEPA can be found in Pertinent Correspondence Appendix E, Attachment 1.

6.3 PUBLIC INVOLVEMENT, VIEWS, AND RESPONSES

A Scoping Letter, dated December 6, 2007, was mailed to interested stakeholders and the NOI to prepare an EIS was published in the Federal Register December 13, 2007. A scoping meeting was held January 9, 2008 at the Port of Palm Beach. The transcript of the scoping meeting and

all correspondence are included in Pertinent Correspondence Appendix E, Attachment 1. An NOA letter, dated April 19, 2013, was mailed or emailed to interested stakeholders for the Draft FR/EIS. The transcript for the May 9, 2013 public meeting is included in Pertinent Correspondence Appendix E. In addition to the transcript, comment cards from the public meeting and correspondence received during the public review period are also included.

6.4 LIST OF RECIPIENTS

The draft EIS was made available to appropriate stakeholders and agencies as well as placed on the internet. A list of stakeholders who received notification is included within Pertinent Correspondence Appendix E.

6.5 COMMENTS RECEIVED AND RESPONSE

Comments received during scoping included the following issue, as summarized: impacts to seagrass, hardbottom, coral, mangrove, essential fish habitat, migratory birds, manatees, sea turtles, boating, diving, snorkeling, erosion of the shoreline, further interruption of sand flow across the inlet, storm surge, public safety, property values, quality of life, commerce, future of the Port, and the economy. The transcript of the scoping meeting is included in Pertinent Correspondence Appendix E, Attachment 1.

Comments received during scoping and associated responses can be found in Pertinent Correspondence Appendix E. Comments received during the review period for the Draft FR/EIS can be found in Pertinent Correspondence Appendix E, Attachment 1. A table summarizing comments received on the Draft FR/EIS and USACE responses is also included at the start of the appendix.

Comments received during the Draft FR/EIS comment period included the following issues, as summarized: opposition to the use of Little Lake Worth and Turtle Cove for seagrass mitigation, concerns over potential effects on the Blue Heron Bridge dive site, concerns for construction duration and potential effects on navigation and recreational boating, clarification of economic discussions, storm surge, and potential effects on nearby infrastructure as a result of the proposed widening.

6.6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

NATIONAL ENVIRONMENTAL POLICY ACT of 1969

Environmental information on the project has been compiled and this Environmental Impact Statement (EIS) has been prepared. The draft EIS was circulated for review by NOA in the Federal Register April 19, 2013. All correspondence has been included as Pertinent Correspondence Appendix E. The project is in compliance with the National Environmental Policy Act (NEPA).

ENDANGERED SPECIES ACT of 1973

Consultation was initiated with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) upon completion and submittal of the Biological Assessments (BA), Pertinent Correspondence Appendix E. A concurrence with the USACE's finding of not likely to adversely affect species under USFWS jurisdiction was received on December 12, 2012. A Biological Opinion from the NMFS was received November 7, 2013 (See Pertinent Correspondence Appendix E, Attachment 1). This project has been fully coordinated under the Endangered Species Act (ESA) and is therefore in compliance with the Act.

FISH & WILDLIFE COORDINATION ACT of 1958

This project has been coordinated with the USFWS. A Coordination Act Report is included as part of the coordination with USWFS under ESA. The USFWS stated (by letter dated December 12, 2012) the SPBO satisfies the requirements under the Fish and Wildlife Conservation Act (FWCA). The USACE will continue to coordinate future actions with the USFWS. The project is in compliance with the Act.

NATIONAL HISTORIC PRESERVATION ACT of 1966 (*INTER ALIA*)

USACE determined that no historic properties will be affected by the proposed action. Federal undertakings will comply with the Archeological and Historical Preservation Act of 1974 (16 USC 469-469c); Executive Order 11593, the Abandoned Shipwreck Act of 1987 (PL 100-298; 43 U.S.C. 2101-2106); the National Historic Preservation Act of 1966, as amended (16 USC 470); and the Advisory Council on Historic Preservation's implementing regulations under 36CFR800 (*Protection of Historic Properties*). Section 106 of the National Historic Preservation Act requires federal agencies to provide the SHPO (as agent to the Advisory Council on Historic Preservation) reasonable opportunity to evaluate and comment on any federal undertaking. The Act requires the agency to coordinate with SHPO whether or not the agency believes there would be impacts to significant historic resources. The project is in compliance with each of these Federal laws. Consultation with the Florida State Historic Preservation Officer (SHPO), appropriate federally recognized tribes, and other interested parties was initiated July 20, 2012. Consultation with the Florida SHPO, appropriate federally recognized tribes, and other interested parties has been completed for the proposed project. The SHPO concurred with the USACE determination of no effect to historic or archaeological properties by letter dated November 20, 2013. A copy of the letter(s) indicated above has been placed in Pertinent Correspondence Appendix E, Attachment 1.

CLEAN WATER ACT of 1972

The project will be in compliance with this Act. A Section 401 water quality certification will be obtained prior to construction. All state water quality standards will be met. A Section 404(b) evaluation is included within Environmental Appendix D, Attachment 1 of this document

because materials are proposed to for deposition for mitigation as well as at the Ocean Dredged Material Disposal Site (ODMDS).

CLEAN AIR ACT of 1972

The short term impacts from dredge emissions and other construction equipment associated with the project would not significantly impact air quality. No air quality permits are required for this project. Palm Beach County is designated as an attainment area for Federal air quality standards under the Clean Air Act (CAA). The U.S. Environmental Protection Agency's (USEPA) General Conformity Rule to implement Section 176(c) of the CAA does not apply and a conformity determination is not required because the project is located within an attainment area. This project was coordinated with the USEPA during the public review period and is in compliance with Section 309 of the Act.

COASTAL ZONE MANAGEMENT ACT of 1972

In accordance with the Coastal Zone Management Act, a Federal Consistency Determination (CD) was prepared and included in Environmental Appendix D, Attachment 2. The Federal CD is coordinated with Florida Department of Environmental Protection (FDEP) as part of the Draft EIS review. The project is in compliance with this Act. The State of Florida determined the Draft FR/EIS and CD are consistent with the Florida Coastal Management Program (FCMP) by letter dated June 14, 2013. To ensure the project's continued consistency with the FCMP, the concerns identified by the reviewing agencies must be addressed prior to project implementation. 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 be determined during the state's environmental permitting process, in accordance with Section 373.428, *Florida Statutes*.

FARMLAND PROTECTION POLICY ACT of 1981

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable.

WILD AND SCENIC RIVER ACT of 1968

No designated wild and scenic river reaches would be affected by project related activities. This Act is not applicable.

MARINE MAMMAL PROTECTION ACT of 1972

The Marine Mammal Protection Act (MMPA) prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) directs the Secretary of Commerce (Secretary) to allow, upon request, the

incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issue or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings are set forth. NMFS has defined "negligible impact in 50 CFR 216.103 as: "an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance which has the potential to: (i) injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). An Incidental Harassment Authorization (IHA) may be issued, except for activities that have the potential to result in serious injury or mortality (i.e., it may only authorize Level A and B harassment), for a period of no more than one year, following a 30-day public review period. Alternatively, regulations may be granted for a period of five years and may include takes by serious injury and mortality. Upon rulemaking (i.e., defining regulations), Letters of Authorization (LOAs) will be issued to the authorization holder. The rulemaking and associated LOAs cannot be valid for a period of more than five consecutive years. For both an IHA and regulations, authorization shall be granted if the Secretary finds that the taking will have a negligible impact on a species or stock, and that the IHA or regulations are prescribed setting forth the permissible methods of taking, the means of effecting the least practicable adverse impact, and requirements pertaining to monitoring and reporting.

Protective measures for marine mammals such as manatees and dolphins would be implemented during construction activities as outlined in coordination documents with USFWS and NMFS included in Pertinent Correspondence Appendix E. Additional information can be found in Chapter 5 of this report. This project has been coordinated with the USFWS and NMFS. The project will be in compliance with this Act.

ESTUARY PROTECTION ACT of 1968

No designated estuary would be affected by project activities. This Act is not applicable.

FEDERAL WATER PROJECT RECREATION ACT

Recreation opportunities and potential impacts to current recreation were considered during the planning processes for this study. Although the Lake Worth Inlet/Palm Beach Harbor entrance provides recreational benefits, the principles of this Act (Public Law 89-72) as amended, are not applicable to this project.

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 of Florida and is in compliance with the Act.

COASTAL BARRIER RESOURCES ACT and COASTAL BARRIER IMPROVEMENT ACT of 1990

There are no designated coastal barrier resources in the project area that will be affected by this project. These Acts are not applicable.

RIVERS AND HARBORS ACT of 1899

The proposed work would not obstruct navigable waters of the United States. The project is in compliance with this Act.

ANADROMOUS FISH CONSERVATION ACT

Anadromous fish species would not be affected. The project is being coordinated with NMFS and is in compliance with the Act.

MIGRATORY BIRD TREATY ACT and MIGRATORY BIRD CONSERVATION ACT

No migratory birds will be affected by project activities. The USACE standard MBPP will be used to minimize potential impacts to migratory birds. The project is in compliance with these Acts.

MARINE PROTECTION, RESEARCH and SANCTUARIES ACT (OCEAN DUMPING ACT)

The term "dumping" as defined in the Act [3(33 U.S.C. 1402) (f)] does not apply 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 as currently proposed, however if any of the dredged material is disposed in the ODMDS, then this Act would apply. Concurrence from EPA under Section 103 of the Act would be required along with any required testing of the material for suitability for ocean dumping. More information on the ODMDS site can be found in the Final Environmental Impact Statement for the Designation of the Port Everglades and Palm Beach ODMDS's prepared by EPA and completed in July 2004. The disposal activities addressed in this EIS have been evaluated under Section 404 of the Clean Water Act.

MAGNUSON-STEVENS FISHERY CONSERVATION and MANAGEMENT ACT

The USACE has determined that the project would not have a significant adverse impact on EFH or federally managed fish species occurring along the east-central coast of Florida. The EFH Assessment has been integrated within the draft EIS and is being coordinated with NMFS during the normal NEPA coordination as per the May 3, 1999, Statement of Findings between NMFS and the USACE, Jacksonville District. The project is in compliance with this Act.

EXECUTIVE ORDER (EO) 11990, PRTOECTION of WETLANDS

No wetlands would be affected by project activities. The proposed project is in compliance with the goals of this Executive Order (E.O.).

E.O 11988, FLOOD PLAIN MANAGEMENT

The proposed project would have no adverse impacts to flood plain management and is in compliance with the goals of this E.O.

E.O. 12898, ENVIRONMENTAL JUSTICE

The purpose of the proposed action is to provide increased safety, efficiency, and lower costs for navigation while protecting the environment. The proposed activity would not (a) exclude persons from participation in, (b) deny persons the benefits of, or (c) subject persons to discrimination because of their race, color or national origin, nor would the proposed action adversely impact "subsistence consumption of fish and wildlife." The proposed project would benefit shipping and the general economy including minority and low income populations. Furthermore, construction activities and any additional trucking/commerce that would be due to the project is not anticipated to disproportionately affect economically disadvantaged residential areas or persons belonging to minority groups. Construction traffic and logistic traffic use commercial traffic routes immediately adjacent to the Port, including U.S. Highways and Interstate highways. Construction activities and any additional trucking/commerce that would be due to the project are not expected to disproportionately affect economically disadvantaged residential areas of persons belonging to minority groups. The proposed project is in compliance with the goals of this E.O.

E.O. 13089, CORAL REEF PROTECTION

This project would not impact those species, habitats, and other natural resources associated with coral reefs as defined in the E.O. The USACE has minimized the impacts to hardbottom resources within the proposed widening footprint. Compensatory mitigation for impacts to hardbottoms is included in project plans and cost estimates. The mitigation plan is included as Environmental Appendix D, Attachment 3. The proposed project is in compliance with the goals of this E.O.

E.O. 13112, INVASIVE SPECIES

This project would not introduce or affect the status of any invasive species and is therefore in compliance with the goals of this E.O.

E.O. 13045, PROTECTION of CHILDREN

This E.O. requires each Federal agency to "identify and assess environmental 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." This project has no environmental or safety risks that may disproportionately affect children and is in compliance.

E.O. 13186, MIGRATORY BIRDS

The proposed project would not cause the destruction of migratory birds, their eggs, or hatchlings. The proposed project is in compliance with the goals of this E.O.

6.7 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with NEPA, the USACE has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose on environmental issues and ensure that environmental conservation, preservation, and restoration are considered in all USACE activities.

Sustainability can only be achieved by the combined efforts of Federal agencies, tribal, state and local governments, and the private sector, each doing its part, backed by the citizens of the country. These principles help USACE define its role in that endeavor. USACE Environmental Operating Principles are:

1. Foster sustainability as a way of life throughout the organization.

Throughout the planning process, the team strived for minimization of impacts to the surrounding environment and will mitigate for any losses within as close a proximity to the area of loss as possible to maintain the same level of quality of the environment.

2. Proactively consider environmental consequences of all Corps activities and act accordingly.

Throughout the planning process, the interdependence of the built environment, navigation environment, economics environment, and living environment remained evident and each project measure was carefully considered for all elements.

3. Create mutually supporting economic and environmentally sustainable solutions.

The project uses dredged material to restore seagrass beds in formerly dredged holes, thus keeping material within the system. While the project is required to mitigate for a certain amount of acreage, there is potential to use as much project material as allowable to fill the dredged holes more to create more even more seagrasses, thus using the project to support the environment. Although quarry rock is proposed currently for hardbottom mitigation, there may still be potential to use native rock from the project to create reefs, if it meets required state standards. Beach quality sand from dredging operations will be placed on the nearshore to support the natural systems and add to human recreational opportunities.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.

Each element of human health, welfare, and viability of natural systems was thoroughly assessed throughout this report in a responsible manner.

5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

Cumulative impacts to the environmental were thoroughly assessed in this report and any impacts have been thoroughly evaluated with a fair mitigation plan.

6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.

The USACE collected a great deal of information throughout the preparation of this study which has been thoughtfully prepared and organized in a manner so as to facilitate a greater knowledge base about the area, its challenges, and the opportunities which can be achieved.

7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activites.

The USACE worked with many agencies, individuals, and groups throughout this study, sharing scientific, economic and social information and exchanging ideas for the betterment of a design that will find solutions to the problem while maintaining the level of quality within the surrounding environment.

ODDESSEY YACHT

7.0 RECOMMENDATIONS

7 RECOMMENDATIONS

I concur with the findings presented in this report. The recommended plan developed is technically sound, economically justified, and socially and environmentally acceptable.

The work proposed is not within existing authority. I recommend that the plan selected herein, widening by the proposed footprint and deepening to a project depth of 39 feet mean lower low water (MLLW) in the inner harbor and 41 feet MLLW in the entrance channel, with improved advance maintenance features, be authorized by Congress for implementation. Mitigation compensation for seagrasses will be required and is not expected to exceed 11.25 acres of beneficial dredge material placement based on conservative calculations completed by USACE using the HEA model; mitigation compensation for hardbottom will be required and is not expected to exceed 11.25 acres of artificial reef creation based on conservative calculations completed by USACE using the HEA model. Relocation, establishment, and disestablishment of aids to navigation are to be funded by the United States Coast Guard.

The total estimated cost of the project, including the cost of aids to navigation, is $88,556,000. The average annual costs were determined to be $3,960,000 and average annual benefits were $7,940,000, with a benefit to cost ratio of 2.0 to 1. Average annual net benefits are $3,980,000.

The total project first cost, which does not include the cost of aids to navigation, is $88,531,000, with a Federal share of $66,393,000 and a non-federal share of $22,138,000.

The recommended plan conforms to the essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines on project development. If the project were to receive funds for Federal implementation, it would be implemented subject to the cost sharing, financing, and other applicable requirements of Federal law and policy for navigation projects including WRDA 1986, as amended; and would be implemented with such modifications, as the Chief of Engineers deems advisable within his discretionary authority. Aids to navigation are to be funded by the U.S. Coast Guard. Federal implementation is contingent upon the non-federal sponsor agreeing to comply with applicable Federal laws and policies. Prior to implementation, the non-federal sponsor shall agree to:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for commercial navigation equal to:

(1) 25 percent of the cost of design and construction of the GNFs.

b. Provide all lands, easement, and rights-of-way (LER), including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, all as determined by the Government to be necessary for the construction or operation and maintenance of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Government for the value of the LER and relocations, including utility relocations, provided by the non-Federal sponsor for the GNFs. If the amount of credit afforded by the Government for the value of LER, and relocations, including utility relocations, provided by the non-Federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNFs, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the Government, the local service facilities 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 Government;

e. In the case of project features greater than -45 feet MLLW in depth, provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Government determines would be incurred for operation and maintenance if the project had a depth of 45 feet;

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

g. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

h. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

i. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LER that the Federal Government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigation 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;

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

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

l. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law99-662, as amended, (33 U.S.C. 2211(e)) 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;

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

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, PL 88-352 (42 USC 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive changes the provision 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);

o. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of 1 percent of the total amount authorized to be appropriated for the project; and

p. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project costs unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

q. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government.

r. Mitigation monitoring during construction and post construction shall be cost shared between the Federal government and non-federal sponsor, 75% and 25%, respectively.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the State of Florida, the Port of Palm Beach (the non-Federal sponsor), interested Federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

22 AUG 2013
Date

Alan M. Dodd
Colonel, U. S. Army
District Commander

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LAKE WORTH INLET
Palm Beach Harbor

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9.0 REFERENCES, INDEX, AND GLOSSARY

BULK CARRIER – POWER PLANT MODULES

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GLOSSARY

(NED Manual for Deep Draft Navigation, IWR Report 10-R-4, April 2010; ERDC Overdepth Dredging and Characterization Depth Recommendations, June 2007)

A

Advance Maintenance - Advance maintenance is dredging to a specified depth and/or width beyond the authorized channel dimensions in critical and fast shoaling areas to avoid frequent re-dredging and ensure the reliability and least overall cost of operating and maintaining the project authorized dimensions. For maintenance dredging of existing projects, Division Commanders are authorized to approve advance maintenance based on written justification. For new navigation projects, advance maintenance is approved as part of the feasibility report review and approval process based on justification provided in the feasibility report.

Affected environment - Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Air quality - Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Allisions - When a moving vessel strikes a fixed object.

Anthropogenic - Human-created.

Aquatic - Living or growing in or on the water.

Associated Costs - Any public or private Federal or non-federal expenditures on general navigation features ancillary to the project necessary to achieve estimated benefits or traffic levels for each project alternative.

Authorization - An act by the Congress of the United States which authorizes use of public funds to carry out a prescribed action.

Authorized Dimensions - Authorized dimensions are the depth and width of the channel authorized by Congress to be constructed and maintained by USACE. These authorized channel dimensions are generally based on maximizing net transportation savings considering the characteristics of vessels using the channel and include consideration of safety, physical conditions, and vessel operating characteristics. For entrance channels from the ocean into harbors, the authorized dimensions often include an additional allowance of safety for wave action for that portion of the channel crossing the ocean bar. For example, a 45-ft entrance channel may have an authorized 47-ft depth over the ocean bar.

Average Annual Equivalent - A discounting technique that converts a stream of unequal payments into an equivalent stream of equal payments, where both streams have the same present value. This is different from average annual because average annual does not amortize the total present value, but rather it averages the value.

B

Backhaul -'Backhaul' cargo refers to cargo that is on a vessel's return trip.

Bale Capacity - Capacity of a vessel based on standardized cubic measure for cargo and stowage.
Ballast - Water that is held in the bottom of a ship to prevent the ship from capsizing.

Baseline Condition - A scenario from which project impacts can be measured, i.e., a point of reference.

Bathymetry - Measurement of water depth.

Beam - The beam of a ship is its width at its widest point. Vessel beams are an important factor determining the width of channels.

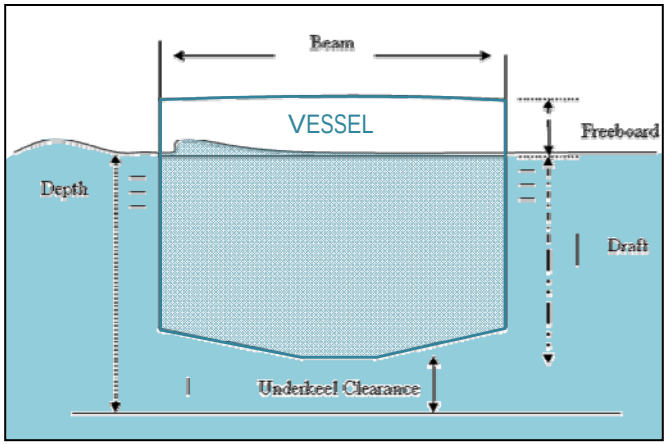


Figure 1: Vessel Diagram

Benefit-Cost Analysis - An analytical method for comparing the positive (benefits)and negative (costs) impacts of an action.

Benefit-Cost Ratio (BCR) - The ratio of discounted project benefits to discounted project costs. BCR's are less than one when a project's costs exceed its benefits.

Benthic - Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.

Berth - A space where vessels come to dock or set anchor.

Best Management Practice (BMP) - The best available technology or process that is practical and achieves the desired goal or objective.

Biodiversity - The number of different species inhabiting a specific area or region.

Biological opinion - Document issued under the authority of the Endangered Species Act stating the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service (NMFS) finding as to whether a Federal action is likely to jeopardize the continued existence of a threatened or

endangered species or result in the destruction or adverse modification of critical habitat. This document may include:

Critical habitat - A description of the specific areas with physical or biological features essential to the conservation of a listed species and which may require special management considerations or protection. These areas have been legally designated via Federal Register notices.

Jeopardy opinion - The U.S. Fish and Wildlife Service or NMFS opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The finding includes reasonable and prudent alternatives, if any.

No jeopardy opinion - U.S. Fish and Wildlife Service or NMFS finding that an action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat.

Bow - The bow of the ship refers to the forward part of a vessel.

Breakwater - Structures designed to provide shelter from waves and improve navigation conditions. Such structures may be combined with jetties where required.

Bulk Carriers - Ships designed to carry dry or liquid bulk cargo. Category includes: ore/bulk/oil carriers (OBO) and other combination bulk/oil carriers.

Bulkhead - Similar to a seawall, it is a constructed barrier in the water.

C

Call - This denotes when a ship is coming to visit a port and berth.

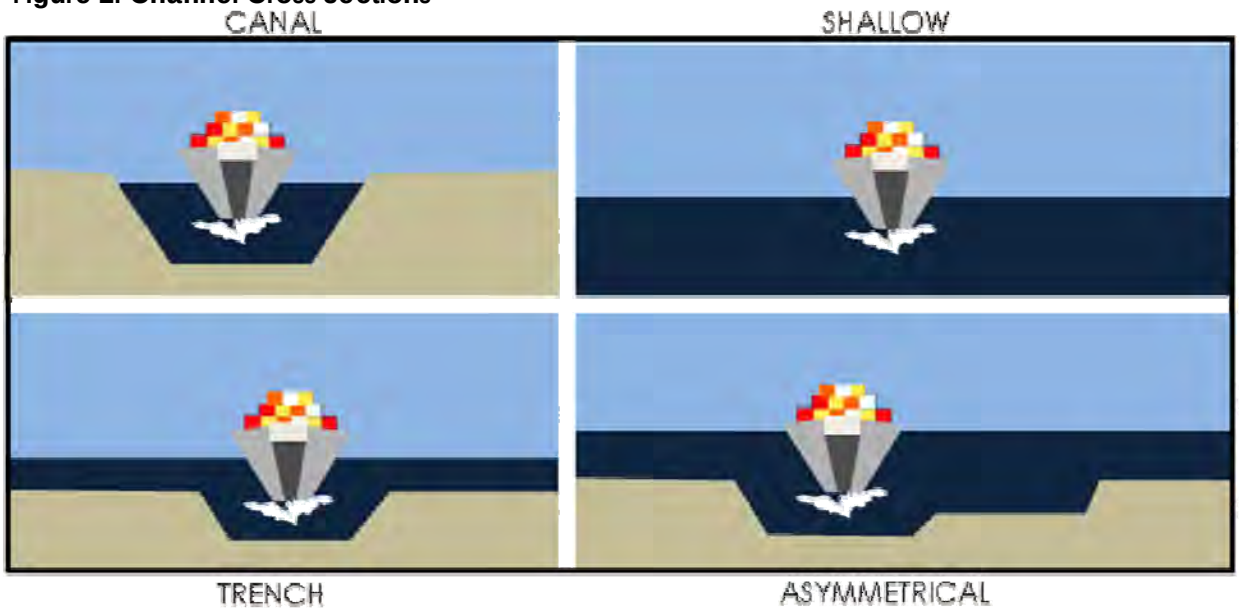
Candidate species - Plant or animal species not yet officially listed as threatened or endangered, but which is undergoing status review by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Catch - At a recreational fishery, refers to the number of fish captured.

Channel - A natural or man-made deeper course through a reef, bar, bay, or any shallow body of water, often used by ships; natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Channel, entrance – A navigable channel connecting the ocean or lake to an enclosed water body such as a bay, estuary, river, or mouth of a navigable stream; often requires extra depth due to wave conditions.

Figure 2: Channel Cross Sections



Climax community (referring to seagrasses) - The final stage of biotic succession attainable by a plant community in an area under the environmental conditions present at a particular time. The species composition of the climax community remains the same because all of the species present successfully reproduce themselves and invading species fail to gain a foothold. The climax stage is not completely permanent because climatic changes, ecological processes, and evolutionary processes cause changes in the environmental over very long periods of time.

Collision - When two moving vessels strike each other.

Container Vessels - Ships equipped with permanent container cells that hold containers.

Cooperating agency - This is defined as an agency that meets the following criteria: (1) is included in 40 CFR Chapter V, Council on Environmental Quality (CEQ) Rules and Regulations, Appendix 1 - Federal and Federal-State agency National Environmental Policy Act (NEPA) contacts; and/or (2) has study area-wide jurisdiction by law or special expertise on environmental quality issues; (3) has been invited by the lead agency to participate as a cooperating agency; and (4) has made a commitment of resources (staff and/or funds), for regular attendance at meetings, participation in workgroups, in actual preparation of portions of the programmatic environmental impact statement (PEIS), and in providing review and comment on activities associated with the PEIS as it progresses. The role of the cooperating agency is documented in a formal memorandum of agreement with the lead agency.

Cost Reduction Benefits - Project benefits which result from a decrease in the cost of shipping commodities that reflect the same origin-destination pattern and harbor in all project conditions.

Critical Parameters - Those analytical factors that are the major determinants of the level of project benefits and costs.

Cryptic species (relating to hardbottom habitat) - Cryptic species are two or more distinct species that were classified as a single species due to their morphological similarity.

Cubic feet per second - A measure of the volume rate of water movement. As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 meter /second (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

D

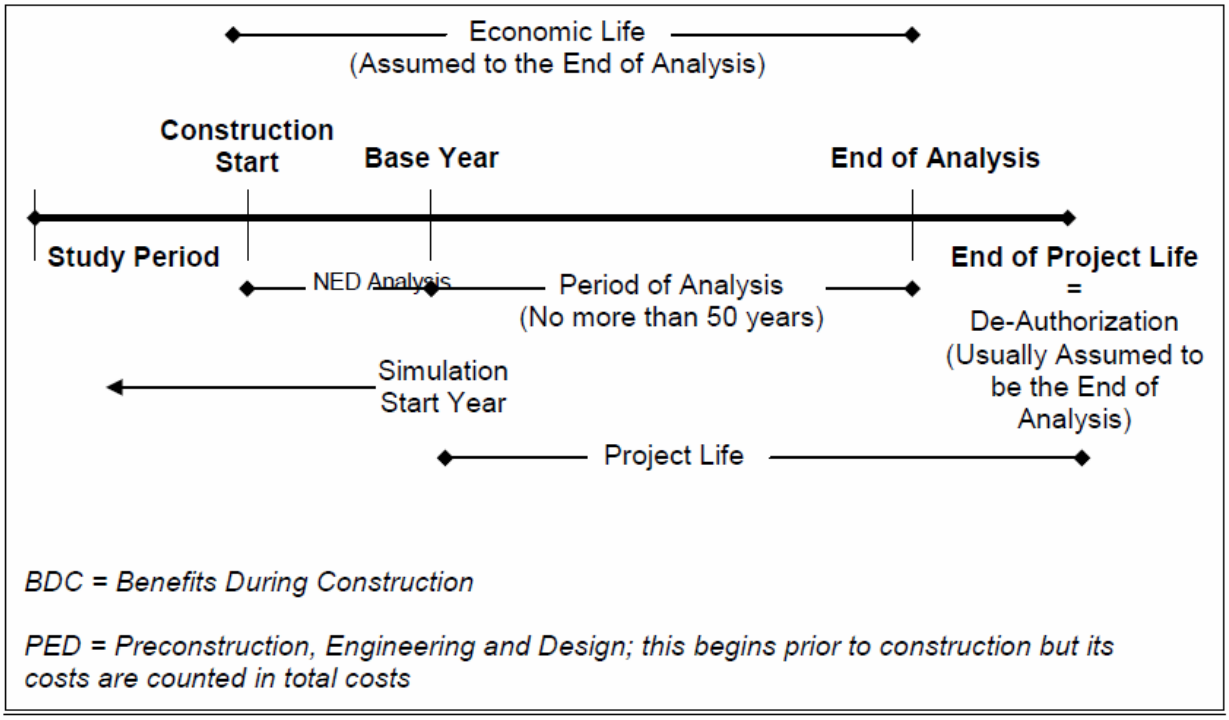
Design Vessel - A prototypical vessel configuration that is used for evaluation of design specification of a navigation feature.

Diurnal - Having a period or cycle approximately 1 tidal day. Thus, the tide is considered diurnal when only one high water and one low water occur during a tidal day, and the tidal current is considered diurnal when there is a single flood and single ebb period in the tidal day.

Discount Rate - The interest rate used to convert a flow (benefits or costs) into an equivalent stock (Present Value).

Discounting - A procedure which adjusts the value of a stream of benefits or costs to reflect the time value of money. Discounting converts a flow into an equivalent stock at some point in time. This stock is called the present value of the flow discounted at interest rate r.

Figure 3: Planning Cycle.



Dissolved oxygen (D.O.) - A commonly employed measure of water quality.

Draft or Draught - The draft (or draught) of a vessel is one of the most common pieces of information used in Corps navigation studies and can be defined as the distance between the waterline and the bottom of the ship's hull (keel) (see Figure 1). In other words, it is the amount of water needed to for a ship to navigate safely. Channel deepening projects generally require a thorough analysis of vessel drafts. There is an important distinction between a vessel's design draft and its operating draft. The design draft of a vessel is the maximum draft a vessel could potentially reach fully loaded whereas the operating draft (as required for most Corps studies) examines the typical draft that is employed since it is rare that vessels will sail at their maximum design draft

DWT (Deadweight Tonnage) - The carrying capacity of a vessel in tons (most references now show metric tons). It is the difference between the light and loaded displacement (weight of the ship itself versus ship plus cargo, fuel, stores and water).

E

Ecosystem - The complex system of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an ecological unit..

Endangered species - Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion of its range. Federally endangered species are officially designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register.

Environmental consequences - The impacts to the Affected Environment that are expected from implementation of a given alternative.

Environmental Impact Statement (EIS) - An analysis required by the National Environmental Policy Act for all major federal actions, which evaluates the environmental risks of alternative actions.

Estuary - A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Existing Condition - A description of the project setting based on present conditions; it simply describes "what is" at the time the analysis is undertaken.

Extreme High Water - The highest elevation reached by the sea as recorded by a tide gauge during a given period.

Extreme Low Water - The lowest elevation reached by the sea as recorded by a tide gauge during a given period.

Exotic species - Introduced species not native to the place where they are found.

F

Feasibility study - The second phase of a project. The purpose is to describe and evaluate alternative plans and fully describe recommended project.

Feedermax Vessel - A cellular containership that holds about 500 to 1,000 TEUs.

FEU (Forty-foot equivalent unit) - This is a 40 X 8 X 8.5 feet dry cargo intermodal container used as a measurement of container volume. See also TEU, twenty-foot equivalent-unit. One FEU equals two TEU.

Fouling community and colonization (relating to hardbottom) - The term "fouling" is commonly employed to distinguish the assemblages of animals and plants which grow on artificial structures from those occurring on rocks, stones, and other natural objects. The. animals and plants which take part in fouling are primarily the attached, or sessile,
forms which occur naturally in the shallower water along the coast. Each of these is adapted to live successfully under some restricted set of environmental conditions which limit the particular places, both on a geographical and local scale, where it may be found. The development of an assemblage of fouling organisms on any structure immersed in the sea depends on the ability of certain members of the natural population locally present to live successfully in the new situations created by man.

Freeboard - The freeboard of a ship is the distance above the waterline and represents a margin of safety for vessel loading.

Fronthaul - Cargo that is carried on the trip out versus return trip, opposite of backhaul.

G

Grounding - When a vessel strikes the bottom of the sea or channel.

GRT (Gross Registered Tons) - Internal cubic capacity of the ship expressed in tons on the basis of 100 cubic feet per ton. This differs from DWT because it measures the area versus the weight, same as gross tonnage.

H

Habitat - Area where a plant or animal lives.

Heterogeneity - Unlike, dissimilar, not uniform

High Water (HW) - The maximum height reached by a rising tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions.

Higher High Water (HHW) - The higher of the two high waters of any tidal day.

Higher Low Water (HLW) - The higher of the two low waters of any tidal day.

Hinterland - The geographic areas where port commerce originates and terminates.

Harbor - A harbor is a sheltered part of a body of water deep enough to provide anchorage for ships or a place of refuge. Key features of all harbors include shelter from both long and short period open ocean waves, easy safe access to the ocean in all types of weather, adequate depth and maneuvering room within the harbor, shelter from storm winds and cost-effective navigation channel dredging.

Homogenous TEU Capacity - Standardized measure of slot capacity relative to the deadweight rating of a ship hull; traditionally, this measure has been 14 metric tons per TEU.

Hull - A hull is the body of a ship or boat. It is a central concept in floating vessels as it provides the buoyancy that keeps the vessel from sinking, also known as an IMO number.

I

IDC ("interest during construction") - is the opportunity cost of capital incurred during construction.

Increased Traffic Benefits - Project benefits which can be attributed to increased traffic levels as a result of decreasing transportation costs. The increase in traffic may result from any of the following reasons: shift of origin, shift of destination, or induced movements.

Incremental Analysis - A process to determine the next added segment of a project, or project scales. This analysis answers the question, "are there more benefits than costs if we add this next piece or scale to a project?" The analysis continues until costs are greater than benefits.

Incremental Benefits (Costs) - The difference in benefits (costs) between two Project Alternatives.

Induced Movement (Traffic Benefits) - Project benefits that result from an increase in commodity flows relative to the without-project condition and which do not reflect a change in origins or destinations.

Indicator species - Organism, species, or community which indicates presence of certain environmental conditions.

Internal Rate of Return (IRR) - The interest rate which discounts the benefit and cost streams so that they yield a Net Present Value of zero.

Interior Channel - The access channel system inside a water body that connects the entrance channel (inlet or bar) to a port or harbor with appropriate ship facilities. Interior channels are usually located to provide some protection from waves and weather and are located in bays, estuaries, or rivers.

Interstitial (relating to sand patches and hardbottom habitat) - Occurring in the spaces between - i.e. sand patches occurring in the spaces between areas of hardbottom habitat.

J

Jetties - Structural features that provide obstructions to littoral drift, control entrance currents, prevent or reduce shoaling in the entrance channel, maintain channel alignment, and provide protection from waves for navigation.

These structures, shown to the left, are designed to force the water passing by them into the channel. The energy of the flowing water helps to keep sediments from settling and building shoals in the channel. By redirecting the flow of the river, pile dikes protect the bank from erosion, too.

Figure 4: Jetties and Pile Dikes

Juvenile - Young fish older than 1 year but not having reached reproductive age.

K

L

LOA - Length Overall.

LO/LO ("lift on/lift off") - containerized cargo which is loaded and offloaded by a port's cranes.
Low Water (LW) - The minimum height reached by a falling tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of meteorological conditions.

Lower High Water (LHW) - The lower of the two high waters of any tidal day.

Lower Low Water (LLW) - The lower of the two low waters of any tidal day.

M

Manifest - A detailed summary sheet of all cargo being carried for each vessel trip; information also includes origin, destination, value, number, etc.

Mean High Water (MHW) - A tidal datum. The arithmetic mean of the high water heights observed over a specific 19-year metonic cycle.

Mean Higher High Water - A tidal datum. The arithmetic mean of the higher high water heights of a mixed tide observed over a specific 19-year metonic cycle.

Mean Low Water (MLW) - A tidal datum. The arithmetic mean of the low water heights observed over a specific 19-year metonic cycle.

Mean Lower Low Water (MLLW) - A tidal datum. The arithmetic mean of the lower low water heights of a mixed tide observed over a specific 19-year metonic cycle.

Mitigation - One or all of the following: (1) Avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments.

Model - A tool used to mathematically represent a process which could be based upon empirical or mathematical functions. Models can be computer programs, spreadsheets, or statistical analyses.

Most Likely Scenario - Those future conditions the analyst believes most likely to prevail.
Mercury - Heavy metal that is toxic to most organisms when converted into a byproduct of inorganic-organic reaction. Distributed into the environment mostly as residual particles from industrial processes.

N

NED Costs- The complete cost stream associated with implementation of a project alternative over the project life that is necessary to achieve the estimated benefit or traffic levels.

NED Plan (National Economic Development Plan) – The recommended plan determined based on the highest net economic benefits.

Neobulk - Type of general cargo such as cars, timber, steel, etc.
NED Benefits - The complete benefit stream associated with implementation of a project alternative over the project life that is obtained when the project alternative is implemented.

Net Present Value - The excess of inflows (benefits) over outflows (costs) discounted to reflect the time value of money.

Nominal TEU Capacity - Maximum number of TEUs that a vessel can carry by volume; the sheer number of capacity as measure by the number of slots.

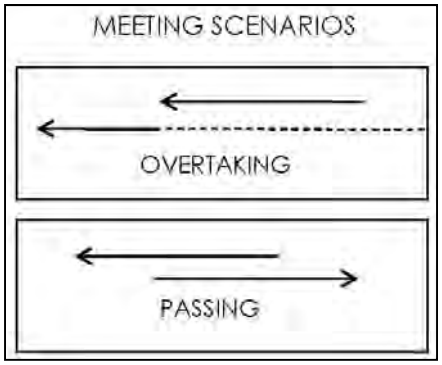
Non-Structural Alternatives - A project alternative which does not alter the physical characteristics associated with the existing condition. Non-structural alternatives would include operational and management practices, and minor structural improvements that enhance utilization of the existing project.

O

Opportunity Cost - The cost of passing up the next best choice in a decision.

Overdepth, allowable (payable) - Allowable overdepth dredging (depth and/or width) is a construction design method for dredging that occurs outside the required authorized dimensions and advance maintenance (as applicable) prism to compensate for physical conditions and inaccuracies in the dredging process and allow for efficient dredging practices. The term "allowable" must be understood in the contracting context of which dredging quantities are eligible for payment, rather than in the regulatory context of which dredging quantities are reflected in environmental compliance documents and permits. Environmental documentation must reflect the total quantities likely to be dredged including authorized dimensions, advance maintenance, allowable overdepth, and non-pay dredging. The paid allowable overdepth should reflect a process that seeks to balance consideration of cost, minimizing environmental impact, and dredging capability considering physical conditions, equipment, and material to be excavated. ER 1130-2-520 (USACE 1996) provides that District Commanders may authorize dredging of a maximum of 2 feet of paid allowable overdepth in coastal regions and in inland navigation channels. Paid allowable overdepth in excess of those allowances or the use of zero paid allowable overdepth requires the prior approval of the MSC Commander.

Overtaking - A meeting scenario.



Oxygen demand—The biological or chemical demand of dissolved oxygen in water. Required by biological processes for respiration.

P

Panamax Vessel - Ships built to maximize capacity within the Panama Canal lock size limits of 950 feet long, 106 feet wide. Design draft is usually no greater than 40 feet and sails no greater than the 39.5 feet canal limit, with deadweights up to 80,000 tons.

Passing – A meeting scenario (see "Overtaking").

Payback Period - The shortest project life yielding a Net Present Value of zero at the current discount rate.

Phased Construction - An implementation strategy whereby the project is constructed in discrete segments with benefits and costs assigned to each individual segment.

Phosphorus - Element or nutrient required for energy production in living organisms. Distributed into the environment mostly as phosphates by agricultural runoff (fertilizer) and life cycles. Frequently the limiting factor for growth of microbes and plants.

Port - A port is a place by a waterway where ships and boats can dock, load and unload.

Post-Panamax Vessel - A fully cellular containership that can carry more than 4,000 TEUs; a vessel that is larger than the original Panama Canal dimensions, but will fit under the Panama Canal expansion.

Project Depth – The authorized depth. Actual depths may vary depending on conditions in the channel.

Project Segmentation - The practice of dividing a project alternative into discrete components which can be individually evaluated and implemented.

Proposed action - Plan that a Federal agency intends to implement or undertake and which is the subject of an environmental analysis. Usually, but not always, the proposed action is the agency's preferred alternative for a project. The proposed action and all reasonable alternatives are evaluated against the no action alternative.

Public involvement - Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any EIS.

Q

R

Reconnaissance study - The first phase of a project. It has four phases (1) to define problem, (2) asses sponsor's level of interest and support, (3) decide to progress to feasibility phase based on Federal interest, (4) estimate time and money to complete feasibility study.

Record of Decision - Concise, public, legal document which identifies and publicly and officially discloses the responsible official's decision on the alternative selected for implementation. It is prepared following completion of an Environmental Impact Statement.

RO/RO (Roll-On/Roll-Off Vessels) - Ships which are especially designed to carry wheeled containers, vehicles, or trailers and only use the roll-on/roll off method of loading and unloading. Containers and trailers are usually stowed onboard on their chassis. Vehicles can be driven on and off.

S

Sailing Draft - The vertical depth below the water surface in which the vessel moves in.

Scoping—The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under the National Environmental Policy Act.

Self-Liquidating Costs - A self liquidating cost is the cost of a particular asset that can be operated in such a way that it repays the money spent to acquire it.

Semi-diurnal - Having a period of cycle of approximately one-half of a tidal day. The predominating type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day.

Sensitivity Analysis - An analytical technique designed to identify those factors that are the major determinants of the level of project benefits and costs. The sensitivity analysis will assist in identifying critical study parameters and how they impact the results.

Separable Element - A functional general navigation feature that can be evaluated separately from the rest of the project.

Shift of Origin (Destination) Benefits - Project benefits that result from changes in the origins or destinations of traffic movements due to project implementation that increases efficiency.

Slack water - Occurring twice daily, the short period of time between high or low water, when the water is completely unstressed.

Squat - The tendency of a ship to draw more water astern than when stationary; this amounts to less available underkeel clearance.

Sub-Panamax Vessel - A fully cellular containership that is less than the maximum dimensions to transit the Panama Canal and can carry between 2,000 and 3,000 TEUs.

Surge direction - The longitudinal oscillatory linear motion about the center of gravity (origin of body axis) in the ship travel direction, usually due to wave effects; motion backward and forward (fore and aft).

Stern - The stern refers to the back end of the vessel.

Structural Alternatives - A project alternative which significantly alters the physical characteristics of the project area associated with the Existing Condition.

Study Year - The year in which a project is being studied, often it is the same as the existing condition; it is usually not the same as the base year.

T

Tank Vessel (Tanker) - Ships which carry liquid products, such as crude petroleum, petroleum product, chemicals, liquid natural gas and molasses.

TEU (Twenty-foot equivalent unit) - A dry cargo container unit measuring 40 X 8 X 8.5 feet used as a measure of container capacity.

Threatened species - Legal status afforded to plant or animals species that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range, as determined by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Tide - Water with relatively high salinity levels and is influenced by earth's diurnal tide cycle.

Tiering - Procedure which allows an agency to avoid duplication of paperwork through incorporation by reference of the general discussions and relevant specific discussions from an environmental impact statement (EIS) of broader scope into a subsequent EIS of narrower scope.

Ton – A unit of measurement used in shipping assuming 100 cubic feet of cargo equals one ton, equals 2000 pounds and is also called a "short ton", a "long ton" equals 2240 pounds, and a "tonne" is 2204 pound

Tonne - a metric tonne is 2204 pounds.

TPC Immersion - The amount of tons that it takes to lower a ship's draft one centimeter.

TPI (Tons per Inch) - Measure of vessel capacity equal to the weight of displaced water if vessel draft were to change by one inch.

Traffic Diversion - Any commodity flow which ceases to use the project under some project alternative or scenario.

Trim - To adjust a vessels balance through ballast or cargo movements.

Tugs - A small powerful boat used to pull or push larger ships.

Turning Basin - An area that provides for the turning of a ship (bow to stern). Turning basins are usually located at or near the upper end of the interior channel and possibly at one or more intermediate points along long channels.

TSP (Tentatively Selected Plan) – The plan prior to the endorsement of the recommended or NED plan.

U

Underkeel Clearance - The distance between the bottom of the ship and the sea or channel floor directly under the vessel.

V

W

Watershed - A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Wetland - A zone periodically or continuously submerged or having high soil moisture, which has aquatic and/or riparian vegetation components, and is maintained by water supplies significantly in excess of those otherwise available through local precipitation.

Wet season - Hydrologically, for south Florida the months associated with a higher than average incident of rainfall, May through October.

"With-project" Condition - The set of future conditions the analyst believes most likely to prevail for each project implementation over the period of analysis. These conditions may vary for each project alternative.

"Without-project" Condition - The set of future conditions most likely to prevail in the absence of the proposed project. It does not describe conditions as they exist at the time of the study, but describes the conditions that are expected to prevail over the planning horizon in the absence of a project.

X

Y

Z

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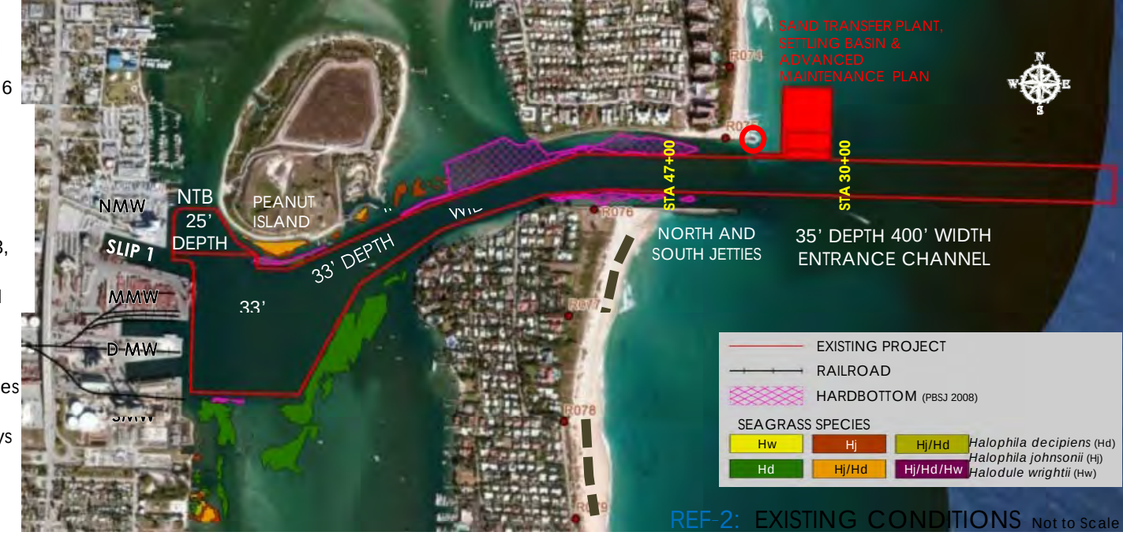
PORT FACILITIES

- North Marginal Wharf (NMW): Slip 1, Berths 1- 6
- Main Marginal Wharf (MMW): Slip 1& 2, Berths 7 - 12
- Mid-Marginal Wharf (MID MW): Slip 2 & 3, Berths 13 - 16
- South Marginal Wharf (SMW): Slip 3, Berth 17
- 156 acres of landside facilities
- In proximity to major roadways (e.g. I-95)
- Rail access to/from port



REF-2: EXISTING CONDITIONS Not to Scale

WIDENING MEASURE S INITIALLY PROPOSED

A1: Offshore current from the south up to 4 knots.
A2: Areas of large swells to the north of the entrance.
B1 & B2: Larger margin of error to prepare for turn where channel narrows to 300 feet.
C: On the ebb tide, currents move across the area in a northeasterly direction causing dangerous currents at a critical point of transition to smaller width near rock outcroppings
D: Suction effects from currents on flood tide.
E: Extend the Northern Turning Basin 250 feet to the north.
F: Large vessels may need more turning area.
G: Large vessels may need more turning area. Also – if port expands, more turning area needed.

REF-3: EXISTING CONDITIONS PLUS WIDENING MEASURES Not to Scale

ADVANCE MAINTENANCE PLAN

SETTLING BASIN 1
51' REQ + 1'

SETTLING BASIN 2
34' REQ + 1'

SETTLING BASIN 3
22' REQ + 1'

ADVANCED MAINTENANCE ZONE A
51' REQ + 1'

ADVANCED MAINTENANCE ZONE B
47' REQ + 1'

ADVANCED MAINTENANCE ZONE C
51' REQ + 1'

REF-4: RECOMMENDED PLAN Not to Scale

Port of Palm Beach District

Florida U.S.A.