SAN JUAN HARBOR

SAN JUAN HARBOR PUERTO RICO

INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

EXECUTIVE SUMMARY and MAIN REPORT

AUGUST 2018

U.S.ARMY

US Army Corps of Engineers

AUTORIDAD de PUERTOS de PUERTO RICO

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Figure ES-1: Recommended Plan

RECOMMENDED PLAN

WIDENING & EXPANSION

- Widen Army Terminal Channel from 350' to 450' maximum
- Army Terminal Turning Basin flares (East & West)
- 1,050' Expansion of San Antonio Channel Extension

DEEPENING

- Cut 6 to 46'
- Anegado Channel to 44'
- Army Terminal Channel to 44'
- Army Terminal Turning Basin to 44'
- San Antonio Channels to 36' (AUTHORIZED)
- Cruise Ship Basin East to 36' (AUTHORIZED)

With PREPA LNG Conversion

Total Federal Cost: $ 40,636,000
Total Non-Federal Cost: $ 363,338,000
TOTAL COST: $ 403,975,000

AAEQ Benefits: $ 75,269,000
AAEQ Costs: $ 15,172,000
AAEQ NET BENEFITS: $ 60,097,000
BCR: 5.0 at 2.75%

W/O PREPA LNG Conversion

Total Federal Cost: $40,636,000
Total Non-Federal Cost: $15,314,000
TOTAL COST: $ 55,950,000

AAEQ Benefits: $4,322,000
AAEQ Costs: $2,281,000
AAEQ NET BENEFITS: $ 2,041,000
BCR: 1.9 at 2.75%

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EXECUTIVE SUMMARY

Integrated Feasibility Report and Environmental Assessment (IFR/EA) are used to determine if there is a Federal interest in navigation improvements at San Juan Harbor, Puerto Rico. The USACE study authority for this IFR/EA is House Resolution 2764 of the Committee on Transportation and Infrastructure, U.S. House of Representatives, adopted September 20, 2006, which authorizes the Secretary of the Army to determine the feasibility of providing navigation improvements at San Juan Harbor, Puerto Rico to increase security, safety and efficiency.

DESCRIPTION OF REPORT

The lead agency for this navigation study is the U.S. Army Corps of Engineers, Jacksonville District (USACE). The Puerto Rico Ports Authority (PRPA) is the non-Federal sponsor.

The USACE navigation mission statement is to provide safe, reliable, efficient, and environmentally sustainable waterborne transportation systems for movement of commerce, national security, and recreation consistent with the Environmental Operating Principles. The Environmental Operating Principles are:

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all the U.S. Army Corps of Engineers (USACE) 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 USACE, which may impact human and natural environment.
- 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 the USACE actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in the USACE activities.

In accordance with the USACE navigation mission and the Environmental Operating Principles, this Integrated Feasibility Report and Environmental Assessment (IFR/EA) documents the study process and presents the results of investigations and analyses conducted to evaluate modifications to the existing Federal navigation system to improve its ability to efficiently serve the current and future vessel fleet and process the forecasted cargo volumes.

The San Juan Harbor, Puerto Rico study area encompasses the bar (entrance) channel, inner harbor channels, offshore dredged material placement sites, beneficial use dredged material placement sites, and any extension of the water bodies and shorelines that could be impacted by proposed improvements. This IFR/EA presents: (1) a survey of existing and future conditions; (2) an evaluation of related problems and opportunities; (3) development of potential alternatives; (4) a comparison of costs, benefits, adverse impacts, and feasibility of those alternatives; and (5) the results of the engineering, economic, environmental, and real estate investigations performed for this study which are used to determine if there is a Federal interest in navigation improvements at San Juan Harbor for identification of a National Economic Development (NED) Plan and a Recommended Plan.

PURPOSE AND NEED

As the cargo transportation industry continues to shift to larger, more efficient petroleum tankers and larger cruise ships to meet increased passenger transportation needs, the vessel fleet is trending toward larger, deeper-draft vessels, particularly for gasoline, jet fuel, diesel, liquefied petroleum gas (LPG) products, and liquefied natural gas (LNG). The Federal channels serving San Juan Harbor's major terminals are currently authorized to depths ranging from -30 to -40 feet MLLW. To reach port terminals, existing petroleum product tankers must light load, which results in additional transits to provide the required quantities of gasoline, jet fuel, diesel fuel, and other petroleum products for the island. These channel depth constraints require vessel operators to forego potential transportation cost savings available from the economies of scale associated with existing and larger ships drafting deeper. Restrictive channel widths along Army Terminal Channel also limit access of larger Long Range (LR2) tankers and future LNG ships to terminals at the Army Terminal Turning Basin. Additionally, prevailing winds from the east at 25-30 knots can increase the effective beam of vessels. This problem is particularly notable in the Bar Channel. For cruise ships, the limiting channel depths in cruise ship related channels and basins restrict maneuverability for turn-and-go movements, ultimately increasing transit time within the harbor. The purpose of this study is to reduce or eliminate transportation cost inefficiencies for the petroleum product tankers and larger cruise ships transiting the Federals channels of San Juan Harbor and to avoid and/or minimize environmental impacts.

The study is needed as the existing depths and widths of the Federal channels place constraints on vessels currently calling San Juan Harbor. These navigation concerns are primarily attributed to three main problems: difficult wind and wave conditions, limited channel and turning basin widths, and insufficient Federal channel depths.

RECOMMENDED PLAN

Federal interest in cost sharing of the navigation improvements for the Recommended Plan are based on the expected returns to the national economy, or National Economic Development (NED) benefits. NED benefits are generated by reducing inefficiencies in the existing transportation system resulting in transportation cost savings or reducing transportation costs. Net benefits are calculated by subtracting the total cost to construct and maintain the improvements over a 50-year study period from the total transportation cost savings (project benefits) that would be generated by the proposed improvements over that period. The NED Plan is the alternative that reasonably maximizes net average annual equivalent (AAEQ) NED benefits (AAEQ benefits minus AAEQ costs) while remaining consistent with the Federal objective of protecting the Nation's environment.

Alternative plans combining multiple structural and nonstructural measures to improve the efficiency of the navigation system were assessed to determine the Recommended Plan. In this study, the Recommended Plan is the NED plan. It proposes navigation improvements by combining the identified measures within the following economic modeling phases:

From Economic Modeling Phase 1: Widen Army Terminal Channel 100 feet (from an existing width of 350 feet to a width of 450 feet) at the existing depth of -40 feet mean lower low water (MLLW).

From Economic Modeling Phase 2: Deepen Cut-6 to -46 feet MLLW, Anegado Channel to -44 feet MLLW, widen Army Terminal Channel by 100-foot to a width of 450 feet, deepen Army Terminal Channel (ATC) to -44 feet MLLW, deepen Army Terminal Turning Basin (ATTB) to -44 feet MLLW, and construct two flares (east and west) in the Army Terminal Turning Basin to -44 feet MLLW.

And, from Economic Modeling Phase 5: Deepen San Antonio Channel, San Antonio Approach Channel, San Antonio Channel Extension, and Cruise Ship Basin East to the authorized depth of -36 feet MLLW. Expand the limits of San Antonio Channel Extension by 1,050 feet to the east.

Dredged Material Placement Options:

Base Plan - Place dredged material at the existing Ocean Dredged Material Disposal Site (ODMDS). Estimate includes use of a mechanical clamshell dredge in combination with a hydraulic hopper dredge to excavate approximately 2.2 million cubic yards of material.

Optional beneficial use of dredged material involves the filling of artificial depressions in Condado Lagoon to restore seagrass habitat and improve water quality.

The Recommended Plan is economically justified. Based on evaluation of existing surveys and benthic surveys conducted by both the National Marine Fisheries Service (NMFS) Habitat Conservation Division (HCD) and the USACE Planning and Operations Divisions (PD/OD), deepening and widening improvements of the Recommended Plan are not anticipated to result in direct impacts to submerged aquatic vegetation (SAV). Impacts to listed corals from dredging and dredged material transport related turbidity are not anticipated.

The Recommended Plan recommends widening and deepening the inner harbor channels leading to several petroleum terminal operators within the Army Terminal Turning Basin. Deepening would also occur to the Federal channels leading to cruise ship terminals. Specifically, the Recommended Plan recommends deepening Cut-6 of the entrance channel from -42 feet to -46 feet MLLW, deepening the Anegado Channel, the Army Terminal Channel, and the Army Terminal Turning Basin from -40 feet to -44 feet MLLW. Widening involves a 50-foot widener to both sides of Army Terminal Channel to increase the total width by 100 feet from 350 feet to 450 feet, and eastern and western flares at the southern terminus of the Army Terminal Turning Basin to accommodate larger vessels. The Recommended Plan also includes a 1,050 foot expansion of the San Antonio Channel Extension. Additionally, the Recommended Plan includes deepening the Federal channels adjacent to the cruise ship terminals, to include the San Antonio Approach Channel and the San Antonio Channel from -35 feet MLLW to the authorized depth of-36 feet MLLW, the San Antonio Channel Extension from -30 feet MLLW to the authorized depth of -36 feet MLLW, and the Cruise Ship Basin East from -30 feet MLLW to the authorized depth of -36 feet MLLW. Although these segments are already authorized, their construction to the authorized depth of -36 feet MLLW was deferred. This IFR/EA provides the economic justification to construct to the previously authorized depths. Figure ES-1 compares the existing channel dimensions with the proposed improvements, summarizes the economic benefits and costs associated with the Recommended Plan and illustrates the general locations of the proposed improvements.

COSTS AND BENEFITS

Throughout this IFR/EA, two economic analyses are presented for the Recommended Plan, a with LNG conversion analysis and a without LNG conversion analysis. The two economic analyses represent the same Recommended Plan, but differ in the future with-project assumptions that the Puerto Rico Electric Power Authority (PREPA) will or will not convert its two San Juan area power plants to LNG. Estimated project first costs of the Recommended Plan are approximately $54,042,000 with or without the LNG conversion.

The benefits attributable to the Recommended Plan are generated from: (1) transportation savings through the use of existing ships drafting deeper and larger ships to transport the projected cargo volumes and (2) increased maneuverability of cruise vessels, but also (3) power generation cost reduction benefits in the "with LNG conversion" future with-project condition. Based on existing and projected future vessel traffic, vessel fleet mix, trade route allocations, and liner services currently associated with the San Juan Harbor, four design vessels were selected. Characteristics of the design vessels were used to develop channel dimensions and alignment adjustments through HarborSym ship simulation. Ship simulation, with input from the harbor pilots, determined the optimal future with-project channel footprint. The dimensions of the four design vessels used for ship simulation are: (1) a 965-foot length, 106-foot beam, and a 44-foot draft container ship; (2) a 802-foot length, 138-foot beam, and a 51-foot draft LR2 tanker; (3) a 951-foot length, 151-foot beam, and 39-foot draft LNG tanker; (4) a 1187-foot length, 154-foot beam, and 31-foot draft cruise ship. Recommended Plan's benefits are developed by comparing the future with-project condition to the future without-project condition. The Recommended Plan reasonably maximizes net benefits by providing AAEQ net benefits of $60,097,000 with the LNG conversion and $2,041,000 without the LNG conversion. The entire project is economically justified. The Recommended Plan also maintains a robust benefit-to-cost ratio (BCR) of 5.0 with the LNG conversion and a BCR of 1.9 without the LNG conversion. Table ES-1 provides a summary of the Federal and non-Federal costs and Table ES-2 provides the annualized benefits and costs for the Recommended Plan.

Table ES-1: Federal and Non-Federal Costs

FEDERAL/NON-FEDERAL COST APPORTIONMENT for RECOMMENDED PLAN October 01, 2017 Price Levels (FY 2018) Deepen Cut-6 to 46' + Widen & Deepen ATC to 44' + Deepen Anegado Channel & ATTB to 44' + Deepen SAC, SAAC, SAC Extension & CSBE to 36'*			
	Total Cost	**Federal Share**	**Non-Fed Share**
GENERAL NAVIGATION FEATURES (GNF)	>20' to 50'	75%	25%
Mobilization & Demobilization (Clamshell)	$3,350,000	$2,512,000	$837,000
Standby Time (Mechanical Clamshell)	$234,000	$175,500	$58,500
Mobilization & Demobilization (Hydraulic Hopper)	$2,744,000	$2,058,000	$686,000
Standby Time (Hydraulic Hopper)	$349,000	$261,750	$87,250
~Economic Modeling Phase 1~			
Widen ATC 100' @ Existing 40' (Cut 8)	$7,389,000	$5,541,750	$1,847,250
~Economic Modeling Phase 2~			
Deepen Cut 6 @ 46'	$742,000	$556,500	$185,500
Deepen Anegado (Cut 7) @ 44'	$6,762,000	$5,071,500	$1,690,500
Deepen and Widen ATC 100' @ 44' (Costs only for deepening/widening improvements > 40')	$8,475,000	$6,356,250	$2,118,750
Deepen ATTB @ 44' (Cut 8)	$7,352,000	$5,514,000	$1,838,000
ATTB East & West Flares @ 44'	$1,354,000	$1,015,500	$338,500
~Economic Modeling Phase 5~			
Deepen SAAC @ 36' (Cut 18)	$494,000	$370,500	$123,500
Deepen SAC @ 36' (Cut 18)	$2,849,000	$2,136,750	$712,250
Deepen SAC Extension @ 36' (Cut 20)	$596,000	$447,000	$149,000
Deepen CSBE @ 36' (Cut 22)	$2,346,000	$1,759,500	$586,500
Sea Turtle Non-Capture Trawl Sweeping	$39,000	$29,250	$9,750
Real Estate Administrative Costs	$66,000	$49,500	$16,500
Preconstruction, Engineering, & Design	$4,619,000	$3,464,250	$1,154,750
Construction Management (S&A)	$4,282,000	$3,211,500	$1,070,500
PROJECT FIRST COSTS (ROUNDED)	$54,041,000	$40,530,750	$13,510,250

* ATC= Army Terminal Channel, ATTB=Army Terminal Turning Basin, SAC=San Antonio Channel, SAAC=San Antonio Approach Channel, CSBE=Cruise Ship Basin East

**The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 1986.

Table ES-2: Costs and Benefits of the Recommended Plan with or without the LNG conversion

FY2018 Price Levels - Cost Estimate 2/28/18	RECOMMENDED PLAN	
50-Year Period of Analysis / 2.75 % Discount Rate		
Average Annual Equivalent (AAEQ) Benefits and Costs		
	WITH LNG CONVERSION	*WITHOUT* LNG CONVERSION
AAEQ COSTS		
Economic Investment	$15,008,000	$2,117,000
Increased O&M for Dredging	$164,000	$164,000
Total AAEQ Costs	$15,172,000	$2,281,000
AAEQ BENEFITS		
Transportation Costs Savings	$1,612,000	$4,315,000
Unemployment Benefits	$7,000	$7,000
Power Generation Costs Reduction	$73,650,000	$0
Total AAEQ Benefits	$75,269,000	$4,322,000
AAEQ NET BENEFITS	$60,097,000	$2,041,000
BENEFIT-COST RATIO (at 2.75% FY18 Discount Rate)	5.0	1.9

ENVIRONMENTAL IMPACTS AND MITIGATION

Public and environmental resource agencies expressed concerns about the effects of the study alternatives on Endangered Species Act (ESA) listed corals, green and hawksbill sea turtles, sea grasses, mangroves, manatees, dolphins, and boat wake induced shoreline erosion.

Based on database search of existing surveys and preliminary benthic surveys conducted from January through December 2016 by both the National Marine Fisheries Service (NMFS) Habitat Conservation Division (HCD) and USACE Planning (PD) and Operations Divisions (OD), the deepening and widening measures along the Army Terminal Channel would not result in direct impacts to submerged aquatic vegetation (SAV). SAV including macroalgae and seagrass has been mapped in many scattered areas of the San Juan Harbor, but typically in less than 15'-20' water depths. In addition, all seven ESA listed threatened coral species have been documented on the discontinuous linear or fringing reef consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore along the north coast of the San Juan metropolitan area. However, the closest previously mapped hardbottom habitat (colonized pavement) is 1,500 feet from the closest dredge area (Cut-6) and Acroporid coral designated critical habitat (DCH) is approximately 2,500 feet north of Cut-6. Therefore, direct impacts to listed corals and Acroporid DCH from dredging and dredged material transport related turbidity are not anticipated. The fringing reefs east of the San Juan Harbor bar channel in the Isla Verde area have been significantly stressed or affected from sedimentation and organic pollution coming from the San Juan Bay Estuary. This is evident by a remarkably high frequency of hard coral colonies impacted by Black Band Disease, which suggests poor water quality (Coll Environmental, 2005). Construction may affect but is not likely to adversely affect manatees and listed corals or result in adverse modification to Acroporid DCH. Additionally, construction would not be likely to jeopardize the continued existence of sea turtles. In conclusion, no long-term impacts from the Recommended Plan are expected to listed species or Acroporid DCH.

A background investigation and cultural resources remote sensing survey of the San Juan Harbor channel Area of Potential Effect (APE) was conducted for the proposed project in consultation with the Puerto Rico State Historic Preservation Officer (SHPO) and the Instituto de Cultura Puertorriqueña. While background research revealed numerous shipwrecks within the project vicinity, no previously identified cultural

resources were located within the APE. SEARCH, Inc. (SEARCH) conducted a remote sensing survey of the San Juan Harbor between June 1 and June 6, 2017. As a result of this survey, no historic properties were identified within the Recommended Plan. The USACE has determined that the Recommended Plan for the San Juan Harbor Navigation Improvements Study poses no effect to historic properties listed or eligible for listing in the National Register of Historic Places (NRHP). The Puerto Rico SHPO concurred with the determination.

Construction of the Recommended Plan would cause temporary and minor adverse impacts to water quality in the areas near dredging activities. The USACE, Jacksonville District will monitor impacts of the project, if any, and ensuring that they are similar to those predicted during the study and will update its NEPA analysis, as appropriate.

AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

Concerns raised by agencies and the public included effects of the study alternatives on ESA corals, green and hawksbill sea turtles, seagrasses, mangroves, manatees, dolphins, and boat wake induced shoreline erosion. These concerns were addressed in the completed consultations with the NMFS and the U.S. Fish and Wildlife Service and within this final IFR/EA. If during PED any unanticipated potential impacts are identified, additional evaluation may be conducted.

AREAS OF RESIDUAL RISK

The conservative assumptions used to reflect the level of data collection efforts for the study make it more likely that costs and impacts will be lower than those presented in the IFR/EA. Any beneficial uses of dredged material would be implemented at the option of the USACE and the cost difference would be cost-shared with the entity requesting the beneficial use of the material.

As previously discussed, two economic analyses are presented for the Recommended Plan to address the uncertainty surrounding the anticipated conversion of the two San Juan area power plants to LNG and associated power generation cost reduction benefits. The economic analysis which assumes that there will be no conversion to LNG removes any power generation cost reduction benefits generated from a conversion to a more efficient power generation. The BCR without the LNG conversion is 1.9 and with the LNG conversion is 5.0 at the Federal Water Resources Discount Rate (FY18) of 2.75%.

With either economic analysis used, the proposed navigation improvements of the Recommended Plan remain economically justified. To determine which economic analysis and BCR should be used for decision-making purposes, the progress of PREPA's LNG conversion will be assessed prior to any future budgeting of Federal funds for design and construction of the project. It is likely that the higher BCR resulting from the with LNG conversion would increase the project's budgetary priority above what it would be for the without LNG conversion. This assessment will be managed out of USACE project management.

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SAN JUAN HARBOR IMPROVEMENTS
INTEGRATED FEASIBILITY REPORT/ENVIRONMENTAL ASSESSMENT

* Items required for an Environmental Assessment by the National Environmental Policy Act

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LIST OF ACRONYMS AND ABBREVIATIONS

AAEQ	average annual equivalent
ACS	American Community Survey
APE	area of potential effect
AQCR	Air-Quality Control Regions
ASA (CW)	Assistant Secretary of the Army for Civil Works
BCR	benefit to cost ratio
CAA	Clean Air Act
CAR	Caribbean Basin
CBRA	Coastal Barrier Resources Act
CECW	Corps of Engineers Civil Works
CEDA	Central Dredging Association
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CSRA	cost & schedule risk analysis
CWA	Clean Water Act
cy	cubic yards
dB	decibels
dB re 1uPa @1m	decibels relative to 1 micropascal at 1 meter
DNER	Department of Natural & Environmental Resources
DO	dissolved oxygen
DPS	distinct population segment
DQM	dredging quality management
E	Endangered
EA	environmental assessment
EC	entrance channel
EFH	Essential Fish Habitat
EJ	Environmental Justice
Em	Engineering Manual
EO	Executive Order
EOPs	Environmental Operating Principles
EPA	Environmental Protection Agency
EQ	environmental quality
ER	Engineering Regulation
ERDC	Engineering Research & Development Center
ESA	Endangered Species Act
ESO	endangered species observers
FMC	fishery management council
FR	Federal register
FS	feasibility study
ft	foot/feet
FWOP	future without-project
GI	global insight
GIS	geographic information system
GNF	general navigation features
HAB	hazardous air pollutants

HAPC	habitat areas of particular concern
HTRW	Hazardous, Toxic, & Radioactive Waste
Hz	Hertz
IDC	interest during construction
IFR/EA	Integrated Feasibility Report & Environmental Assessment
kHz	kilohertz
LERRs	Land, Easement, Rights-of-way & Relocation Areas
lm/ft^2	linear meters per square foot
LOA	length overall
LPP	locally preferred plan
m	meter
MANLAA	may affect not likely to adversely affect
mg/L	milligrams per liter
MHW	mean high water
ml	milliliters
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
mm/s	millimeters per second
MPRSA	Marine Protection, Research, & Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation & Management Act
NAAQS	National Ambient Air Quality Standards
NAVFAC	Naval Facility
NE	no effect
NED	National Economic Development
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOA	notice of availability
NOAA	National Oceanic & Atmospheric Administration
NO_x	nitrous oxides
NPS	National Park Service
NRHP	National Register of Historic Places
NTU	nephlometric turbidity units
O_3	ozone
O & M	Operations & Maintenance
ODMDS	Ocean dredged material disposal site
OMRR&R	Operations, Maintenance, Repair, Rehabilitation, & Replacement
OPA	otherwise protected area
OSE	other social effects
PDT	project delivery team
PED	Preconstruction Engineering & Design
PIERS	Port Import/Export Reporting System
PM	particulate matter

PPA	project partnership agreement
PPT	parts per thousand
PRPA	Puerto Rico Ports Authority
RCRA	Resource Conservation & Recovery Act
RED	Regional Economic Development
RHA	Rivers & Harbors Act
RP	Recommended Plan
SAD	South Atlantic Division
SAFMC	South Atlantic Fishery Management Council
SAJ	Jacksonville District
SAMP	Special Area Management Plan
SARBO	South Atlantic Regional Biological Opinion
SHPO	State Historic Preservation Officer
SLC	sea level change
SMART	Specific, Measurable, Attainable, Risk Informed & Timely
SMMP	Site Management & Monitoring Plan
sp	species
T	Threatened
T & C	terms & conditions
T & E	threatened & endangered
TEDs	turtle excluder devices
TMDL	total maximum daily load
TPCS	total project cost summary
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish & Wildlife ` Service
USGS	United States Geological Survey
USVI	United States Virgin Islands
VOC	volatile organic carbon
WIIN	Water Infrastructure Improvements for the Nation Act
WQC	water quality certification
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform & Development Act

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1.0 STUDY INFORMATION

Figure 1-1: San Juan Harbor Cruise Ship Terminals along San Antonio Channel

This Integrated Feasibility Report and Environmental Assessment (IFR/EA) documents the feasibility study process and presents the results of investigations and analyses conducted to evaluate potential navigation system improvements at San Juan Harbor, Puerto Rico (Figure 1-1).

1.1 Introduction*

San Juan Harbor is located on the north coast of Puerto Rico and is the island's principal port (Figure 1-2). The majority of the Commonwealth's waterborne cargo and cruise ships pass through the harbor. In 2015, approximately 78% of the Commonwealth's non-petroleum and non-coal waterborne commerce came in through San Juan Harbor. Additionally, San Juan Harbor provides the only natural harbor offering all-weather protection to shipping along the entire north coast.

Currently medium range petroleum tankers must reduce their cargo capacity by loading lighter than their design draft allows or light load to access terminals at Army Terminal Channel. Additionally, some container ships serving the terminals along Puerto Nuevo Channel must exit the harbor by retracing their path instead of using the most direct route by way of Graving Dock Channel, which limits the draft of these vessels due to the 36-foot depth constraint of Graving Dock Channel. The Federal channels serving San Juan Harbor's major terminals are currently authorized to a depth of -40 feet MLLW for Army Terminal, -39 feet MLLW for Puerto Nuevo, -36 feet MLLW for Graving Dock, -36 feet MLLW for San Antonio Approach, -36 feet MLLW for the San Antonio, -36 feet MLLW for the San Antonio Channel Extension, and -36 feet MLLW for the Cruise Ship Basin East (Figure 1-3). The existing dimensions of those channels place constraints on deeper-drafting petroleum tankers, which result in reduced efficiency and increased costs. The feasibility study analyzed the beneficial and adverse effects associated with various alternatives that would increase the channel dimensions or apply non-structural measures and balances the economic, environmental, and engineering considerations. This report summarizes the results of the study and will provide the basis for a decision whether to authorize modifications to the existing navigation system or not.

Projections of future waterborne commerce, port-specific traffic, cargo volume, commodity characteristics, vessel size, and trade lane distribution drive the analysis of transportation cost savings across various alternatives. The study weighs the overall costs and benefits of each alternative against each other to identify and recommend the best solutions. Dredging and placement of dredged material constitute the major project costs for this study. The models used to forecast the future conditions and changes for this study maintain consistency with those used on other harbor investigations and have received certification or approval for use by the USACE.

Figure 1-2: Location Map

Figure 1-3: Location of the primary Federal channels, features, and major terminals.

1.2 Study Authority*

The USACE study authority for this IFR/EA is House Resolution 2764 of the Committee on Transportation and Infrastructure, U.S. House of Representatives, adopted September 20, 2006, which authorizes the Secretary of the Army to determine the feasibility of providing navigation improvements at San Juan Harbor, Puerto Rico to increase security, safety and efficiency.

The costs for the IFR/EA are shared between the USACE and PRPA according to Section 105 of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, as amended. The study phase will end on the date the report is submitted to Congress by the Assistant Secretary of the Army for Civil Works (ASA (CW)) for authorization.

1.3 Federal Policy and Procedures

The USACE planning process follows the six-step process defined in the Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies. This process, used for all planning studies conducted by the USACE, provides a structured approach to problem solving and provides a rational framework for sound decision making. The six steps include: 1) Identify Problems and

Opportunities, 2) Inventory and Forecast Conditions, 3) Formulate Alternative Plans, 4) Evaluate Alternative Plans, 5) Compare Alternative Plans, and 6) Select a Plan.

As a part of the SMART (Specific, Measurable, Attainable, Risk Informed, Timely) planning modernization initiative a charrette was held. The charrette involved a single-day meeting held at the beginning of the study process on November 4, 2015, to apply a risk-based approach to streamline the study scope and process by eliminating non-essential activities from the decision-making process. These initiatives followed Congressional action in Section 1001(a) of the Water Resources Reform and Development Act of 2014 (WRRDA 2014) which codified, generally, the USACE's planning parameters limiting the duration, cost, and agency approval process for future feasibility studies. The USACE has applied these provisions by ensuring that appropriate parameters are maintained for the duration, cost, and agency approval process for the feasibility study for the Project.

While completing studies faster and at lower costs, the modernized USACE planning process intends to generate reports that are more concise and easier to understand but still present a thorough analysis of all important considerations. The combination of this feasibility report and Environmental Assessment (EA) into an integrated document meets the requirements of water resource development law and policy, the National Environmental Policy Act (NEPA) (42 U.S.C. §4321 *et seq.*), and necessary environmental clearances.

1.4 Objectives*

The overall Federal objective related to water resources project planning contributes to National Economic Development (NED), consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Water resources project plans alleviate problems and take advantage of opportunities in ways that contribute to this objective. The Economics Appendix provides additional information about contributions to NED.

The expected return to the national economy on the total investment to construct and maintain the improvements over a 50-year study period, spanning from 2026 to 2075, characterizes the analysis to determine if a Federal interest exists in implementing navigation improvements at San Juan Harbor. Like most USACE navigation studies, the return to the national economy involves reducing transportation costs by addressing inefficiencies in the existing transportation system. Unique to San Juan Harbor, returns to the national economy in terms of reduction in costs of power generation for the Commonwealth is also considered. For a Federal interest to exist, the contribution to NED must exceed the cost to construct and maintain the project over the 50-year period of analysis, which for San Juan Harbor it is from 2026 through 2075. The NED benefits associated with each of the alternatives considered include the costs to implement and maintain the improvements. This IFR/EA and the supporting appendices summarize the results and include recommendations.

1.5 Purpose and Need*

The purpose of this project is to allow for petroleum product tankers and larger cruise ships to efficiently transit the Federal Channels by reducing or eliminating transportation cost inefficiencies, such as light loading, while minimizing and avoiding environmental impacts. The project is needed because the existing depths and widths of the Federal channels place constraints on larger more efficient petroleum product tankers and larger cruise ships. To reach port terminals, some of the existing ships must light load, which results in additional transits to provide the required quantities of gasoline, jet fuel, diesel fuel, and other petroleum products for the island. Channel depth constraints

require the vessel operator to forego potential transportation cost savings available from the economies of scale associated with existing and larger ships drafting deeper. The widening of Army Terminal Channel will allow Liquefied Natural Gas (LNG) tankers to access the Puerto Rico Electric Power Authority (PREPA) terminal at the Army Terminal Turning Basin, which provides for the introduction of natural gas to PREPA's San Juan power plants as a more economical fuel source compliant with U.S. Environmental Protection Agency (USEPA) regulations such as the Mercury and Air Toxic Standards (MATS). Deepening of Cut-6 through the Army Terminal Turning Basin will allow petroleum product tankers to load more deeply resulting in the potential for reduced transits and associated transportation cost savings. Section 3 of this report contains more detailed information about the project objectives and the alternatives developed in accordance with this purpose and need statement.

1.6 Scope

This IFR/EA includes (1) a survey of existing and future conditions; (2) an evaluation of related problems and opportunities; (3) development of potential alternatives; (4) evaluation of alternatives; (5) a comparison of costs, benefits, adverse impacts, environmental acceptability, and feasibility of those alternatives; and (6) identification of a Recommended Plan. Information for the analysis came from land and hydrographic surveys, hydrodynamic and water quality modeling, socioeconomic projections, sediment sampling, and numerous other data collection efforts. This study includes data from previous studies augmented with information from the PRPA, the PREPA, commercial shippers, Federal, Commonwealth, and local resource agencies, as well as Geographic Information System (GIS) mapping of significant resources and features.

This IFR/EA forecasts waterborne cargo volumes, traffic patterns and vessel fleets, and evaluates the need for navigation system improvements over a 50-year period of analysis. It considers a wide range of structural and some non-structural measures within and near the harbor that could address inefficiencies within the system. However, it concentrates on potential changes to water-based transportation system components that are within the scope of the study authority described above.

1.7 Study Area*

Figure 1-2 locates San Juan Harbor on the northeast coast of the Commonwealth of Puerto Rico. The Commonwealth's cruise ships, containerized cargo, dry bulk grains, general cargo (including automobiles), and petroleum products pass through San Juan Harbor. The entrance channel accesses the Atlantic Ocean to the north between Isla de Cabras and Old San Juan. Figure 1-3 shows the locations of the Federal channels and major terminals considered in this study. It also illustrates the relative locations of the Inner Harbor, Entrance Channel, and terminals.

As shown in Figures 1-3 and 2-2 the study area includes the entrance channel, the Federal inner harbor channels, Ocean Dredged Material Disposal Site (ODMDS), beneficial use of dredged material placement areas, and any extension of these water bodies and shorelines that would be impacted by channel enlargement alternatives or any potential associated landside infrastructure changes.

1.8 Existing Project*

Historical Perspective

San Juan Harbor has been in use since the colonization of the Island by the Spanish. Authorization for Federal improvements began in 1907 by the River and Harbor Act of 1907, Public Law 59-168. The existing navigation project was authorized in Section 202(a) of the Water Resources Development Act

of 1986, Public Law 99-662, as amended by Section 301(a)(12) of the Water Resources Development Act of 1996, Public Law 104-303.

The authorized navigation features described in the General Reevaluation Report and Environmental Assessment dated March 1994, revised June 1994, were approved by the Acting Assistant Secretary of the Army (Civil Works) on July 8, 1994. The last federally constructed navigation improvements under this authority included deepening the bar channel (Cuts 1-3) to project depths of 56-51 feet, the Entrance Channel to 48-42 feet, Anegado Channel to 40 feet, Army Terminal and Turning Basin to 40 feet, Puerto Nuevo Channel to 39 feet, Graving Dock Channel to 36 feet, Graving Dock Turning Basin to 30 feet, Anchorage Area E to 36 feet, Anchorage Area F to 30 feet, San Antonio Channels to 35 feet, Cruise Ship Basin West to 36 feet and Cruise Ship Basins East to 30 feet, and the San Antonio Channel Extension to 30 feet.

In the 1994 GRR, the Corps deferred the authorized deepening of the Cruise Ship Basin, the San Antonio Channel and the San Antonio Extension to 36 feet because these improvements could not be economically justified at that time. Authorized deferred features are being reconsidered in this study.

The U.S. Census data reveals that the population of Puerto Rico increased from 1950 to 2000, with a net increase of 1,597,907, which constitutes an average annual increase of 1.5%, or 31,958 per year during that period. The 2010 census shows a population of 3,725,789, a net loss of 82,821 or 2.2% decline from the 2000 census.

San Juan is also the tourist capital of the country with over half of the island's hotels located in the metropolitan area. In addition to being the governmental, commercial, industrial, and financial hub of Puerto Rico, San Juan is the transportation center. San Juan International Airport ranks in the world's top tier in traffic. The city is the focal point for a network of highways reaching every part of the island. Bus systems also serve the metropolitan area and link San Juan with other cities.

Existing Federal Navigation Project

The San Juan Harbor Federal navigation project currently provides a system of channels with traffic typically following a counterclockwise pattern around the triangular area including Army Terminal, Puerto Nuevo, and Graving Dock Channels. Turning basins and anchorage areas provide maneuvering and waiting areas for ship traffic. The following table, Table 1-1, provides more detailed characteristics of the existing channel dimensions that are depicted in Figure 1-3.

Authorized in the WRDA of 1986, construction of the existing project initiated in 1998 and concluded in 2001. Most of the project, has been completed with the exception of deepening the San Antonio Channels, where the San Antonio Approach Channel has been constructed to a depth of -35 feet MLLW, the San Antonio Channel has been constructed to a depth of -35 feet MLLW, the San Antonio Channel Extension has been constructed to to a depth of -30 feet MLLW, and the Cruise Ship Basin East has been constructed to a depth of -30 feet MLLW, as opposed to the authorized depths of -36 feet MLLW.

Table 1-1: Federal Project Existing Dimensions

Channel Segment	Project Depth - Feet	Width - Feet
Bar Channel (Cuts 1-3)	56 – 51	800
Entrance Channel (Cuts 4-6)	48 - 42	Range Varies
Anegado Channel	40	800
Army Terminal Channel	40	350
Sabana Approach Channel	32	Range Varies
Army Terminal Turning Basin	40	1450-foot Turning Diameter
Puerto Nuevo Channel	39	350
Puerto Nuevo Turning Basin	39	1015-foot Turning Diameter
Graving Dock Channel	36	350
Graving Dock Turning Basin	30	Range Varies
San Antonio Approach Channel	35 (Authorized to 36)	Range Varies
Cruise Ship Basin North	36	Range Varies
Cruise Ship Basin East	30 (Authorized to 36)	Range Varies
San Antonio Channel	35 (Authorized to 36)	Range Varies
San Antonio Channel Extension	30 (Authorized to 36)	Range Varies
Anchorage - E	36	Range Varies
Anchorage - F	30	Range Varies

Channel Name	Approximate Length (miles)
Bar and Entrance Channels	1.1
Anegado Channel	1.4
Army Terminal Channel	1.5
Puerto Nuevo Channel	1.7
Graving Dock Channel	1.5
San Antonio Approach Channel	0.7
San Antonio Channel	0.7

1.9 Prior Reports and Studies*

Over the past few decades, there have been a succession of feasibility-related reports concerning development projects for San Juan Harbor. Advances in engineering, economics, and other sciences have aided each successive investigation. An abbreviated list of the most important studies and reports relating directly to harbor development are summarized below.

1.9.1 Feasibility Studies

Navigation Study for San Juan Harbor, Puerto Rico, General Reevaluation Report (GRR) and Environmental Assessment, March 1994 (Revised June 1994). The San Juan Harbor improvement project authorized by the WRDA 1986 was re-authorized by Section 301 of WRDA 1996 to include the recommendations made in the 1994 General Reevaluation Report (GRR). The plan recommended in the March 1994 GRR (Revised June 1994) and re-authorized in WRDA 1996 represented a departure from the project previously authorized in WRDA 1986. In the 1994 GRR, the USACE deferred deepening of the Cruise Ship Basin, Anchorage Area E, the San Antonio Channel and San Antonio Channel Extension because those areas were not economically justified.

Navigation Study for San Juan Harbor, Puerto Rico, Limited Reevaluation Report (LRR) and Environmental Assessment, August 2002. This draft LRR examined economically justifying the two Cruise Ship Basins (East and West) and the San Antonio Channel. At the time of the LRR both Cruise Ship Basins were constructed and are being maintained at -30 feet MLLW. The San Antonio Channel was constructed and is being maintained at -35 feet MLLW with -30 feet MLLW at its eastern end. The San Antonio Channel Extension was private with depths of -34 feet to -37 feet MLLW, but was also authorized to be added to the Federal project with a 36-foot depth. Since private interests deepened the San Antonio Channel Extension, the LRR did not investigate that segment, but recognized it could be evaluated in the future as part of a subsequent feasibility study.

1.9.2 Port Inventory

The latest USACE Port Series document, Port Series #13, was published in 1997 and provides a complete inventory (current at that time) of every port terminal covering their berthing statistics, loading/unloading equipment, and landside storage, nationwide. This document also provides basic tidal and climate conditions and dimensions of all the harbor channels. The USACE no longer publishes the Port Series.

1.9.3 Dredging Reports

San Juan ODMDS, Site Management and Monitoring Plan, January 2011. This plan was prepared and reviewed by the U.S. Environmental Protection Agency (USEPA), the USACE, the U.S. Fish and Wildlife Service (USFWS); the Puerto Rico Department of Natural and Environmental Resources (DNER), and the PRPA. This modified site management and monitoring plan replaces the original and incorporates subsequent monitoring results and provisions of the WRDA 1992.

Dredged Material Management Plan, Preliminary Assessment, San Juan Harbor, San Juan, Puerto Rico, November 1996. This report concluded that there was more than 20 years of capacity to contain the dredged material from San Juan Harbor maintenance dredging.

1.9.4 Waterborne Commerce Statistics

Waterborne Commerce Statistics are published annually by the USACE Institute of Water Resources, Waterborne Commerce Statistics Center. The Waterborne Commerce Statistics provide the vessel calls by number, draft, and loads for all United States ports.

1.9.5 Permits

As port facilities have been added or expanded, they have required Federal and state permits. These documents, on file with the Antilles Permits Section, Jacksonville District, Regulatory Division, provide additional insight to the social, economic, and environmental conditions of San Juan Harbor.

1.9.6 Water Quality Studies

The Engineering Appendix contains Sediment Trend Analysis (STA) performed in 2002 by GeoSea Consulting (Canada) Ltd. for San Juan Harbor and a July 1998 WES study, *San Juan Bay and Estuary Study: Hydrodynamic Field Data Collection*.

1.10 Report Organization

This integrated report serves as the USACE decision document and EA to meet NEPA requirements for the proposed action. It is also formatted to facilitate review and processing by the ASA (CW) to provide a report with recommendations to Congress. Sections intended to meet NEPA requirements are qualified with an asterisk.

2.0 EXISTING AND FUTURE WITHOUT-PROJECT CONDITION/ NEPA AFFECTED ENVIRONMENT*

This section describes the existing economic conditions, navigation features, and the physical and natural environment of San Juan Harbor, all of which are described and analyzed consistent with the NEPA regulations. This section summarizes the existing conditions (baseline), as well as a forecast of the future without-project conditions, to provide a sound basis for plan formulation in Section 3 and impact analysis in Section 5. The future without-project condition is synonymous with the No Action Alternative for the NEPA analysis. It describes the anticipated conditions at the end of the study's 50-year period of analysis, which spans from 2026 to 2075. The existing conditions provide the baseline to forecast the changes that would be expected without USACE action to address inefficiencies in the Federal navigation system. The topics in this section mirror the topics presented in Section 5, where the future with-project conditions and impacts of the Recommended Plan receive consideration.

2.1 General Setting*

San Juan Harbor is located within the San Juan metropolitan area along the north coast of Puerto Rico and is the island's principal port. Bahia de San Juan is about 60 miles east of Punta Borinquen and 30 miles west of Cabo San Juan. It is the only harbor on the north coast which affords protection in all weather. It is protected on the north by the relatively high land of Isla San Juan and on the south, east, and west by the adjacent low mangrove swamps of the Puerto Rico mainland. The bay is about three miles long in a southeast direction and varies in width from 0.6 to 1.6 miles, but the entire southwest side is comprised of a shoal. The southwest shore is divided into two large bights by Punta Cataño, the point which extends about 0.6 mile northeast into the harbor. Metropolitan San Juan, the capital and principal port of Puerto Rico, includes Isla San Juan on the north side of Bahia de San Juan and the communities surrounding the bay. The principal cruise tourism facilities are on the south side of Isla San Juan (Old San Juan) and on the north side of Isla Grande. Container cargo terminals are located at Puerto Nuevo in the southeast part of the bay. The principal imports into the harbor include foodstuffs, textiles, building materials, machinery, fertilizers, and petroleum products. Exports include sugar, molasses, fruit, tobacco, coffee, petrochemicals, pharmaceuticals, and alcoholic products. Over half the commerce of Puerto Rico passes through San Juan Harbor. Most commercial and government activities are located here.

2.2 Economic Conditions*

2.2.1 Relative Trade Volume and Trends

Existing Condition

San Juan Harbor is Puerto Rico's principal cargo port and is located in the island's population center with nearly two-thirds of the island's inhabitants residing in the San Juan-Carolina-Caguas Metropolitan Statistical Area (MSA). As Puerto Rico is an island, waterborne commerce is relied upon heavily to supply the Commonwealth with food, manufactured goods, fuels, and nearly all other items needed to power the economy and sustain the island's inhabitants and visitors (Figure 2-1). Waterborne commerce also facilitates the movement of goods off of the island, including goods produced in Puerto Rico and goods transshipped through Puerto Rico. In 2015 the Waterborne Commerce Statistics Center estimated that over 50% of all waterborne commerce taking place on the island passed through San Juan Harbor. In the same year, approximately 78% of all non-petroleum and non-coal cargo passing through Puerto Rico was shipped to/from San Juan Harbor, while about 35% of all petroleum and coal handled passed through the among all other harbors on the island (Table 2-1).

Figure 2-1: Ports of Puerto Rico

Table 2-1: Total Waterborne Commerce in Puerto Rico - 2015 (metric tons)

Year	Commodity Type	San Juan Harbor	Puerto Rico*	Percentage of Total to San Juan
2015	Petroleum and coal products	3,780,000	10,667,000	35%
	All other products	6,258,000	8,022,000	78%
	Total	10,038,000	18,688,000	54%

*****Puerto Rico includes San Juan Harbor throughput and throughput for Guanica, Guayanilla Harbor, Humacao, Jobos Harbor, Mayaguez, Ponce, Tallaboa, and Yabucoa.

Source: Waterborne Commerce Statistics Center resources entitled *State to State and Region to Region Commodity Tonnages Public Domain Database* (2015) and *Waterborne Commerce of the United States Calendar Year 2015 Part 2–Waterways and Harbors Gulf Coast, Mississippi River System and Antilles.*

In addition to the port's importance in supplying goods to Puerto Rico, a significant number of cruise passengers visit each year via San Juan Harbor. Cruise itineraries brought over 1.4 million cruise passengers to San Juan in 2015, both homeport passengers (passengers on cruises that begin and end in San Juan) and transit passengers (passengers participating in cruises for which San Juan is a stop on the cruise itinerary). That same year, San Juan Harbor ranked 8th among North American and Caribbean cruise ports in terms of total number of passengers. Among Caribbean ports, San Juan Harbor ranked 4th in total passengers. Table 2-2 shows that over the period from 2009-2015 the highest and second highest number of passenger movements occurred in the two most recent years for which data is available, 2015 and 2014, respectively, suggesting the industry is currently strong and growing in San Juan Harbor.

Table 2-2: Cruise Passenger Movement in San Juan Harbor 2009-2015 (by Calendar Year)

Calendar Year	Homeport Passengers	Transit Passengers	Total Passengers
2009	449,670	729,352	1,179,022
2010	545,395	645,660	1,191,055
2011	529,884	602,255	1,132,139
2012	409,337	642,382	1,051,719
2013	428,541	744,190	1,172,731
2014	436,117	928,180	1,364,297
2015	488,813	971,176	1,459,989
Source: Puerto Rico Tourism Company – Cruise Passenger Movement in Old San Juan (by Calendar Year)			

Future Without-Project Condition

Moving from the existing condition to the future without-project condition, no growth is assumed for all commodities (cargo). Growth in cruise calls and passengers from 2015 thru 2018 is applied, but no cruise growth is assumed beyond 2018. The Economics Appendix provides additional details on how the future without-project commodity volumes and number of cruise calls/passengers were estimated. Estimated future without-project tonnages used in the analysis are summarized below in Table 2-3.

Table 2-3: San Juan Harbor Future Without-Project Commodity Tonnages

Commodity Category	2026 FWOP
Containers	5,114,000
Dry Bulk	780,000
Bulk Petroleum Products[1]	3,053,000
General Cargo	241,000
Liquid Bulk[2]	312,000
LPG	42,000
LNG	0
Total	**9,542,000**

[1] Includes bulk petroleum products bound for petroleum docks in Army Terminal Turning Basin area

[2] Includes non-petroleum liquid bulk cargo bound for petroleum docks in Army Terminal Turning Basin area and all liquid bulk cargo bound for other docks throughout the harbor

2.2.2 Existing Fleet - Vessel Classes

As an island, Puerto Rico relies on waterborne commerce to meet the needs of residents and visitors to the island. Thus, San Juan Harbor receives calls by vessels of all types and sizes carrying all types of cargo. The island's Caribbean location paired with the tourist attractions found in Old San Juan have led to many annual cruise calls to San Juan Harbor as well. Table 2-4 provides summary data on the estimated frequency of vessel calls by vessel type in 2014 based on Waterborne Commerce Statistics Center data.

Table 2-4: Estimated Number of Vessel Calls by Vessel Type 2014

Vessel Type	Call Count
Bulker	29
Container (Cont)	650
General Cargo (GC)	430
LPG-LNG	17
Miscellaneous (Misc)	238
RoRo	338
Tankers	180
Cruise	516
Notes: Number of calls here is likely understated as it may not include all calls that carried exclusively imports or exclusively exports (i.e. not both imports and exports). General Cargo vessels include dry barges. Tanker vessels include liquid barges. Miscellaneous vessels are made up primarily of supply ships ("goletas"). Sources: Waterborne Commerce Statistics Center	

Channel dimension-related problems at San Juan Harbor occur under the existing conditions and will continue to occur under the future without-project conditions. Problem statements important in framing the economic analysis are the following:

- Existing cargo shippers experience increased operation costs due to light loading, vessel size limitations, and congestion delays.
- PREPA experiences increased power generation costs in northern power plants due to inability to reliably bring LNG by ship to its proposed San Juan Harbor terminal, given the world fleet of available LNG tankers.
- Existing cruise vessel operators experience increased in-port maneuvering costs due to channel and turning basin width and depth constraints.
- Existing Liquefied Petroleum Gas (LPG) importers on the island of Puerto Rico experience increased operating costs due to transporting LPG to San Juan from the southern coast by truck rather than by ship direct to San Juan Harbor.

Future Without-Project Condition

As mentioned previously, the channel dimension-related problems listed above at San Juan Harbor will continue to occur under the future without-project conditions. The future without-project fleet summary is provided in Table 2-5.

Table 2-5: Future Without-Project Condition Fleet Summary

Vessel Class	FWOP 2026 Fleet
SubPanamax Container Vessels	537
Panamax Container Vessels	273
5K-35K DWT tankers and tank barges	102
MR	79
LR1	9
LR2	0
RoRo and Vehicle Carriers	231
Cruise	651
LPG	13
LNG	0
Bulkers and General Cargo	259
Other	514
Total	**2668**

2.2.3 Existing Operational Conditions

Existing Condition

The following items affect the operations of all vessels using San Juan Harbor:

- Cruise ship priority – Cruise (passenger) vessels are given priority over all other vessel types on both arrival and departure from San Juan Harbor. The San Juan Bay Pilots shift the arrival and departure times of non-cruise vessels to accommodate cruise vessels if needed.
- Safety and security zones – A safety zone of 100 yards when in transit (300 feet) and 50 yards when at dock (150 feet) is required for tanker vessels carrying LPG and LNG commodities. Similarly, a security zone of 100 yards when in transit (300 feet) and 50 yards when at dock (150 feet) is required around cruise vessels. A safety zone is created when the cargo onboard a ship is potentially hazardous and is designed to protect those not on the ship from any harm that the cargo could cause. A security zone is designed to protect what is on the ship, in this case the passengers on board of the cruise vessel.
- Meeting and overtaking – From Buoy 11 to Buoy 13 (straight stretch in Anegado Channel between the USCG station and Crowley dock), two vessels may meet while transiting the channel simultaneously (one inbound and one outbound vessel). No meeting is permitted from the harbor entrance to Buoy 11, beyond Buoy 13, or anywhere else outside of Anegado Channel. Additionally, overtaking is prohibited in any part of the harbor.
- Small tidal range – Tidal datums computed from NOAA Tide Station 9755371 and referenced to Mean Sea Level (MSL) and Puerto Rico Vertical Datum 2002 (PRVD02) indicate the mean tide range is 1.11 feet and the spring tide range is 1.57 feet. This is a relatively small tidal range and there is no indication from stakeholders that tide is used to allow vessels to load deeper than is possible at mean tide or that vessels routinely wait on tide at the harbor entrance. Furthermore, because the difference between the mean tide level at 0 feet and mean high water (MHW) at 0.55 feet is less

than a foot and because sailing draft data is often rounded to the nearest foot, any use of sum small tide would be very difficult to capture in the economic analysis. Thus, tide is not considered a factor in the economic analysis. *See* the Engineering Appendix for additional details regarding tidal range.

- Port rules dictate minimum under keel clearance requirements as follows[1]:
  - One foot of under keel clearance for double-hulled vessels
  - Two feet of under keel clearance for single-hulled vessels

  Actual observed underkeel practices are discussed in greater detail in the Economics Appendix.
- Strong wind, wave, and current conditions – The effects of these conditions are particularly notable in the Bar Channel, where prevailing winds from the east at 25-30 knots can increase the effective beam of the ship and the combination of wind, waves, and currents causes ships to roll and heel increasing the draft of the ship.

Future Without-Project Conditions

As mentioned above, the items affecting the operations of all vessels transiting San Juan Harbor will continue to occur under the future without-project condition.

2.2.4 Port Hinterland

Existing Condition

The San Juan Harbor hinterland is considered a captive hinterland and includes the entire island of Puerto Rico. Puerto Rico relies heavily on waterborne commerce to supply the island with food, manufactured goods, fuels, and nearly all other items needed to power the economy and sustain the island's inhabitants and visitors, as very clearly demonstrated during recovery efforts following hurricanes Irma and Maria. Waterborne commerce also facilitates the movement of goods off of the island, including goods produced in Puerto Rico and goods transshipped through Puerto Rico.

Future Without-Project Condition

Since Puerto Rico is an island, the port hinterland in the future without-project condition is not expected to change.

2.3 Navigation Features

2.3.1 Navigation History

Federal involvement in the San Juan Harbor navigation project began 100 years ago and improvements have been authorized periodically since then. Major historical improvements at San Juan Harbor are summarized in Section 1.8.

[1] Source: Rules provided by San Juan Bay Pilots - Reglamento 6763 11 de diciembre 2004.

2.3.2 Existing Navigation Configuration and Dimensions

Existing Condition

A feasibility study completed in 1994 provided the existing Federal navigation channel configurations. Figure 1-3 illustrates the important features and Table 1-1 provides detailed dimensions. Unless otherwise stated, all depths referenced in this IFR/EA are relative to MLLW.

The entrance to the harbor is composed of Cuts 1-6, which decrease in depth from 56 feet down to 42 feet as vessels pass into the protected waters of the inner channel and vertical motion concerns decline. Anegado Channel is the harbor's central inner channel and must be transited by all vessels bound for all terminals. Anchorage Area F is located south of the Anegado Channel. The USCG currently has Anchorage Area F designated as an area for ships carrying explosives. Inside of the Anegado Channel, the harbor can be divided into five distinctive areas identified by the letters A thru E as described in detail below and in the Economics Appendix.

A. The Army Terminal Turning Basin area is home to docks receiving petroleum products (liquid bulk), containerized cargo, and bulk grains. The Cataño Oil Dock (COD) East and COD West (collectively referred to as "COD" going forward) are leased from the Puerto Rico Land Authority for shared use by Tropigas, BTB Placco, Puma Energy Caribe (Puma), and Total Petroleum Puerto Rico (Total). Tropigas and BTB Placco bring propane and bitumen, while Puma and Total handle primarily gasoline, jet fuel, and diesel. Puma also operates its own private use dock at the Army Terminal Turning Basin's western edge. Landside storage facilities with significant capacity for storage of a variety of petroleum products are located nearby COD and the Puma Caribe dock. The PREPA dock located on the southeastern side of the turning basin receives fuel oil #6 and diesel (fuel oil #2) for use in power generation at the San Juan and Palo Seco Power Plants. In addition to the petroleum docks, Trailer Bridge brings containerized cargo to the Army Terminal dock located between the Puma dock and COD, and bulk grain cargos are received by various companies at docks just north of the Army Terminal Turning Basin.

B. The Puerto Nuevo Channel area receives primarily containerized cargo with smaller amounts of liquid bulk (molasses, alcohol, etc.), general cargo, and Roll-On, Roll-Off (ro-ro) cargo. The liquid bulk arrives primarily at the northern Puerto Nuevo docks (Piers L-O) on tankers and services a rum production facility in San Juan. Terminal operators along the channel include Luis A. Ayala Colón Sucrs., Inc., Island Stevedoring, and Puerto Rico Terminals (formerly Tote Maritime Puerto Rico and Internship). Puerto Rico Terminals (PRT) has eight newly renovated cranes, can handle ro-ro and Load-On, Load-Off (lo-lo) cargos, and covers 122 acres of land, including warehousing and container storage space.

C. The Graving Dock Turning Basin area is located north of the Puerto Nuevo Channel and currently receives general cargo, containerized cargo, and ro-ro cargo (vehicles) on general cargo and ro-ro vessels.

D. The Crowley terminal handles containerized cargo. The terminal recently completed construction of a 900-foot by 114-foot pier, dredging to accommodate new combination container and ro-ro (con-ro) vessels (34-foot design draft), the paving of 15 acres to be used for container stacking, and receipt of three new-build ship-to-shore gantry cranes. *See* Figure 1-3 for location of Crowley terminal. Existing vessels calling on this terminal are mainly tugs and barges, although the composition of the fleet calling on this terminal is expected to change by the project base year (estimated at 2026) as part of the terminal improvements underway and described above.

E. The San Antonio Approach Channel (SAAC), San Antonio Channel (SAC), and San Antonio Channel Extension (SAC Extension) includes all of the port's cruise facilities. Home-ported cruise facilities are located south of the SAC and SAC Extension at the Pan American Cruise Docks East and West (PAD-E and PAD-W) and in-transit cruise vessels utilize the berths north of the SAAC. Containerized and bulk cargos are also received at docks along the SAC. Supply ships, known locally as "goletas", operate mainly out of Piers 8-10 and transship a variety of goods, equipment, and materials to smaller Caribbean islands.

Future Without-Project Condition

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 system of channels would occur. However, as part of the future without-project condition, the USCG has plans to expand and deepen Anchorage Area F to the approved depths in adjacent channels for safety purposes as a safety area for ships experiencing mechanical failures or other emergencies. Their rule making process will change the purpose of Anchorage Area F from a location for ships carrying explosives to a safety zone for all commercial vessels.

2.3.3 Maintenance Dredging/Dredged Material Management

Existing Condition

The existing project requires periodic maintenance dredging to maintain authorized depths. Historically, dredged material removed from San Juan Harbor has been placed within the San Juan ODMDS, which is approximately one square mile (Figure 2-2). The average annual maintenance dredging needs of the Federal channels is approximately 155,400 cubic yards. The Federal Government currently maintains the existing project approximately every five to seven years and the material is disposed of in the ODMDS. This ODMDS has been used for dredged material disposal activities since 1975 and was last used in 2017. It is located approximately 2.2 nautical miles north-northwest of the entrance to San Juan Harbor. Water depths start at approximately 213 meters (700 feet) at the southern boundary and slope moderately to approximately 400 meters (1,300 feet) at the northern boundary with average depths of 292 meters (965 feet). The site is managed and monitored under the 2011 Site Management and Monitoring Plan (SMMP) which can be found at https://www.epa.gov/ocean-dumping/site-management-and-monitoring-plan-smmp-san-juan-harbor-ocean-dredged-material. The Recommended Plan does not anticipate the need to expand the ODMDS. If needed, an evaluation under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) for any newly authorized areas to be dredged will be performed prior to material disposal in the ODMDS.

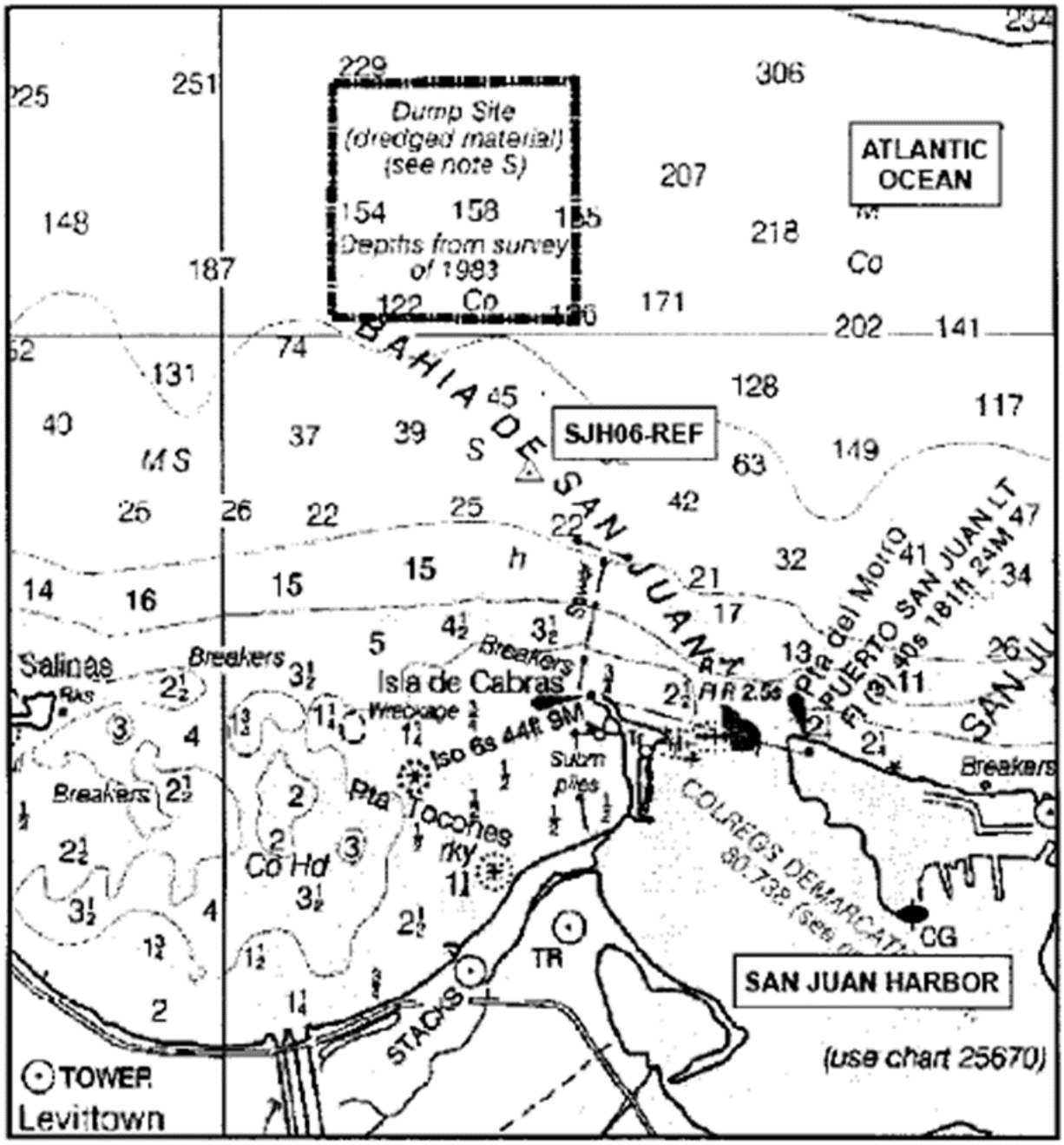

Figure 2-2: Location of the ODMDS from the Site Management and Monitoring Plan (SMMP) for San Juan Harbor, Puerto Rico

Future Without-Project Condition

The existing maintenance dredging schedule and methods would continue under the future without-project condition. The same disposal areas would be used, although the use of other upland disposal areas would be considered. There are no capacity limitations at the ODMDS so continued dredged material operations and maintenance are expected in the future.

2.4 Environmental Conditions*

2.4.1 Wind and Wave Climate

Existing Condition

Easterly trade winds predominate throughout the entire year, primarily from the ENE direction. Wind speeds in the area are moderate. The mean annual wind speed is 14.2 km/hr, but shows considerable daily and monthly variation. Maximum wind speeds occur in July (mean monthly velocity = 16.1 km/hr) and minimum wind speeds generally occur in October (11.3 km/hr). Infrequent tropical storms and hurricanes are sometimes severe, occur any time from August to October, and generally produce considerable rainfall (USEPA, 1982).

As winds move over water, friction generates waves. The distance of open water (fetch) a wind blows over affects the size of waves produced (USACE, 2008). At a given wind speed and duration, a longer fetch will generate larger waves. At large fetch lengths in deep water, the wave height becomes dependent only on duration of the wind. The heights and energies of wind generated waves increase as long as the wind blows over them until they eventually reach shore. Conversely, vessel wakes dissipate as they move away from the transiting vessel. The average waves generated by winds and the average waves generated by vessels within San Juan Harbor are estimated to be of similar heights, on average, but occur with extremely different distributions and frequencies.

In San Juan Harbor, the effect of waves (including vessel wakes) on the Cataño shoreline are of particular interest due to the existing public infrastructure and development. Coastal areas are subject to constantly changing erosion and accretion trends. Additionally, the natural variability of wind speed and direction combined with wave addition and cancelling effects make it difficult to reliably predict whether vessel- and wind-generated waves will cause erosion or accretion at specific locations. Tidal effects can cancel out over time due to back and forth flows. Vessels wakes follow a similar back and forth path as tides in San Juan Harbor but may be concentrated at certain tide stages and could have erosion and accretion effects that are difficult to predict.

Seas in the area usually run less than eight feet. Waters are roughest in winter and midsummer. For example, waves of eight feet or more are encountered off the north coast 10-12% of the time in July. High seas are usually associated with strong winds out of the northeast through southeast blowing over a long fetch of water. Extreme wave heights are generated by hurricanes and can reach 40 feet or more in deep water (NOAA 2017).

Future Without-Project Condition

The natural wind and wave climate will remain roughly the same as the existing condition with some potential changes related to changes in sea level.

2.4.2 Tides

Existing Condition

The tidal range throughout San Juan Harbor is uniform and microtidal. The astronomically-generated high and low tides within the Federal channel range from about one to two feet over the year.

Future Without-Project Condition

Tidal range will remain essentially the same as the existing condition, with some potential changes related to mean sea level change projections as discussed in 2.4.4. 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.

2.4.3 Currents

Existing Condition

Currents at San Juan Harbor are greatly influenced by the direction and strength of the trade winds. The trades blow primarily from the northeast, which in conjunction with the east-west alignment of the coastline results in a westerly, alongshore current. Surface currents show general westward drift (mean speed 0.6 knots) with a significant tidal component (USEPA 2011).

Future Without-Project Condition

Currents will remain the same as in the existing condition, but could experience some slight changes due to sea level changes.

2.4.4 Relative Sea Level Change

Existing Condition

The baseline sea level change scenario referenced to the midpoint of the latest National Tidal Datum Epoch (1992), produces a 0.39-foot (or 4.08-inch) increase between 2018 and 2075 for the "low" scenario, a 0.94-foot increase for the "intermediate" scenario, and a 2.29-foot increase for the "high" scenario. Relative sea level change was calculated using the USACE Sea Level Change Curve Calculator, which is available at: http://www.corpsclimate.us/ccaceslcurves.cfm. This calculator uses the methodology described in Engineer Regulation (ER) 1100-2-8162, *Incorporating Sea Level Changes in Civil Works Programs* (USACE 2013a). The tool also provides comparisons to scenarios in the NOAA Technical Report OAR CPO-1 titled *Global Sea Level Rise Scenarios for the United States National Climate Assessment* (2012); the National Research Council's (NRC) *Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future* report (NRC 2012); and the *NPCC2 Climate Risk Information 2013: Climate Methods Memorandum*, drafted by the New York City Panel On Climate Change (NPCC 2013b). At present, tracking changing sea level using a midpoint moving average shows that local mean sea level (LMSL) is generally tracking the low curve, with some variability in the intermediate range. But, a 5-year midpoint moving average, showing more variability as expected, shows recent trends at and above the intermediate scenario. Using the calculator and given that FEMA elevations are referenced to LMSL (PRV02), the 1% AEP with no waves could impact the lower BFE at Puerta de Tierra between 2045 (high scenario) and 2090 (intermediate scenario). The time to impact will be sooner than these estimates if waves are considered. Based on the FEMA maps, adverse impacts exist today under 1% AEP conditions and likely more frequent events as well.

Future Without-Project Condition

Potential impacts of rising sea level on total water levels experienced at the site include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. The total regional sea level change predicted by the three scenarios (baseline, intermediate, and high) will not have a significant impact to the performance of the San Juan Harbor Federal navigation project 1) as there are no associated emergent Federal General Navigation Features (GNF) which would need to be redesigned to account for SLC and greater wave loading and 2) because a small region of San Juan Harbor infrastructure is tied to the FEMA BFE which could be impacted between 2045 and 2090. A

positive potential impact of SLC on the project is a reduction in required maintenance due to increased depth in the channel, but this is not quantified.

2.4.5 Geotechnical

Existing Condition

The Commonwealth of Puerto Rico's geology can be divided into two broad formations belonging to rocks of volcanic or sedimentary origin. Those of sedimentary origin consist mostly of limestone, and are normally found underlying the northern part of the Island and sections of the southern coastal plains.

The coastal plain of San Juan Harbor shows a surficial geology dominated by lagoon and estuarine environments, covered by fluvial and eolian deposits that have dictated the geomorphologic evolution of this region. Estuary areas are characterized by low-lying flat land that has evolved to its present conditions by erosion, deposition, compaction, and subsidence, all of which are still active.

The study area is located within the shallow marine shelf that surrounds the Commonwealth of Puerto Rico. Sediments of Holocene to Pleistocene overlie limestone of Tertiary age. The limestone is found at depths varying from 40 feet to more than 100 feet in depth. Periods of fluctuating sea levels occurred during the glacial periods at the close of the Tertiary thus exposing the limestone allowing for weathering and erosion to occur. Shallow lagoons formed in depressions along the coast. Silt and clay were and still are transported from upland areas by rivers and streams and are deposited into the San Juan Harbor.

Details related to the geotechnical investigations for the study area are presented in the Engineering Appendix. Geotechnical investigations were conducted throughout the years for deepening projects and maintenance dredging. Thus, a variety of historic data that includes borings logs, and wash probe data are available, dating back to 1972. Various historic borings reach below the recent maximum dredging depth and are viable to evaluate the subsurface conditions of the proposed project. However, for the construction phase, additional investigations will be required to characterize unknown areas, as well as to characterize materials at greater depths.

The majority of the core borings reveal soft clay (CL) and stiff plastic clay (CH). Sand and gravel mixes were also encountered (i.e. sand mix, sand and clay, and gravel and clay). Some hard limestone and sandstone were also encountered. Materials encountered in each channel section are discussed below. Further rock description and considerations are included in the Engineering Appendix.

Cut-6: Boring logs indicate primarily sandy deposits, with possible lenses of gravel or layers of hard brown calcareous quartz sandstone, intermixed with soft clay or soft silt. Sand (SM) with gravel fragments are described to -44.3 in boring CB-SJ90-21. Rock was found at the end of the boring. None of the existing borings extend to the proposed depth. Wash probes encountered refusal at similar depths. Additional borings will be required to delineate the subsurface material.

Anegado Channel: Anegado Channel bottom material is characterized primarily by very soft clay with very low strength, with lesser occurrence of high plastic clays. Limestone or sandstone may be present below a depth of approximately -50 feet MLLW. This is six feet below the proposed project depth and it is not anticipated to be encountered.

Army Terminal Channel and Army Terminal Turning Basin: Materials encountered in the Army Terminal Channel and Army Terminal Turning Basin are primarily soft clay, clay and sand, with a few instances of weathered rock. The clay is generally highly plastic, and includes traces of shell, sand, and gravel.

Information available is limited to the existing channel. No data is available for the proposed widening. Rock interlayered with clays were found during the last widening of the Army Terminal Channel. Medium hard to hard limestone and sand and clay interlayers are found within the dredging template. Seismic surveys and additional borings are needed to delineate the location of what, if any, rock exists in this area because that data cannot be ascertained from the standard placement of core borings. Nonetheless, the USACE has environmental resource side scan sonar and towed video, as well as cultural resource remote sensing surveys of the widening measures and areas beyond the widening measures. These document the area and the results indicate this project would not have a direct impacts to environmental resources.

Cruise Ship Basin East: Materials in the Cruise Ship Basin are mostly unconsolidated materials primarily composed of soft clays and sandy material. Refusal was encountered in some wash probes refusal depths of -40 MLLW, below the proposed dredge template.

San Antonio Approach Channel and San Antonio Channel: San Antonio Channel constructed depth is approximately -36 feet MLLW, meeting the currently authorized project depth of -35 feet MLLW and also the proposed project depth of -36 feet MLLW. Therefore, no new work is necessary to obtain the proposed depth with the exception of contract overdepths.

San Antonio Channel Extension and Expansion: No geotechnical information is currently available for the San Antonio Channel Extension areas. However, the sponsor is currently constructing the expansion area to the authorized project depth of -36 feet MLLW, plus applicable overdepths. It is assumed that Federal involvement in this area will be limited to Operations and Maintenance (O&M) in the future.

Core boring logs, wash probes, and various laboratory results, including grain size analysis and suspended sediment-time curves are included in Attachment B of the Engineering Appendix.

Future Without-Project Condition

No geotechnical changes are anticipated in the future without-project condition.

Shoaling Rate Existing Condition

Shoaling occurs when sediments fall out of suspension and deposit on the bottom of a body of water. Sediments enter the harbor from overland runoff, shoreline erosion, and, stormwater discharges, etc. While shoals are generally favorable for fish habitat, they present a problem for navigation when they impede either recreational or commercial vessel traffic. Shoaling within the navigation channel does not occur in every reach of the channel; rather, it occurs in particular reaches and rates and magnitudes are higher in some reaches than others. Historic dredging records were analyzed to aid in determining maintenance dredging quantities for each reach. Maintenance dredging data and details of the analysis can be found in the Engineering Appendix.

Future Without-Project Condition

A Sediment Trend Analysis (STA) was performed in 2002 by GeoSea Consulting (Canada) Ltd. for San Juan Harbor (Engineering Appendix, Attachment A). The analysis delineated regions of the harbor where the sediment transport regimes were described as Dynamic Equilibrium, Net Accretion, Net Erosion, and Total Deposition in the Engineering Appendix. In addition, the STA analysis detailed the different regions of the harbor and the processes that lead to the particular transport regime. Results of the analysis, detailed in the Engineering Appendix, conclude that shoaling would continue in the

future without-project condition in the same areas it occurs now. The existing maintenance dredging schedule and methods would continue for the future without-project condition.

2.4.6 Water Quality

Existing Condition

San Juan Harbor is an important component of the San Juan Bay estuary system which includes San Juan Bay, the Condado Lagoon, the San José Lagoon, Los Corozos Lagoon, La Torrecilla Lagoon, and the Piñones Lagoon, as well as the interconnecting Martín Peña and San Antonio Channels and the Suárez Canal. "San Juan Bay is the focal point for most of the past and present development within the San Juan metropolitan area, and the bay's drainage basin has been almost completely urbanized. The intensity and diversity of human activities taking place within the metropolitan area have influenced the water and sediment quality of the estuary in many ways, impairing in many instances its functions and values" (SJBEP 2000). However, San Juan Bay's direct connection to the Atlantic Ocean via the Boca del Morro results in average dissolved oxygen levels between 5.0-6.5 mg/L and salinities of 33-37 ppt just below the water's surface (-2 feet) within San Juan Harbor (Anamar 2008; Anamar 2011). The Rio Puerto Nuevo turning basin is located in the southeast portion of the harbor near the mouth of the Puerto Nuevo River which is the main source of sediment and fresh water into the harbor. The River connects to the low flowing Caño Martín Peña which connects to the San José Lagoon. The Caño Martín Peña and San José Lagoon are severely degraded from highly turbid, organic and bacteria-rich waters with low levels of dissolved oxygen.

Freshwater flows from the Puerto Nuevo River are driven by local rainfall which flushes untreated and treated stormwater runoff and wastewater from Caño Martín Peña and San José Lagoon into the harbor. Despite this, the Puerto Rico Environmental Quality Board (EQB), through the promulgation of the Puerto Rico Water Quality Standards Regulation, has designated the waters of the San Juan Harbor as SC, Coastal waters intended for uses where the human body may come in direct contact with the water (such as fishing, boating, etc.) and for use in propagation and preservation of desirable species. The turbidity standard for SC waters in Puerto Rico is not to exceed 10 nephelometric turbidity units (NTU), except by natural phenomena (EQB 2016). To date sediments from the harbor have been suitable for placement in the San Juan ODMDS.

A Water Quality Certification (WQC) (33 U.S.C. §1341) pursuant to Section 401 of the Clean Water Act (CWA) was issued to the USACE for disposal of dredged material associated with the project by EQB on January 14, 2015 (Appendix K). This WQC covers the discharge of dredged material into the Condado lagoon artificial depressions. Special protocols are in place to manage the discharge, including turbidity increases, in an environmentally acceptable manner. A new WQC will be sought from EQB for the new dredging areas after completion of this IFR/EA. Per the process of obtaining a WQC in Puerto Rico, any NEPA documentation will be submitted to the Office of Permits General (OGPe) after signature/approval for another round of public and agency coordination. Once the OGPe approves the project by letter, that letter and the CZMA consistency concurrence is submitted to the EQB who will then issue the WQC.

Future Without-Project Condition

Operations and maintenance dredging activities would continue to cause temporary increases in turbidity along and adjacent to the navigation channel when dredging is occurring. EQB water quality regulations require that water quality standards not be violated during dredging operations. The USACE would continue to maintain the harbor under the existing Section 401 WQC. The existing

Section 401 WQC contains various protective measures that would continue to ensure compliance with the Commonwealth's water quality criteria.

2.4.7 Wetlands and Submerged Aquatic Vegetation (SAV)

Existing Condition

Centuries of development have severely altered the natural ecosystems of San Juan Harbor. Most of the shoreline is now hardened and developed. However, the San Juan Bay Estuary is the largest estuary in Puerto Rico, part of the National Estuary Program (NEP), and an estuary of national importance. Coastal mangrove wetland habitats are still found along La Esperanza peninsula and at the mouth of the Puerto Nuevo River. Mangrove species found in San Juan Harbor include: red (*Rhyzophora mangle*), black (*Avicennia germinans*), and white (*Laguncularia racemosa*). Like seagrasses, mangroves are a highly productive habitat that "provide feeding, breeding, nesting, and roosting areas for birds, mammals, and reptiles, with the vegetative detritus of mangroves serving as the base of the food web for crabs, mollusks, shrimp, and fish, among others" (SJBEP, 2000). Mangroves are important for shoreline protection and stabilization. In addition, mangrove habitats provide many important ecological functions, including providing refuge for juvenile stages of managed fish species and have been identified as significant resources for federally listed species. These systems also provide organic matter that forms the basis of a littoral-zone, marine food web. Sloughs (channels of slow-moving water) penetrate mangrove wetlands adjacent to channel areas. Some of these sloughs are natural, while some are man-made. These are extremely important areas that provide species with passageways for movement into and out of interior mangrove areas. They are also important for refuge and feeding areas for various fishes and invertebrates such as juvenile spiny lobster (*Panulirus argus*) and gray snapper (*Lutjanus griseus*).

As with most dredging projects, it is important to consider impacts to subsurface features that serve as essential fish habitat (EFH) or provide unique habitat features or services. The predominant benthic substrate within the project area is mud with invertebrate burrow holes. However, submerged aquatic vegetation (SAV) consisting of marine macro-algae and seagrass occurs within San Juan Harbor at scattered locations and generally at depths less than -15feet (-4.6 meters). Both red and green macro-algae are prevalent throughout the bay. Seagrass species include shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudinum*). All four species of seagrass occur in Condado Lagoon while manatee, turtle, and paddle grass occur along the shorelines adjacent to the San Juan Marina east of the terminus of the San Antonio Channel. Scattered turtle and paddle grass beds have been found in San Juan Bay (NOAA 2016; USACE 2017). These include mono-specific beds of paddle grass, mixed red and green macro-algae with paddle grass, and sparse turtle grass as documented with underwater video during benthic surveys conducted by the NMFS and the USACE from January through December 2016 (Reports available at: http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/.

Seagrasses significantly modify the physical, chemical, and geological properties of coastal areas; they provide nutrients, primary energy, and habitats which sustain our coastal fisheries resources; and they provide foraging grounds for some endangered marine species (Vicente, 1990). Federally protected species such as green sea turtles (*Chelonia mydas*) and Antillean manatees (*Trichechus manatus manatus*) feed directly on seagrasses. Seagrass beds also serve as a substrate for epiphytes, such as filamentous algae and epiphytic diatoms, which in turn serve as food for invertebrates and fish.

Future Without-Project Condition

In the future without-project condition/No Action Alternative, O&M dredging will have no effect on existing mangrove wetlands in San Juan Harbor. O&M dredging at the currently authorized depths could result in minor indirect impacts to SAV due to turbidity. A greater number of vessels are anticipated to call on the port in the future without-project condition. Therefore, more pressure wave and propeller wash impacts to SAV habitat could occur, which could limit the growth of this habitat.

2.4.8 Hardbottom Habitat

Existing Condition

In addition to the SAV, hardbottom habitat occurs within San Juan Harbor but primarily adjacent to entrance channel Cuts 1-3 (narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes [i.e., eolianites], see Figure 2-3 along the Cataño shoreline (scattered rocks with macro-algae, Figure 2-4), and elsewhere on hard substrates (rocks, pilings, docks, bulkheads). Encrusting zoanthids, octocorals (*Leptogorgia, Briareum*), sponges, polychaetes, and sea stars have been documented. Scleractinian corals (including seven threatened species) are found on the fringing reefs along the northern coastline.

Hardbottom habitat provides valuable structure for benthic (occurring at the bottom of a body of water) fauna and flora, as well as fish habitat. Hardbottom refers to a classification of coral communities that occur in temperate, subtropical, and tropical regions that lack the diversity, density, and reef development of other types of coral communities (SAFMC 1998). For the purposes of this investigation, hardbottom habitat is defined as exposed areas of rock or consolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by a thin veneer of live or dead biota (the plant and animal life of a region). Hardbottom provides habitat and foraging grounds for a diverse array of invertebrate and fish species. These communities support habitat-structuring sessile (non-mobile) epifauna (organisms living on the sea floor) such as sponges, corals, bryozoans, and ascidians (Burgess et al. 2011).

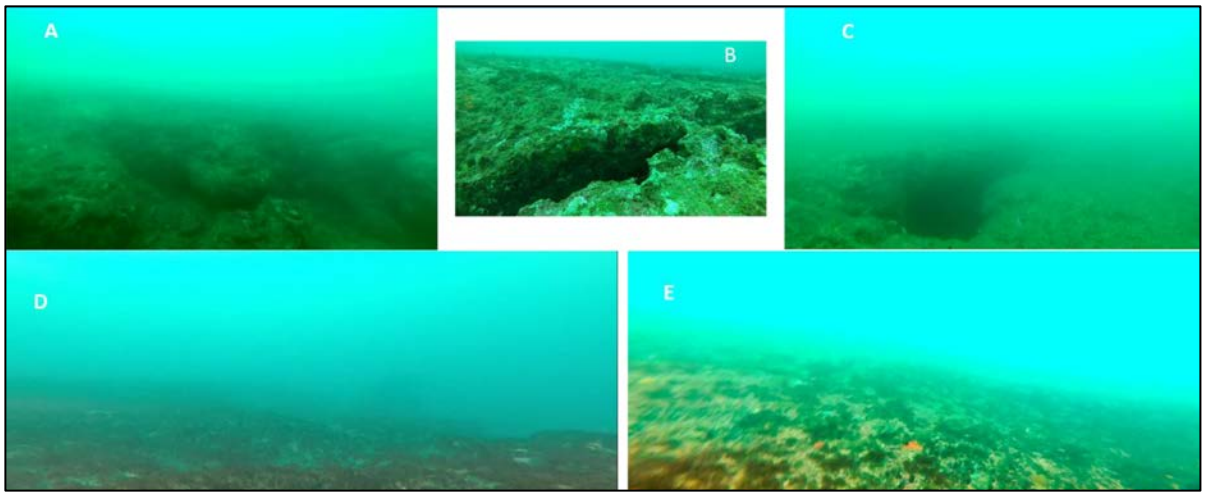

Figure 2-3: Limestone substrate adjacent entrance channel (Source: NOAA 2016)

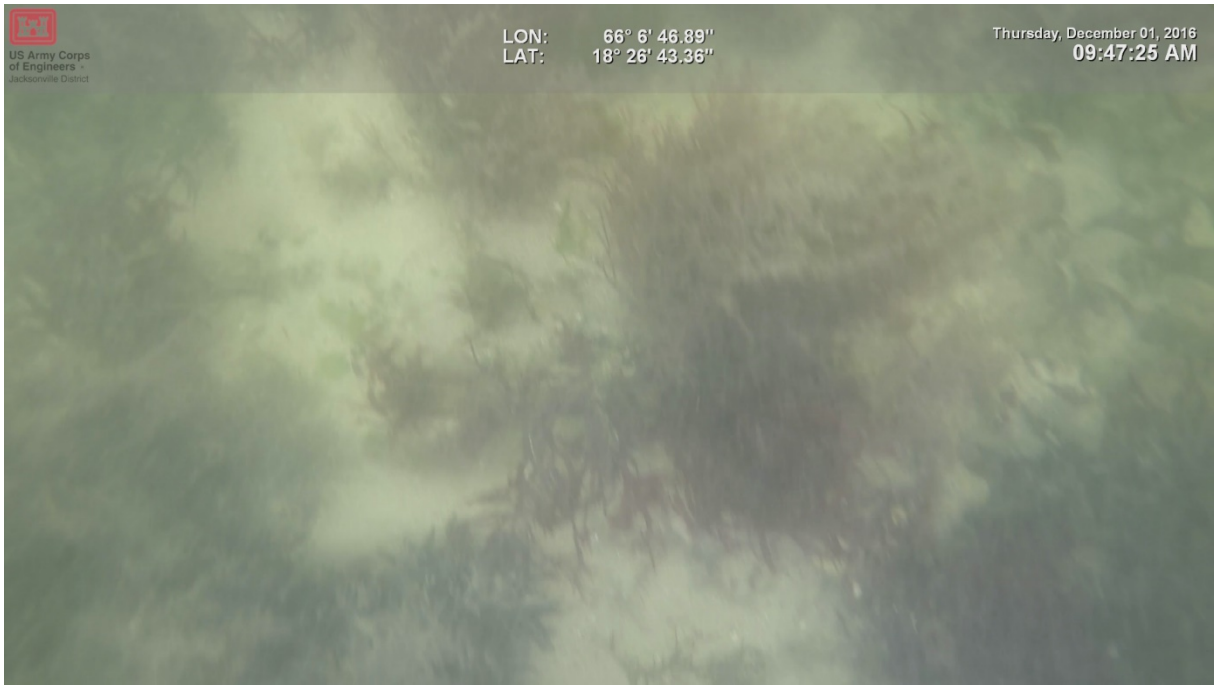

Figure 2-4: Cataño hardbottom with macro-algae

Future Without-Project Condition

Continuing to perform O&M dredging at the currently authorized depths could result in minor indirect impacts to hardbottom benthos due to turbidity. The bottom of the channels would normally be recolonized by organisms from adjacent similar habitats following completion of dredging events. No direct impacts to hardbottom habitats are anticipated in the future without-project condition. An increase in the number of vessels calling on the port would be expected to increase propeller wash impacts to hardbottom habitat, which could limit the growth of this habitat.

2.4.9 Essential Fish Habitat

Existing Condition

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. §801 *et. seq*.) set forth a new mandate for the NMFS, regional fishery management councils (FMC), and other Federal agencies to promote the protection, conservation, and enhancement of EFH. The EFH provisions of the Magnuson-Stevens Act support one of the nation's overall marine resource management goals to maintain sustainable fisheries. The Magnuson-Stevens Act's final rule, to manage fishery resources and their habitats, was released on January 17, 2002. NMFS and its affiliate, the CFMC, oversee the managed species and their habitats potentially found within the proposed project's footprint. If a construction, permitting, funding, or other proposed action potentially affects EFH(s), then applicable Federal permitting agencies must consult with the NMFS. The EFH consultation ensures the potential action considers the effects on important habitats and supports the management of sustainable marine fisheries (NOAA, South Atlantic Region 2008).

In the Caribbean waters under the jurisdiction of the U.S., EFH is identified and described based on areas where the life stages of 17 managed species of fish and marine invertebrates occur. Fourteen of the 17 managed species, which have been documented in the study area, are listed in Table 2-6 below.

Since all of these species occur in all habitats within the Caribbean waters under U.S. jurisdiction, EFH includes all waters and substrates, including coral habitats, submerged vegetation, and adjacent intertidal vegetation, including wetlands and mangroves that are necessary for the reproduction, growth, and feeding of marine species.

All of San Juan Harbor is tidally influenced, so it and adjacent wetlands are considered EFH. Therefore, EFH within the project area includes estuarine and marine submerged and emergent vegetation, tidal freshwater wetlands, tidal creeks, water column, intertidal and subtidal mudflats (unconsolidated bottom), coastal inlets, coral and artificial reefs, and hardbottom. Many of these habitats foster growth and provide food and protection from predators and are integral to producing healthy populations of commercially and recreationally important species. Species that may occur in the project area habitats are noted in Table 2-6.

Table 2-6: Managed species documented in the study area

Species	Common Name	SPAG*	FMP
Chaetodon striatus	Banded Butterflyfish		Reef Fish - aquarium trade
Epinephelus guttatus	Red Hind	X	Reef Fish
Cephalopholis fulvus	Coney	X	Reef Fish
Lutjanus analis	Mutton Snapper		Reef Fish
Lutjanus apodus	Schoolmaster		Reef Fish
Lutjanus griseus	Gray Snapper	X	Reef Fish
Ocyurus chrysurus	Yellowtail Snapper	X	Reef Fish
Haemulon plumieri	White Grunt		Reef Fish
Balistes vetula	Queen Triggerfish		Reef Fish
Sparisoma chrysopterum	Redtail Parrotfish		Reef Fish
Holocentrus ascensionis	Squirrelfish		Reef Fish
Malacanthus plumieri	Sand Tile Fish		Reef Fish
Panulirus argus	Spiny Lobster		Spiny Lobster
Strombus gigas	Queen Conch		Queen Conch

Source: Rivera, 2015; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011. *SPAG: Potential Spawning Aggregation site in San Juan Bay (Ojeda, 2007).

Per the Fishery Management Plan (FMP) for each of the four groups below, EFH is defined as (CFMC and NOAA 2004):

Spiny Lobster FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the exclusive economic zone (EEZ) - habitats used by phyllosoma larvae and seagrass, benthic algae, mangrove, coral, and live/hardbottom substrates from MHW to 100 fathoms depth used by other life stages.

Queen Conch FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the EEZ – habitats used by eggs and larvae and seagrass, benthic algae, coral, live/hardbottom and sand/shell substrates from MHW to 100 fathoms depth used by other life stages.

Reef Fish FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the EEZ – habitats used by eggs and larvae and all substrates from MHW to 100 fathoms depth used by other life stages.

Coral FMP: EFH in the U.S. Caribbean consists of all waters from mean low water (MLW) to the outer boundary of the EEZ (Figure 2-5) – habitats used by larvae and coral and hardbottom substrates from MLW to 100 fathoms depth – used by other life stages.

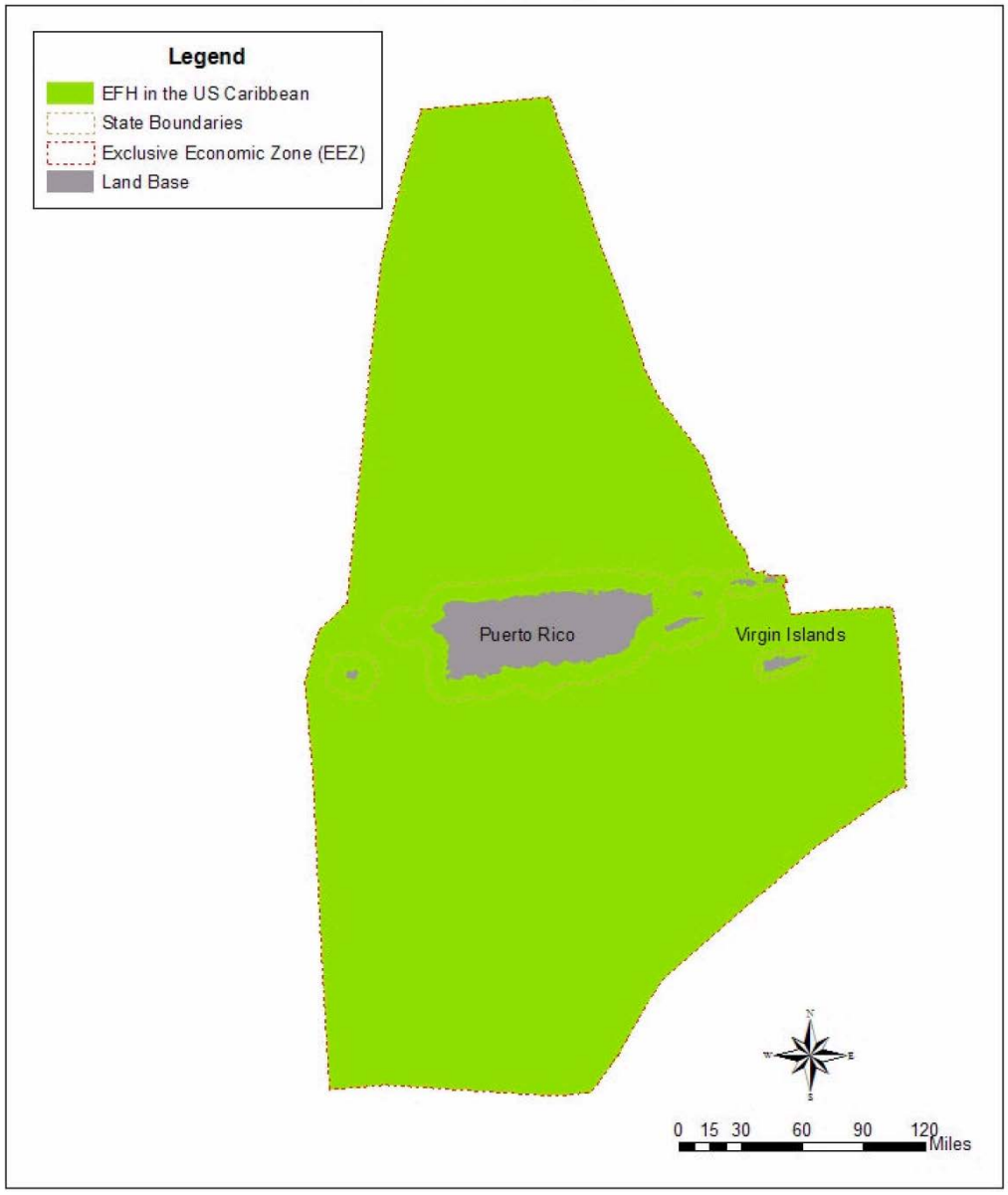

Figure 2-5: Composite EFH for species and life stages of the Spiny Lobster, Queen Conch, Reef Fish, and Coral.

Future Without-Project Condition

No new EFH areas will be dredged for maintenance of Federal navigation channels. Only previously dredged EFH (unvegetated, unconsolidated bottom and estuarine water column) would continue to

be impacted through previously authorized operations and maintenance dredging activities that are needed to address shoaling. The closest EFH Habitat Area of Particular Concern (HAPC) and Marine Protected Areas (MPA) are the Isla Verde MPA and the Piñones State Forest (PSF) located approximately six and 12-15 km (respectively) east of San Juan Harbor. PSF contains the largest remaining mangrove forest in Puerto Rico with all four species present and serves as habitat for at least 38 species of fish (CFMC and NOAA, 2004). Although the Forest is part of the estuarine system of San Juan Bay, it lies outside the area of influence of San Juan Harbor O&M activities.

Therefore, the continued maintenance dredging of the authorized channel depths would not have a substantial adverse impact on EFH or federally-managed fisheries along the north coast of Puerto Rico as discussed in previous NEPA documents for San Juan Harbor operations and maintenance dredging. Substrates within the project area are naturally dynamic and unconsolidated, and measures are implemented. 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 actual channel widths encompass a fraction of the entire water body, and similar habitat occurs immediately adjacent to the channels.

Other Marine/Estuarine Habitats

Benthic macrofauna serve as ecologically important components of the food web by consuming detritus, plankton, and smaller organisms living in the sediments and in turn serving as prey for finfish, shrimp, and crabs. Benthic macrofauna are also relatively sedentary, and many species are sensitive to changing environmental conditions. Dominant species in the harbor channels include mollusks, polychaetes, oligochaetes, nematodes, and amphipods. Populations in the navigation channel are assumed to be not as stable and numerically abundant as nearby wetlands and mudflats due to the frequent disturbance by maintenance dredging.

2.4.10 Protected Species

The USFWS and NMFS have responsibilities under the Endangered Species Act of 1973 (16 U.S.C. §1531 *et. seq.*) (ESA) to protect certain species. There are many threatened and endangered (T&E) species known to occur near San Juan Harbor. However, not all of them would be affected by a proposed action. Accordingly, the USACE is working with USFWS Field Office in Boquerón, Puerto Rico, as well as the NMFS Southeast Regional Office in St. Petersburg, Florida, to focus on the species listed in Table 2-7. This list includes the federally-listed T&E species that could be present in the area based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors. The following sections summarize species-specific information relevant to the Study area.

Table 2-7: Selected federally-threatened and endangered species potentially present in the vicinity of San Juan Harbor, Puerto Rico

Common Name	Scientific Name	Status	Year Listed
Marine Mammals			
Sei whale	Balaenoptera borealis	E	1970
Sperm whale	Physeter macrocephalus	E	1970
Blue whale	Balaenoptera musculus	E	1970
Finback whale	Balaenoptera physalus	E	1972
Antillean Manatee	Trichechus manatus	T	2017
Marine Turtles			
Leatherback turtle	Dermochelys coriacea	E	1970
Loggerhead turtle	Caretta	Northwest Atlantic Ocean DPS;	2011
Hawksbill turtle	Eretmochelys imbricata	E	1970
Green turtle	Chelonia mydas	Northwest Atlantic DPS; T	2016
Fish			
Scalloped hammerhead	Sphyrna lewinii	Northwest Atlantic DPS; TT	2014
Nassau grouper	Epinephelus striatus	T	2016
Giant manta ray	Manta birostris/ M. alfredi	T (proposed)	2017
Corals			
Elkhorn coral	Acropora palmata	T	2006
Staghorn coral	Acropora cervicornis	T	2006
Pillar coral	Dendrogyra cylindrus	T	2014
Rough Cactus Coral	Mycetophyllia ferox	T	2014
Lobed Star Coral	Orbicella annularis	T	2014
Mountainous Star Coral	Orbicella faveolata	T	2014
Boulder Star Coral	Orbicella franksi	T	2014

E – federally-endangered
T – federally-threatened
Endangered: A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened: A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

2.4.10.1 Fishes

2.4.10.1.1 Scalloped Hammerhead Shark

Existing Condition

The hammerhead sharks are recognized by their laterally expanded head that resembles a hammer. The scalloped hammerhead shark (*Sphyrna lewinii*) is distinguished by a marked central indentation on the anterior margin of the head, along with two more indentations on each side of this central indentation, giving the head a "scalloped" appearance. The body is fusiform, with a large first dorsal fin and low second dorsal and pelvic fins. Coloration is generally uniform gray, grayish brown, bronze, or olive on top of the body that shades to white on the underside with dusky or black pectoral fin tips. This shark is a high trophic level predator and opportunistic feeder with a diet that includes a wide variety of teleosts, cephalopods, crustaceans, and rays. The northwest Atlantic Ocean distinct population segment (DPS) was listed under the ESA as threatened on September 2, 2014.

Estuaries and coastal embayments have been identified as particularly important nursery areas, while offshore waters contain important spawning and feeding areas. Adult habitat consists of continental shelf areas further offshore, with adult aggregations common over seamounts and near islands.

The scalloped hammerhead shark can be found in coastal warm temperate and tropical seas worldwide. In the western Atlantic Ocean, the species range extends from the northeast coast of the United States (from New Jersey to Florida) to Brazil, including the Gulf of Mexico and Caribbean Sea. The species could occur along the north coast of Puerto Rico.

Future Without-Project Condition

There would continue to be no effect on scalloped hammerhead sharks from normal operations and maintenance dredging activities (USACE/BOEM 2017). Dredging would continue to operate in accordance with the most up to date Regional Biological Opinion. No additional effects on this species are anticipated in the future without-project condition.

2.4.10.1.2 Nassau Grouper

Existing Condition

The Nassau grouper (*Epinephelus striatus*) is a long-lived (29 years maximum), moderate sized Serranid fish with large eyes and a robust body. The range of color is wide, but ground color is generally buff, with five dark brown vertical bars and a large black saddle blotch on top of caudal peduncle and a row of black spots below and behind its eye. There is also a distinctive dark tuning-fork mark beginning at the front of the upper jaw, extending dorsally (on top) along the interorbital region, and then dividing into two branches on top of the head behind the eyes; another dark band from the tip of the snout through the eye and then curving upward to meet its fellow just before the dorsal-fin origin. Juveniles exhibit a color pattern similar to adults. On 29 June 2016, NMFS issued a final rule (81 FR 42268; 50 CFR Part 223) listing the Nassau Grouper as a threatened species under the ESA.

The Nassau grouper is primarily a shallow-water, insular fish species that has long been valued as a major fishery resource throughout the wider Caribbean, South Florida, Bermuda, and the Bahamas. The Nassau grouper is considered a reef fish, but it transitions through a series of developmental shifts in habitat. The larvae are planktonic and after 35-40 days recruit from an oceanic environment into demersal habitats hiding in macroalgae, coral, and seagrass beds.

The Nassau grouper's confirmed distribution currently includes Bermuda, Florida, throughout the Bahamas, and Caribbean Sea. The species does occur along the north coast of Puerto Rico.

Future Without-Project Condition

There would continue to be no effect on Nassau grouper from normal O&M dredging activities (USACE/BOEM 2017). Dredging would continue to operate in accordance with the most up to date Regional Biological Opinion. No additional effects on this species are anticipated in the future without-project condition.

2.4.10.1.3 Giant Manta Ray

Existing Condition

On January 12, 2017, NMFS published a proposed rule in the Federal Register (82 FR 3694) to list the giant manta ray and reef manta ray (*Manta birostris/M. alfredi*) as threatened species under the ESA. The distribution of the giant manta ray is worldwide in tropical and temperate ocean waters. On the U.S. Atlantic Coast, the giant manta ray has been documented as far north as New Jersey. The giant manta ray is commonly encountered on shallow reefs or sighted feeding offshore at the surface. The giant manta ray is occasionally observed in sandy bottom areas and seagrass beds. Regional sub-populations appear to be small and generally contain less than 1,000 adult individuals and are generally declining except for those areas where they are specifically protected (Hawaii, Maldives, Yap, and Palau). The primary threats to *manta* species are targeted fishing and fishery bycatch.

Future Without-Project Condition

There would continue to be no effect on the giant manta ray from normal operations and maintenance dredging activities (USACE/BOEM 2017). Dredging would continue to operate in accordance with the most up to date Regional Biological Opinion. No additional effects on this species are anticipated in the future without-project condition.

2.4.10.3 Sea Turtles

Existing Condition

The presence of four different sea turtles species could occur in the study area, loggerhead, leatherback, hawksbill, and green. Of the four species, the hawksbill and green are the most common in San Juan Harbor. Although sandy beach habitat occurs within San Juan Harbor along La Esperanza and in Condado Lagoon, DNER has not officially documented nesting there (Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, personal communication, July 12, 2016). Sea turtle nesting is limited to the sandy beaches along the north coast of Puerto Rico adjacent to San Juan Harbor.

Leatherback. Leatherback sea turtles (*Dermochelys coriacea*) are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian oceans (Ernst and Barbour, 1972). Leatherback turtles are the largest living turtles and have a larger migration range than any other sea turtle species. The leatherback is the most pelagic (open ocean) of the sea turtles and is often seen near the edge of the continental shelf; however, they are also observed just offshore of the surf line. They enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

Zug and Parham (1996) pointed out that the main threat to leatherback populations in the Atlantic is the combination of fishery-related mortality (especially entanglement in gear and drowning in trawls) and the intense egg harvesting on the main nesting beaches. Boat strikes are also a threat and source of mortality for leatherbacks in Puerto Rico. There is potential for leatherbacks to be present off the north coast during migration and leatherback nesting has been documented on the sandy beach north of the Avenida Ashford (Dos Hermanos) Bridge (USFWS, 2005 – Harberer 2005). No critical habitat has been designated for leatherback turtles in the project area.

Loggerhead. The loggerhead (*Caretta caretta*) is characterized by a large head with blunt jaws. The carapace and flippers are a reddish-brown color; the plastron is yellow. Adults grow to an average weight of about 200 pounds. The USFWS and the NMFS listed the Northwest Atlantic Ocean DPS of the loggerhead sea turtle as threatened on September 22, 2011 (76 FR 58868).

No loggerhead sea turtle nesting has ever been documented in Puerto Rico (Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, personal communication, July 12, 2016). The species feeds on mollusks, crustaceans, fish, and other marine animals. The loggerhead sea turtle can be found throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. This species could occur offshore San Juan Harbor. No critical habitat has been designated for loggerhead turtles in the project area.

Hawksbill. The hawksbill turtle (*Eretmochelys imbricata*) is small to medium-sized compared to other sea turtle species. Hawksbill turtles are unique among sea turtles in that they have two pairs of prefrontal scales on the top of the head and each of the flippers usually has two claws. This species was listed under the ESA as endangered in 1970.

Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with healthy coral reefs. The ledges and caves of coral reefs provide shelter for resting hawksbills both during the day and at night. Hawksbills are known to inhabit the same resting spot night after night. Hawksbills are also found around rocky outcrops and high energy shoals. These areas are optimum sites for sponge growth, which certain species are the preferred food of hawksbills. They are also known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

The nesting season varies with locality, nesting occurs all year long in Puerto Rico. Hawksbills nest at night and, on average, about 4.5 times per season at intervals of approximately 14 days. They nest under the vegetation on the high beach and nests have been observed having the last eggs of the clutch as close as 3 inches from the sand's surface. Hawksbill sea turtles have been reported in San Juan Bay and nesting has been documented on the sandy beach north of the Avenida Ashford (Dos Hermanos) Bridge (USFWS, 2005 – Harberer 2005). DCH habitat for this species occurs approximately 50 miles east of the project area around Culebra Island.

Green. The nesting range of green sea turtles in the southeastern United States includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina, the U.S. Virgin Islands (USVI) and Puerto Rico (NMFS and USFWS, 1991). Green turtles (*Chelonia mydas*) are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. Green turtle foraging areas in the southeastern United States include any coastal shallow waters having macroalgae or sea grasses, including areas near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic (open ocean) organisms (Hirth, 1997; NMFS and USFWS, 1991). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. DCH for this species occurs approximately 50 miles east of the project area around Culebra Island. The SAV habitat found in San Juan Harbor and Condado Lagoon are important grazing areas for the green sea turtle.

Future Without-Project Condition

Effects on sea turtles resulting from O&M activities in the future without-project condition would not change. Maintenance dredging using hopper dredges would continue to be prohibited in Puerto Rico until NMFS issues an updated South Atlantic Regional Biological Opinion (SARBO). An updated Biological Assessment under the SARBO was provided to NMFS in June 2017 that includes the use of hopper dredges in Puerto Rico for operations and maintenance dredging. It is anticipated that hopper

dredges will be utilized for O&M operations under the SARBO in the foreseeable future to improve efficiency.

2.4.10.4 Whales

Existing Condition

Fin or Finback Whale. Fin or finback whales (*Balaenoptera physalus*) are the second-largest species of whale, with a maximum length of about 75 feet (22 meters) in the Northern Hemisphere, and 85 feet (26 meters) in the Southern Hemisphere. Adults can weigh between 80,000-160,000 lbs. (40-80 tons). Fin whales have a sleek, streamlined body with a V-shaped head. They have a tall, "falcate" dorsal fin, located about two-thirds of the way back on the body, that rises at a shallow angle from the animal's back. Within the United States, the fin whale is listed as endangered throughout its range under the ESA and is listed as "depleted" throughout its range under the Marine Mammal Protection Act of 1972 (MMPA) (16 U.S.C. §1361 *et. seq.*).

Fin whales can be found in social groups of two to seven whales and in the North Atlantic are often seen feeding in large groups that include humpback whales, minke whales, and Atlantic white-sided dolphins. Fin whales are large, fast swimmers and the killer whale (*Orcinus orca*) is their only non-human predator. During the summer, fin whales feed on krill, small schooling fish (e.g. herring, capelin, and sand lance), and squid by lunging into schools of prey with their mouth open, using their 50- 100 accordion-like throat pleats to gulp large amounts of food and water. They then filter the food particles from the water using the 260-480 "baleen" plates on each side of the mouth. Fin whales fast in the winter while they migrate to warmer waters. Males become sexually mature at 6-10 years of age; females at 7-12 years of age. Physical maturity is attained at approximately 25 years for both sexes. After 11-12 months of gestation, females give birth to a single calf in tropical and subtropical areas during midwinter. Newborn calves are approximately 18 feet (6 meters) long, and weigh 4,000-6,000 lbs. (2 tons). Fin whales can live 80-90 years.

Fin whales are found in deep, offshore waters of all major oceans, primarily in temperate to polar latitudes, and less commonly in the tropics. They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. The species could occur off the north coast of Puerto Rico in the vicinity of the ODMDS. No DCH has been designated for this species in the project area.

Humpback Whale. Humpback whales live in all major oceans from the equator to sub-polar latitudes. They typically migrate between tropical/sub-tropical and temperate/polar latitudes. In the Atlantic Ocean, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Six separate feeding areas are utilized in northern waters after their return. These areas are within the biologically important area defined by the 200 meters (656 feet) isobath on the North American east coast. These areas are outside of the project's potential impact area.

On September 8, 2016 NMFS delisted the West Indies Distinct Population Segment (DPS) (one of fourteen DPSs for this species worldwide) but the species is still protected under the MMPA. The best available estimate for the number of individuals in the North Atlantic is 11,750 humpback whales. Recent estimates of abundance in the North Atlantic stock indicate continued population growth; however, the size of the humpback whale stock may be below the optimum sustainable population in the U.S. Atlantic Exclusive Economic Zone (NOAA Fisheries, Office of Protected Resources, Waring, 2011).

Humpback whales face many threats due to human activity. They may become entangled in fishing gear, either swimming away with the gear after entanglement or by becoming anchored by it. Inadvertent vessel strikes can injure or kill humpbacks. Whale watching vessels may harass/stress or strike whales. Traffic through shipping channels, fisheries and aquaculture may displace whales that normally aggregate in that area. No critical habitat has been designated for humpback whales. The species could occur off the north coast of Puerto Rico in the ODMDS.

Sei Whale. Sei whales (*Balaenoptera borealis*) are members of the baleen whale family and are considered one of the "great whales" or rorquals. Two subspecies of sei whales are recognized, *B. B. borealis* in the Northern Hemisphere and *B. B. schlegellii* in the Southern Hemisphere. These large animals can reach lengths of about 40-60 feet (12-18 meters) and weigh 100,000 lbs. (45,000 kg). Sei whales have a long, sleek body that is dark bluish gray to black in color and pale underneath. They have 219-410 baleen plates that are dark in color with gray/white fine inner fringes in their enormous mouths.

This species was listed under the ESA as endangered in 1970. They are usually observed singly or in small groups of 2-5 animals, but are occasionally found in larger (30-50) loose aggregations. Sei whales are capable of diving 5-20 minutes to opportunistically feed on plankton (e.g., copepods and krill), small schooling fish, and cephalopods (e.g., squid) by both gulping and skimming. Sei whales become sexually mature at 6-12 years of age when they reach about 45 feet (13 meters) in length, and generally mate and give birth during the winter in lower latitudes. Females give birth to a single calf that is about 15 feet (4.6 meters) long and weighs about 1,500 lbs. (680 kg). Sei whales have an estimated lifespan of 50-70 years.

Sei whales have a cosmopolitan distribution and occur in subtropical, temperate, and subpolar waters around the world. They prefer temperate waters in the mid-latitudes and can be found in the Atlantic, Indian, and Pacific Oceans. During the summer, they are commonly found in the Gulf of Maine and on Georges Bank and Stellwagen Bank in the western North Atlantic. Populations of sei whales, like other rorquals, may seasonally migrate toward the lower latitudes during the winter and higher latitudes during the summer. They prefer subtropical to subpolar waters on the continental shelf edge and slope worldwide and they are usually observed in deeper waters of oceanic areas far from the coastline. The species could occur off the north coast of Puerto Rico in the vicinity of the ODMDS. No DCH has been designated for this species in the project area.

Sperm Whale. Sperm whales (*Physeter macrocephalus*) are the largest of the odontocetes (toothed whales). Adult females may grow to lengths of 36 feet (11 meters) and weigh 15 tons (13,607 kg) while adult males reach about 52 feet (16 meters) and may weigh as much as 45 tons (40,823 kg). The sperm whale is distinguished by its extremely large head, which takes up to 25 to 35% of its total body length. There are between 20-26 large conical teeth in each side of the lower jaw. Sperm whales are mostly dark gray, but oftentimes the interior of the mouth is bright white and some whales have white patches on the belly.

This species was listed under the ESA as endangered in 1970. Because sperm whales spend most of their time in deep waters, their diet consists of many larger organisms that also occupy deep waters of the ocean. Their principle prey are large squid weighing between 3.5 ounces and 22 pounds (0.1 kg and 10 kg), but they will also eat large demersal and mesopelagic sharks, skates, and fishes. Female sperm whales reach sexual maturity around 9 years of age when they are roughly 29 feet (9 meters) long. After a 14-16 month gestation period, a single calf about 13 feet (4 meters) long is born. Although

calves will eat solid food before one year of age, they continue to suckle for several years. Most females will form lasting bonds with other females of their family and, on average, 12 females and their young will form a family unit. While females generally stay with the same unit all their lives in and around tropical waters, young males will leave when they are between 4-21 years old and can be found in "bachelor schools," comprised of other males that are about the same age and size.

Sperm whales inhabit all oceans of the world. They can be seen close to the edge of pack ice in both hemispheres and are also common along the equator, especially in the Pacific. Sperm whales are found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes. In tropical and temperate areas, there appears to be no obvious seasonal migration. Sperm whales tend to inhabit areas with a water depth of 1,968 feet (600 m) or more, and are uncommon in waters less than 984 feet (300 m) deep. While female sperm whales are sometimes seen near oceanic islands, they are typically far from land. Immature males will stay with female sperm whales in tropical and subtropical waters until they begin to slowly migrate towards the poles, anywhere between ages 4 and 21 years old. Older, larger males are generally found near the edge of pack ice in both hemispheres. On occasion, however, these males will return to the warm water breeding area. No critical habitat has been designated for this species. Since portions of the ODMDS are over 1,350 feet deep, the species could occur off the north coast of Puerto Rico in the vicinity of ODMDS. No DCH has been designated for this species in the project area.

Blue Whale. The blue whale (*Balaenoptera musculus*) is a cosmopolitan species of baleen whale. In the Northern Hemisphere, they are generally smaller than those in the Southern Ocean. Maximum body length in the North Atlantic is about 88.5 feet (27 meters), while the largest blue whale reported from the North Pacific was about 88 feet (26.8 meters). Adults in the Antarctic can reach a maximum body length of about 108 feet (33 meters) and can weigh more than 330,000 pounds (150,000 kg). Blue whales are identified by the following characteristics: a long body and comparatively slender shape; a broad, flat "rostrum" when viewed from above; a proportionately smaller dorsal fin than other baleen whales; and a mottled gray color pattern that appears light blue when seen through the water. This species was listed under the ESA as endangered in 1970.

Scientists have yet to discern many details regarding the life history of the blue whale. The best available science suggests the gestation period is approximately 10-12 months and that blue whale calves are nursed for about 6-7 months. Most reproductive activity, including births and mating, takes place during the winter. Weaning probably occurs on, or en route to, summer feeding areas. The age of sexual maturity is thought to be 5-15 years. The primary and preferred diet of blue whales is krill (euphausiids). In the North Atlantic, blue whales feed on two main euphausiid species: *Thysanoëssa inermisand* and *Meganyctiphanes norvegica*. In addition, *T. raschii* and *M. norvegica* have been recorded as important food sources of blue whales in the Gulf of St. Lawrence. In the North Pacific, blue whales prey mainly on *Euphausia pacifica* and, secondarily, on *T. spinifera*.

Blue whales are found in oceans worldwide and are separated into populations by ocean basin in the North Atlantic, North Pacific, and Southern Hemisphere. They follow a seasonal migration pattern between summering and wintering areas, but some evidence suggests that individuals remain in certain areas year-round. Blue whales inhabit subpolar to sub-tropical latitudes. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement towards the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters of lower latitudes. Although the species is often found in coastal waters, blue whales are thought to occur

generally more offshore than humpback whales, for example. The species could occur off the north coast of Puerto Rico in the vicinity of the ODMDS. NMFS has not designated DCH for this species in the project area.

Future Without-Project Condition

Normal O&M dredging activities would continue to have no effect on whales (USACE/BOEM 2017). USACE has never had a documented whale strike as a result of dredging operations. Dredging would continue to operate in accordance with the most up to date Regional Biological Opinion. No additional effects on finback, Sei, sperm, or blue whales are anticipated in the future without-project condition.

2.4.10.5. Antillean Manatees

Existing Condition

Antillean manatees (*Trichechus manatus manatus*) have large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically grey (color can range from black to light brown) and are occasionally spotted with barnacles attached to them or colored by patches of green or red algae. Average adult manatees are about nine feet long and weigh about 1,000 pounds (https://www.fws.gov/southeast/wildlife/mammals/manatee/).

The Antillean manatee inhabits the coastal waters of Puerto Rico and has been documented both feeding and traveling in the San Juan Harbor and Condado Lagoon area. Seagrass beds in the Lagoon provide suitable foraging habitat for the species. Furthermore, the location of the Lagoon provides suitable shelter for the species (SJBEP, 2011). The USFWS has jurisdiction for protection of the manatee under the ESA and the MMPA. On April 5, 2017, the USFWS published a final rule reclassifying the West Indian manatee and its two recognized subspecies (Florida and Antillean) from endangered to threatened (82 FR 16680). This species is also protected by Law Number 241 (Wildlife Law of the Commonwealth of Puerto Rico) and Regulation Number 6766, which regulates the management of threatened and endangered species in Puerto Rico. USFWS has not designated DCH for this species in the project area.

Future Without-Project Condition

Dredging would continue to operate in accordance with the most up to date manatee protection specifications. Precautions would be taken during dredging events as have been coordinated with the USFWS. No additional impact to manatees is anticipated in the future without-project condition/No Action Alternative.

2.4.10.6 Corals

Existing Condition

Elkhorn Coral. Elkhorn coral (*Acropora palmata*) belong to the most abundant group of corals in the world (Acropora genus) and once represented the most dominant reef building species throughout Florida and the Caribbean. Elkhorn coral is a large, branching coral with thick and sturdy antler-like branches and is found in shallow reefs, typically in water depths from 0-35 feet, as these corals prefer areas where wave action causes constant water movement. Colonies are fast growing: branches increase in length by 2-4 inches (5-10 cm) per year, with colonies reaching their maximum size in approximately 10-12 years. Over the last 10,000 years, elkhorn coral has been one of the three most

important Caribbean corals contributing to reef growth and development and providing EFH. This species was listed under the ESA as threatened on May 9, 2006.

Elkhorn coral was formerly the dominant species in shallow water (3-16 feet [1-5 meters] deep) throughout the Caribbean and on the Florida Reef Tract, forming extensive, densely aggregated thickets (stands) in areas of heavy surf. Coral colonies prefer exposed reef crest and fore reef environments in depths of less than 20 feet (6 meters), although isolated corals may occur to 65 feet (20 meters).

NMFS has designated critical habitat for elkhorn and staghorn corals in four areas: Florida, Puerto Rico, St. John/St. Thomas, and St. Croix. Figure 2-6 shows the designated areas for Puerto Rico, which includes all areas surrounding the islands of the Commonwealth of Puerto Rico, 98 feet (30 meters) in depth and shallower, seaward of the U.S. Coast Guard Convention on the International Regulations for Preventing Collisions at Sea (COLREGS demarcation line). Per NOAA chart 25670, the COLREGS demarcation line transects outer Bar Channel Cut-2 in San Juan Harbor. In addition, a 4(d) (16 U.S.C. §1533(d)) rule (50 CFR Part 223) establishing "take" prohibitions for elkhorn and staghorn corals went into effect on November 28, 2008 for these areas. Take includes collecting, bothering, harming, harassment, damage to, death, or other actions that affect health and survival of listed species. This species has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). DCH for this species occurs in outer Bar Channel Cuts 1 and 2 in San Juan Harbor.

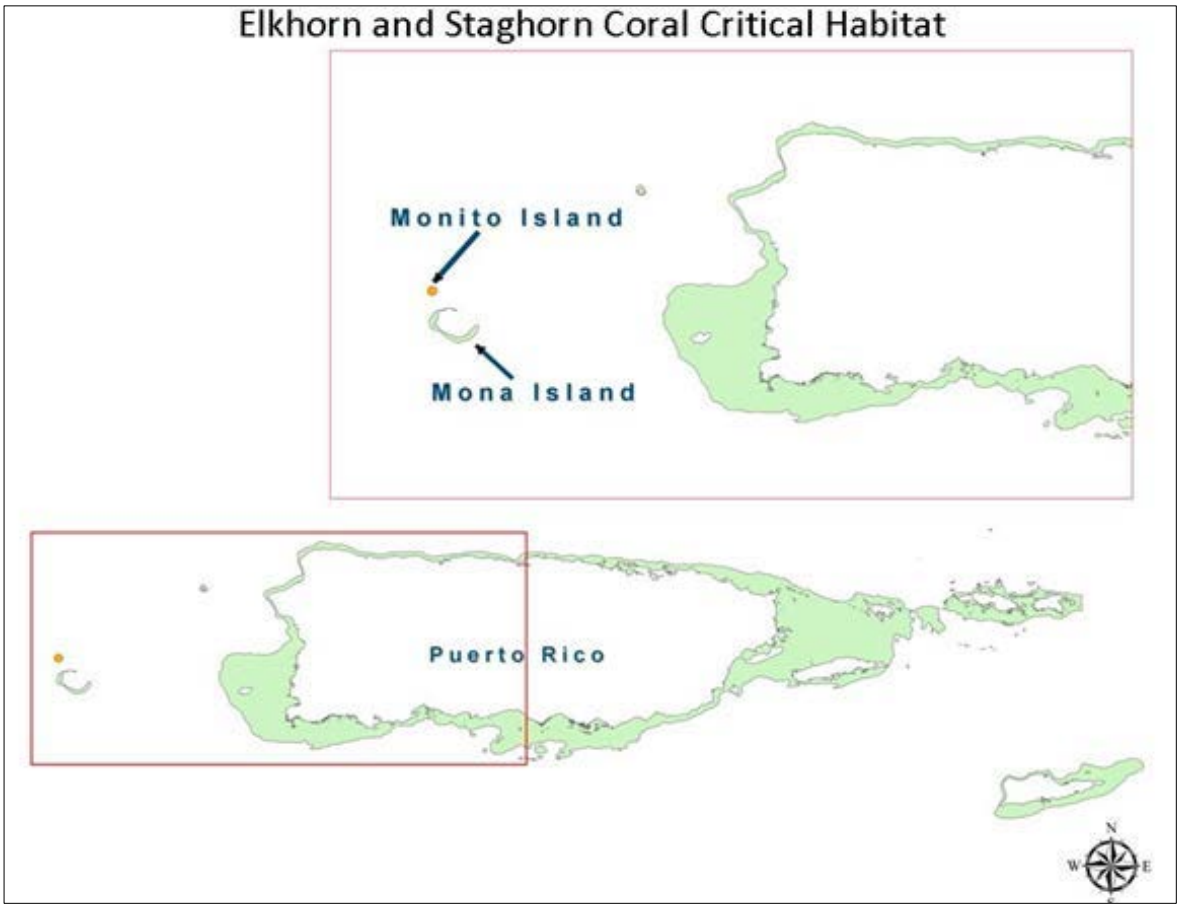

Figure 2-6: Elkhorn and Staghorn Corals Designated Critical Habitat (DCH)

Staghorn Coral. Staghorn coral (*Acropora cervicornis*) is a branching coral with cylindrical branches ranging from a few centimeters to over 6.5 feet (2 meters) in length. This coral exhibits the fastest growth of all known western Atlantic corals, with branches increasing in length by 4-8 inches (10-20 cm) per year. This species was listed under the ESA as threatened on May 9, 2006.

Staghorn coral occurs in back reef and fore reef environments from 0-98 feet (0 to 30 m) deep. In addition to growing on reefs, staghorn corals often form colonies on bare sand. The upper limit is defined by wave forces, and the lower limit is controlled by suspended sediments and light availability. Fore reef zones at intermediate depths of 15-80 feet (5-25 meters) were formerly dominated by extensive single species stands of staghorn coral until the mid-1980s.

Staghorn coral is found in the Atlantic Ocean, Caribbean Sea, and western Gulf of Mexico. Specifically, staghorn coral is found throughout the Florida Keys, the Bahamas, the Caribbean islands, and Venezuela. The northern limit of staghorn coral is around Boca Raton, Florida. The dominant mode of reproduction for staghorn coral is asexual fragmentation, with new colonies forming when branches break off a colony and reattach to the substrate. Sexual reproduction occurs via broadcast spawning of gametes into the water column once each year in August or September. Individual colonies are both male and female (simultaneous hermaphrodites) and will release millions of "gametes." The coral larvae (planula) live in the plankton for several days until finding a suitable area to settle, but very few larvae survive to settle and metamorphose into new colonies. The preponderance of asexual

reproduction in this species raises the possibility that genetic diversity is very low in the remnant populations. This species has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). DCH for this species occurs in outer Bar Channel Cuts 1 and 2 in San Juan Harbor.

Pillar Coral. Pillar coral *(Dendrogyra cylindrus)* colonies form numerous, heavy, cylindrical spires, that grow upwards from an encrusting base mass. The colonies can attain a height of 10 feet (3 meters), with a pillar diameter of more than 4 inches (10 cm). Polyps are normally extended during the day, giving the colony a fuzzy appearance. This species was listed under the ESA as threatened on 10 October 2014. Colonies are typically found on flat gently sloping back reef and fore reef environment in depths of 3-82 feet (1-25 meters). The species does not occur in extremely exposed locations. This species occurs in the Caribbean, the southern Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e. eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Rough Cactus Coral. Rough cactus coral (*Mycetophyllia ferox*) colonies consist of flat plates with radiating valleys. It is a widely recognized valid species with colonies comprised of thin, weakly attached plates with interconnecting, slightly sinuous, narrow valleys. Tentacles are generally absent and corallite centers tend to form single rows. The walls of the valleys commonly join to form closed valleys, a feature not seen in other members of Mycetophyllia. The ridges are usually small and square, with a groove on top. The ridges, or walls between valleys, are commonly quite thin, and are irregular, and valleys are narrower. This species was listed under the ESA as threatened on October 10, 2014.

This species is most common in fore reef environments from 5-30 meters (but is more abundant from 10-20 meters), but also occurs at low abundance in certain deeper back reef habitats and deep lagoons. This species occurs in the Caribbean, southern Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Lobed Star Coral. Lobed star coral (*Orbicella annularis*) colonies grow in several morphotypes that were originally described as separate species. The species occurs as long, thick columns with enlarged, dome-like tops; large, massive mounds; sheets with skirt-like edges; irregularly bumpy mounds and plates or as smooth plates. Colonies grow up to 10 feet (3 meters) in diameter. The surface is covered with distinctive, often somewhat raised, corallites. This species was listed under the ESA as threatened on October 10, 2014.

Lobed star coral inhabits most reef environments and is often the predominant coral between 22-82 feet (7-25 meters). The flattened plates are most common at deeper reefs, down to 165 feet (50 meters). It is common to Florida, Bahamas and Caribbean. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil

sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Mountainous Star Coral. This species has been called the "dominant reef-building coral of the Atlantic" (Brainard et al 2011). *Orbicella faveolata* buds extratentacularly to form head or sheet colonies with corallites that are uniformly distributed and closely packed, but sometimes unevenly exsert. Septa are highly exsert, with septocostae arranged in a variably conspicuous fan system, and the skeleton is generally far less dense than those of its sibling species. Active growth is typically found at the edges of colonies, forming a smooth outline with many small polyps. This species was listed under the ESA as threatened on October 10, 2014.

Orbicella faveolata is found from 3-100 feet (1-30 m) in back-reef and fore-reef habitats, and is often the most abundant coral between 30-65 feet (10-20 m) in fore-reef environments. This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas. May also be present in Bermuda, but this requires confirmation. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Boulder Star Coral. This species (*Orbicella franksi*) builds massive, encrusting plate or subcolumnar colonies via extratentacular budding. The characteristically bumpy appearance of this species is caused by relatively large, unevenly exsert, and irregularly distributed corallites. Boulder Star Coral is distinguished from its sibling *Orbicella* species by this irregular or bumpy appearance; a relatively dense, heavy, and hard skeleton (corallum); thicker septo-costae with a conspicuous septocostal midline row of lacerate teeth; and a greater degree of interspecies aggression. This species was listed under the ESA as threatened on October 10, 2014.

This species mostly grows in the open like other species of this genus but smaller, encrusting colonies are common in shaded overhangs. It is uncommon in very shallow water, but becomes common deeper. This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Future Without-Project Condition

In the future without-project condition, O&M dredging would continue to result in discountable impacts to listed corals. Dredged material transport may affect listed corals adjacent to Bar Channel Cuts 1 and 2 through turbidity and sedimentation. However, by following the USEPA Site Management and Monitoring Plan (SMMP), turbidity and scow leakage would be controlled and there would be no adverse effects to listed corals.

2.4.11 Marine Mammals

Existing Condition

The MMPA, enacted in 1972 and substantially amended in 1996, provides Federal protection to all marine mammals. In addition to the whales species discussed above, the bottlenose dolphin has been described as the most frequently sighted cetacean, especially for inshore waters of Puerto Rico. However, the abundance of the Puerto Rico and U.S. Virgin Islands stock of bottlenose dolphins is unknown (NOAA 2011). Some cetacean species occur in the study area year-round (e.g. bottlenose dolphin, beaked whales), while others (e.g. humpback whale) occur seasonally as they migrate through the area. Several of these marine mammal species discussed previously are also protected by the ESA.

Future Without-Project Condition

In the future without-project condition/No Action Alternative, O&M dredging would continue and vessels would continue to call at the Port. Many of the marine mammals, including the common bottlenose dolphin, are acclimated to commercial and recreational vessels that traverse the area. Increased impacts to marine mammals in the future without-project condition are not anticipated.

2.4.12 Birds

Existing Condition

Various areas within San Juan Harbor are utilized by many species of birds for nesting and feeding. According to the Puerto Rico Breeding Bird Atlas (http://www.aosbirds.org/prbba/Puerto%20Rico%20Status.html), about 58 species of birds are found within the San Juan Bay area, 44 of which are sea birds, waterfowl, or wading birds that utilize the shallows, wetlands, and open water of San Juan Bay. The brown pelican (*Pelecanus occidentalis*) is a permanent resident in the bay. Pelicans feed throughout the bay but prefer the calm waters behind the Esperanza peninsula and mangrove lined shores. Numerous gulls, terns, and frigate birds also use the Esperanza peninsula and sheltered waters behind it for roosting and feeding (USFWS 2017).

Future Without-Project Condition

O&M dredging activities would continue at the currently authorized project depths and are not expected to result in adverse impacts to the bird resources described above.

2.4.13 Invasive Species

Existing Condition

Invasive species can adversely impact native plant and animal populations by disrupting natural ecosystem functions. Islands have long been considered to be particularly vulnerable to biotic invasions. The 1,032 species of alien plants reported for Puerto Rico and Virgin Islands (PRVI) represent about a third of total plant diversity on these islands (DRNA 2015). Some aquatic invasive species that may occur in the project area or in the area of influence include:

- Freshwater Plants
    - *Phragmites australis* (Common reed)
    - *Melaleuca quinquenervia* (Bottlebrush tree)
- Freshwater Animals
    - *Iguana* (Green iguana)

  - *Cherax quadricarinatus* (Australian red claw crawfish)
- Marine/Estuarine Animals
  - *Pterois volitans* (Red lionfish)
  - *Oreochromis aureus* (Blue tilapia)
  - *Petrolisthes armatus* (Green porcelain crab)
  - *Perna viridis* (Asian green mussel)
  - Phyllorhiza punctata (Australian spotted jellyfish)
- Marine/Estuarine Plants
  - *Halophila stipulacea* (Mediterranean seagrass)

Species can be introduced by a variety of different mechanisms; however, most estuarine and marine species introductions are associated with shipping (Ruiz et al. 2000). Commercial shipping is the only direct mechanism related to this project. Presently, the largest single source of shipping-related introductions is ballast water (Carlton 1985, Lavoie et al. 1999). Ballast water is pumped into the hull of a vessel to stabilize the vessel and keep it upright while carrying cargo. This water can be discharged at the receiving port as the cargo is loaded or unloaded. Each vessel may take on and discharge millions of gallons of water. Ballast water taken on in foreign ports may include an abundance of aquatic plants, animals, and pathogens not native to Puerto Rico. If discharged into territory waters, these foreign species may become problematic.

In addition to ballast water discharge, another important source for the introduction of nonindigenous organisms is the fouling community that grows on the hull, rudder, propellers, anchor, anchor chain, or any other submerged structure of vessels that are not properly cleaned or maintained. Historically, such fouling communities were composed of massive layers of a variety of organisms, both attached and merely entrained in or living on that growth. Although such extensive growth is not as common on seagoing vessels in recent times, it still provides an opportunity for worldwide transport of fouling organisms, particularly on towed barges and other structures like mothballed ships and exploratory drilling platforms.

Future Without-Project Condition

In the future without-project condition, the potential will continue to exist for introduction of invasive species. Federal regulations require the master of each vessel subject to the regulation at 33 C.F.R. § 151.1510 to employ one of the listed ballast water management practices. This regulation decreases the rate at which invasive species are introduced to the study area. The USCG will continue to monitor, enforce, and revise regulations related to the discharge of ballast water while vessels are in port in accordance with the aforementioned regulation.

2.4.14 Air Quality

Existing Condition

Puerto Rico is a United States territory with Commonwealth status. The USEPA, Region 2 and the Puerto Rico EQB regulate air quality in Puerto Rico. The Clean Air Act (CAA) (42 U.S.C. §7409) gives USEPA the responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) that set acceptable concentration levels for six criteria pollutants: particulate matter (PM), sulfur dioxide, carbon monoxide, nitrous dioxide, ground level ozone, and lead. Short-term standards (1, 8, and 24-hour periods) have been established for pollutants contributing to acute health effects, while long-term standards (annual averages) have been established for pollutants

contributing to chronic health effects. Each state has the authority to adopt stricter standards; , Puerto Rico adopted the national ambient air quality standards (NAAQS) established by USEPA and developed a State Implementation Plan under the Clean Air Act that incorporates permitting and regulatory requirements for stationary and mobile sources of air pollution. USEPA regulations designate Air-Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. On the basis of the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. USEPA regulations designate AQCRs with levels below the NAAQS as attainment areas. Maintenance AQCRs are areas previously designated nonattainment areas that have subsequently been designated attainment areas for a probationary period through implementation of maintenance plans.

San Juan Harbor is located within the Puerto Rico AQCR which is comprised of the entire Commonwealth of Puerto Rico, including Vieques, Culebra, and surrounding islands (40 CFR § 81.77). All areas within the AQCR are in attainment or unclassifiable (due to lack of data) for NAAQS for the following criteria pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, PM2.5, and lead (USEPA 2008).

Due to its location, San Juan Harbor experiences nearly constant on-shore trade winds and sea breezes. The harbor is surrounded by the municipalities of San Juan, Guaynabo, and Cataño. Non-compliance was due to pollution from power plants, industrial facilities, motor vehicles, and major San Juan emitters. In 2010 the Municipality of Guaynabo came into compliance with air quality standards. In 2011, USEPA provided a grant to the Polytechnic University of Puerto Rico in the amount of $886,095 to install pollution-reduction technology on 72 heavy-duty trucks and replace 10 old heavy-duty trucks with 2010 or newer lower emissions diesel trucks in the Port of San Juan. These upgrades reduced the air emissions of fine particles (PM), nitrogen oxides (NOx), and carbon monoxide from diesel engines operating in the port. The Municipality of Guaynabo is identified as being in moderate non-attainment of the NAAQS for particulate matter with a diameter of 10 micrometers or less (USEPA 2008).

The PREPA owns and operates two power plants in the vicinity of San Juan. The San Juan Power Plant located in the area of the bay and the Palo Seco Power Plant located in Cataño just outside the entrance of the Bay. In order to comply with the Mercury and Air Toxics Standards (MATS) administered by the USEPA and to reduce cost of electricity production in Puerto Rico, PREPA is preparing to convert a number of the power generation units at its San Juan and Palo Seco Power Plants to burn natural gas as the primary fuel instead of Bunker C and Diesel (No. 6 and No. 2 type) fuel oil.

Future Without-Project Condition

There will be no effect on existing air quality if no action is taken. Ambient air quality conditions in San Juan Harbor would more than likely remain the same.

2.4.15 Hazardous, Toxic, and Radioactive Waste

Existing Condition

San Juan Harbor is highly developed. All of the major port storage facilities have confinement areas sufficient to contain any spills and no hazardous or toxic materials or waste have been identified within the project footprint. No hazardous, toxic, or radioactive waste has been encountered or released in the project area. Sediments from the navigation channels of the harbor typically have traces of heavy metals, Polychlorinated biphenyls (PCBs), pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), and

petroleum products, at low levels that do not affect the sediment quality or the water quality of the harbor. To date sediments from the harbor have been suitable for ocean placement, into the San Juan ODMDS. Maintenance dredging of the harbor channels happens approximately every five to seven years.

Future Without-Project Condition

Previous maintenance dredging performed in the existing navigation channels has not encountered any hazardous or toxic wastes. Sediments to be dredged from the harbor have been tested most recently in 2011 for the purposes of ocean disposal (Anamar 2011) and a sediment disposal evaluation was submitted to USEPA in accordance with Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA) (33 U.S.C. §1413) which documents that the proposed dredging and disposal of sediments is suitable for ocean disposal. The analysis confirmed that hazardous and toxic materials are not present in the sediments at levels of concern.

2.4.16 Noise

Existing Condition

Noise is often defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, diminishes the quality of the environment, or is otherwise annoying. Response to noise varies by the type and characteristics of the noise source, distance from the source, receptor sensitivity, and time of day. Noise can be intermittent or continuous, steady or impulsive, and it may be generated by stationary or mobile sources. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dB). The potential impacts of underwater sounds associated with dredging operations have come under increasing scrutiny by regulatory agencies.

San Juan Harbor has functioned as an international harbor since pre-colonial times. Over the last 300 years, San Juan Harbor has evolved to accommodate the growing shipping industry as larger vessels continued to arrive. At the same time, recreational and other commercial boat traffic and industrial noise has continued to increase. Several sources of ambient noise are present in San Juan Harbor. The ambient noise level of an area includes sounds from both natural (wind waves, fish, tidal currents, mammals) and artificial (commercial and recreational vessels, dredging, pile driving, etc.) sources. Tidal currents produce hydrodynamic sounds, which are most significant at very low frequencies (< 100 Hz). Vessel traffic, including vessels passing the immediate study area, generate sounds that can travel considerable distances, in frequencies ranging from 10 to 1000Hz. Sea state (surface condition of the water characterized by wave height, period, and power) also produces ambient sounds above 500 Hz. As a commercial and industrial area, San Juan Harbor experiences a wide range of noise from a variety of industrial activities. Biological sounds associated with mammals, fishes, and invertebrates can also generate broadband noise in the frequency of 1 to 10 kHz with intensities as high as 60 to 90 dB.

San Juan Harbor has the typical noise characteristics of a busy harbor. Sources include recreational and commercial vessel traffic, dredging vessels and dock side facilities. Noise sources for vessels include cranes, whistles and various motors for propulsion. Dockside noise sources include cranes, trucks, cars, and loading and unloading equipment. In addition to the noise in the water/marine environment, noise can impact the human environment. Background noise exposures change during the course of the day in a gradual manner, which reflects the addition and subtraction of distant noise sources. Ambient

noise represents the combination of all sound within a given environment at a specified time. Humans hear sound from 0-140 dB. Sound above this level is associated with pain.

High intensity sounds can permanently damage fish hearing (Nightingale and Simenstad 2001). Dredging operations generally produce lower levels of sound energy but last for more extended periods of time than more intense construction activities (e.g. pile driving) (Nightingale and Simenstad 2001). These sounds have been documented to be continuous and low frequencies (< 1000 Hz) and are within the audible range of listed species of both whales (7Hz–22 kHz) and sea turtles (100-1000Hz) (Clarke et al. 2002).

Noise has been documented to influence fish behavior. Fish detect and respond to sound by utilizing cues to hunt for prey, avoid predators, and for social interaction. Fish produce sound when swimming, mating, or fighting and also noise associated with swimming. Fish use a wide range of mechanisms for sound production, including scraping structures against one another, vibrating muscles, and a variety of other methods. Sounds produced by spawning fishes, such as sciaenids, are sufficiently loud and characteristic for them to be used by humans to locate spawning locations.

Relative to exposure to anthropogenic noise, NOAA guidelines define two levels of harassment for marine mammals: Level A based on a temporary threshold shift (190 dB for pinnipeds and 180 dB for cetaceans) and Level B harassment with the potential to disturb a marine mammal in the wild by causing disruption to behavioral patterns such as migration, breeding, feeding, and sheltering (160 dB for impulse noise such as pile driving and 120 dB for continuous noise such as vessel thrusters) (http://www.nwr.noaa.gov/Marine-Mammals/MM-sound-thrshld.cfm). According to Richardson et al. (1995) the following noise levels could be detrimental to marine mammals:

Prolonged exposure of 140 dB re 1 µPa/m (continuous man-made noise) at 1 km can cause permanent hearing loss. Prolonged exposure of 195 to 225 dB re 1 µPa/m (intermittent noise) at a few meters or tens of meters can cause immediate hearing damage.

NOAA released a draft report that provides guidance for assessing the effects of anthropogenic sound on marine mammal species under the jurisdiction of NMFS (NOAA 2013). The guidance will replace the current thresholds used by NOAA and described above. NOAA compiled, interpreted, and synthesized best available science to update the threshold levels for temporary and permanent hearing threshold shifts. Different target species for protection have widely divergent tolerance levels for sounds (owing to different hearing sensitivities, hearing integration times, etc.). Due to the complexity and variability of marine mammal behavioral responses, NOAA will continue to work over the next years on developing additional guidance regarding the effects of anthropogenic sound on marine mammal behavior (http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm).

Future Without-Project Condition

Construction activity associated with maintenance dredging will continue. This dredging will result in a short term increase in noise over the existing background level though this will not cause a significant increase in the ambient noise levels. San Juan Harbor is within an urban setting and noises related to recreational and commercial vessel traffic, dredging vessels, and dock side facilities would continue similar to the existing conditions.

2.4.17 Coastal Barrier Resources

Existing Condition

The Coastal Barrier Resources Act (CBRA) (16 U.S.C. §3501 *et. seq.*) was enacted by Congress in 1982 to encourage the conservation of coastal barriers that provide quality habitat for migratory birds and other wildlife and spawning, nursery, nesting, and feeding grounds for a variety of commercially and recreationally important species of finfish and shellfish. CBRA seeks to discourage development by restricting Federal expenditures (e.g., Federal insurance) that encourage development. Areas within a designated Coastal Barrier Resources System (CBRS) unit can be developed provided that private developers or other non-Federal parties bear the cost.

CBRS units are areas of fragile, high-risk, and ecologically sensitive coastal barriers. Development conducted in these areas is ineligible for both direct and indirect Federal expenditures and financial assistance. Along with CBRS units are otherwise protected areas (OPAs). OPAs are national, state, or local areas that include coastal barriers that are held for conservation or recreation. The only Federal funding prohibition within OPAs is Federal flood insurance. There are three CBRS units located near San Juan Harbor, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega Otherwise Protected Area (OPA) approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (Figure 2-7).

Future Without-Project Condition

The CBRS units will continue to be protected without a project pending no changes in the current regulations.

Figure 2-7: San Juan Harbor Vicinity Coastal Barrier Resource System Units

2.4.18 Cultural and Historic Resources

Existing Condition

A "historic property" is defined at 54 U.S.C. §300308 in the National Historic Preservation Act (54 U.S.C. §300101 et. seq.) (NHPA) as any prehistoric or historic district, sites, building, structure, artifacts, or object included on, or eligible for inclusion on, the National Register. Several Federal laws and regulations protect these resources, including the NHPA, the Archaeological and Historic Preservation Act of 1974 (54 U.S.C. §§312501- 312508), and the Archaeological Resources Protection Act of 1979 (16 U.S.C. §§470aa-470mm). These Federal laws, specifically Section 106 of the NHPA, require Federal agencies to consider the effects of their actions on cultural resources and historic properties, including districts, sites, buildings, structures and objects included or eligible for inclusion in the NRHP. Additionally, the Council on Environmental Quality's regulations implementing NEPA require that

Federal agencies consider the "[u]nique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas" and "[t]he degree to which the [proposed] action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources." 40 CFR §1508.27(b)(3), (8). Documentation of historic/cultural resources is important for this project because San Juan Harbor provides an environment that is rich in historic human activity; its geological setting is characterized by sediment types, especially heavy muds, which are well known for preserving shipwrecks and their contents.

Section 106 of the NHPA (54 U.S.C. §306108) and its implementing regulations (36 CFR Part 800) requires an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effects (APE), which is defined as the geographic area(s) "within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 CFR 800.16(d)). The APE for the direct impacts for the proposed project includes the areas where ground disturbing activities and the placement of dredged material would occur. This includes the proposed areas of the Inner Harbor Channels to be widened and deepened and the ODMDS. The APE for the indirect impacts associated with the proposed project includes the adjacent shoreline of San Juan Harbor that may be affected by erosion caused by increased vessel wake and historic properties within the viewshed of San Juan Harbor.

San Juan Harbor has been a significant port dating back to the end of the fifteenth century and the European exploration and settlement of the New World. Christopher Columbus landed on the west coast of Puerto Rico at Boquerón Bay in 1943, naming the area San Juan Bautista. At this time, the indigenous population measured approximately 60,000 people. Spanish colonization of the island did not occur until 1508 when Juan Ponce de León established a permanent settlement with the permission of the Taino chiefdom of Guainía (Jiméz de Wagenheim 1998). Ponce de León also explored the northern coast of the island and established *Puerto Rico* (Rich Port) at present day San Juan Harbor to export the island's gold. The Spanish subjection and maltreatment of the indigenous population led to a Taino revolt in 1511. However, due to military subjugation, disease, and abuse from the Spanish, the native population was reduced by 75% in 1515. In order to replace the native workforce of the island's gold mines, the Spanish began importing enslaved Africans and indigenous people from nearby islands (Jiméz de Wagenheim 1998).

By 1521, the islet adjacent to *Puerto Rico* became the central Spanish settlement of San Juan and the island itself had come to be called Puerto Rico. Through the second half of the 16th century, San Juan became increasingly strategic for the export of sugarcane and ginger and as a military outpost for Spain's colonial empire. In order to reinforce the military defenses of Puerto Rico, the Santa Catalina fortress (present-day *La Fortaleza*) was built and construction began on *El Morro* Castle. The city was fortified well enough to rebuke the attack of Sir Francis Drake in 1595. George Clifford, 3rd Earl of Cumberland, attacked and took the city in 1598; however, Spanish forces arrived shortly to rescue the island from the British. In 1625, Dutch forces attacked the city of San Juan, but the Spanish repelled the forces from *El Morro*. After this attack, the Spanish began improving their waterside fortifications, including the initial construction of the City Wall in 1634 (Krivor 2017).

During the eighteenth century, the ruling Bourbon court introduced trade and administrative reforms that stimulated agricultural development, military improvements, and population growth (Jiméz de Wagenheim 1998). City fortifications, including walls and moats, were constructed between 1789 and

1798. *El Morro* was expanded and updated to defend San Juan against warships during this period, and was successfully utilized to resist a British naval invasion in 1797 (Giusti 2014).

During the beginning of the nineteenth century, Spain loosened its grip on Puerto Rico resulting in increased trade with foreign nations. Native Puerto Ricans (*Criollos*) sought political autonomy and gradually transformed the island to a sugarcane and coffee plantation-based economy (Jiméz de Wagenheim 1998). Increased trade caused a significant boost in San Juan Harbor traffic, and the first substantial dredging of the harbor began in the late 1880s. The Spanish American War occurred in 1898 and resulted in three naval battles in the Harbor. During the war, the Spanish scuttled the ships *La Manuela* and *Cristóbal Colón* at the harbor entrance to narrow the entryway into the port. The Spanish also placed mines in the harbor entrance as the Americans attempted to bombard the city's fortifications. The Spanish American War ended in July 1898 with the cession of Puerto Rico to the United States (Acosta 2014).

The early twentieth century saw continued improvement project to San Juan Harbor. Both the USACE and local authorities dredged the Harbor, and the United States government provided the first funding for improvements to San Juan Harbor via the River and Harbor Act in March 1907 (P.L. 59-168). Between 1907 and 1910, the USACE removed thousands of cubic yards of coral and sediment and dumped the material in "a remote part of the harbor" (Krivor 2017). The USACE continued to dredge the Harbor and improve the mangrove areas surrounding the port throughout the twentieth century. The United States also established small military bases on Puerto Rico following the acquisition of Puerto Rico as a territory. *El Morro* was modernized and the San Juan Naval Air Station, the Tenth Naval District Headquarters, the San Juan Naval Dry Dock and Repair Facility, the San Juan USCG Station, and the U.S. Army Terminal were constructed in the vicinity of the Harbor.

During its 500-year history, numerous ships have sunk as a result of storms, war, or running aground on the reef around the entrance to the harbor (Table 2-8). In order to locate and identify these potentially significant submerged cultural resources which may be affected by widening and deepening the San Juan Harbor Federal Channel, numerous cultural resources investigations have been undertaken within the current study area since the initial 1974 San Juan Harbor feasibility report. In 1992, a magnetometer survey of the Bar Channel, Army Terminal Channel, and the Puerto Nuevo Channel identified 13 magnetic targets that had the potential to represent significant cultural resources. The results of this fieldwork is documented in the report entitled *Cultural Resources Magnetometer Survey at San Juan Harbor, Puerto Rico* (Márquez Marin 1993). A subsequent diver identification of these targets was conducted and documented in the report *Cultural Resource Magnetic Anomaly Identification Investigation in San Juan Harbor, San Juan Puerto Rico* (Koski-Karell 1993). Results of the diver investigation determined that one magnetic target (Anomaly 6:7, the wreck of a steel steamship) and a shipwreck site in the vicinity of Buoy R-4 appeared to be potentially significant.

Table 2-8: Shipwrecks in San Juan Bay (Adapted from Koski-Karell 1993).

Year	Cause	Name	Type	Origin	Source
Sixteenth Century					
1524	Reef	Santa Maria	110 Ton Nao	Spanish	Cardona
1529	Caribs	--	Barge 15 Yards Long	Spanish	Cardona

Year	Cause	Name	Type	Origin	Source
1530	Hurricane	--	Navio	Spanish	Cardona
1530	--	--	Ship	Spanish	Cardona
1545	Hurricane	--	Six or Seven Loaded Ships	--	Cardona
1550	Storm	--	Anchored Vessels	--	Cardona
1550	Storm	La Concepcion y Espiritu Santo	150 Ton Galleon	Spanish	Cardona
1551	Storm	San Cristobal	200 Ton Nao	Spanish	Cardona
1554	--	San Salvador Dona Juana Regina Coelis	Naos	Spanish	Hostos Cerame
1560	Reef	San Juan	130 Ton Galliot	Spanish	Cardona
1562	--	San Esteban	--	--	Hostos Cerame
1573	Storm	--	Urca	--	Hostos Cerame
1588	--	Nuestra Señora del Rosario	Navio	Spanish	Cardona
1589	Reef	--	Navio	Spanish	Cardona
1589	--	San Juan Gargantua	Navio	Spanish	Cardona
1595	Sunk at Entrance of Bay	Nuestra Senora de Begoña	960 Ton Galleon	Spanish	Cardona
1595	Sunk at Entrance of Bay	La Pandorga	Naos	Spanish	Cardona
1595	Sunk at Entrance of Bay	San Francisco	70 Ton Navio	French	Cardona
1595	Sunk at Entrance of Bay	Tejada	80 Ton Navio	--	Cardona
1595	Burned by Drake	--	Frigate	Spanish	Hostos Cerame
Seventeenth Century					
1601	Lost at Port's Entrance	San José	380 Ton Nao	Biscayne	Cardona
1615	Hurricane	--	2 Navios 1 Sloop	Spanish local	Cardona/Hostos Cerame
1622	Disabled	San Antonio	Navio	Spanish	Cardona
1623	Storm	St. Joseph	Galleon	Larraspuru Fleet/ Spanish	Cardona
1623	Shoal	Nuestra Senora de Begoña	Galleon	Spanish	Hostos Cerame

Year	Cause	Name	Type	Origin	Source
1625	Blazed at War	Nuestra Señora del Rosario	300 Ton Navio	Spanish	Cardona/Hosto s Cerame
1625	War	--	Sloop	Dutch	Hostos Cerame
1625 -30	Arrived in Distress	Jesus Maria	80 Ton Ship	Spanish	Cardona
1626	Storm	--	Navio	Canaries	Cardona/Hosto s Cerame
1626	Storm	--	Navio	Castille	Cardona/Hosto s Cerame
1626	Storm	--	Ship	Local	Cardona/Hosto s Cerame
1635	Reefs	Nuestra Señora de Pena de Francia	Nao	Spanish	Cardona
1649	--	--	Advice Boat	Spanish	Hostos Cerame
1651	Storm	San Matias Alias La Vizcaina	Nao	Spanish	Coll y Toste
1659 or 1660	Arrived in Distress	--	Sailboat	Spanish	Coll y Toste
Eighteenth Century					
1745	--	--	36 Cannon Ship	French	Hostos Cerame
Nineteenth Century					
1825	Hurricane	La Puertorriqueña	Schooner	Spanish	Hostos Cerame
1825	Hurricane	Congrave	Brigantine	English	Hostos Cerame
1825	Hurricane	--	3 Schooners	Spanish	Hostos Cerame
1827	Hurricane	--	Ship	--	Hostos Cerame
1837	Hurricane	--	38 Ships	--	Hostos Cerame
1837	Hurricane	Pepita	Schooner	Spanish	Hostos Cerame
1853	Hurricane	Carmen	Schooner	Spanish	Coll y Toste
1853	Hurricane	Josefita	Schooner	Spanish	Coll y Toste
1853	Hurricane	Rita	Schooner	Spanish	Coll y Toste

Year	Cause	Name	Type	Origin	Source
1853	Hurricane	--	Felucca	Local	Coll y Toste
1867	Hurricane	--	2 Sloops, 1 Sailboat	Spanish	Hostos Cerame
1876	Hurricane	--	10 Ships	--	Hostos Cerame
1898	War Sunk at Entrance	Manuela	Ship	Spanish	A. Rivera
1898	War Sunk at Entrance	Colon	Ship	Spanish	A. Rivera
Twentieth Century					
1904	--	Mabel Jordan	--	--	Hostos Cerame
1961	Fire	Hilda II	Yacht	Puerto Rico	Hostos Cerame
1962	--	Libertad	--	--	Hostos Cerame
1964	--	S.S. Catalina	--	--	Hostos Cerame
1965	--	M/V Pocahontas	--	--	Hostos Cerame
1968	Reef	Ocean Eagle	Oil Tanker	Liberia	Hostos Cerame

Additional field investigations were conducted during April 1994 by Mid-Atlantic Technology to evaluate two potentially significant resources that had been identified in the above referenced reports. The results of these investigations are documented in the report entitled *Underwater Investigations to Ground Truth Two Potentially Significant Submerged Cultural Resources, San Juan Harbor, San Juan, Puerto Rico* (Hall 1994). One of these resources was found to be a steel-constructed ship, referred to as Target 6:7, which had been partially salvaged and demolished (Hall 1994). The vessel could not be identified; however, its construction was typical of the early to mid-twentieth century. Based on the underwater examination the wreck was found to be ineligible for inclusion in the NRHP. A potentially significant wreck site was identified southwest of Buoy R-4. No timbers or other structural evidence was visible; however, several historic artifacts were identified in the area dating the wreck site from the mid-seventeenth to mid-eighteenth century. The USACE determined the historic wreck site to be potentially eligible for inclusion in the National Register and avoidance was recommended.

In 2000, archaeologists from Panamerican Consultants, Inc. (Panamerican) conducted an additional submerged cultural resources investigation of Target 6:7 (Hall 1994). Based on the original USACE assessment of not eligible for inclusion in the NRHP, wreck removal efforts of Target 6:7 (Hall 1994) were instituted as part of dredging operation; however, additional information emerged about the vessel suggesting that it may be the *Manuela* or the *Cristóbal Colón*. Both ships were scuttled to block the San Juan Harbor entrance channel during the Spanish-American War. Based on this new information that suggested that the vessel might be significant, wreck removal efforts were halted and an investigation was undertaken to determine the wreck's identity and assess its significance. The investigation reported in *Archaeological Diver Identification and Evaluation of an Iron-Hulled Vessel in the Entrance Channel to San Juan Harbor, Puerto Rico* (James et al. 2001) determined that the wreck dated from the mid-to-late nineteenth century and was tentatively identified as the *Manuela*, a propeller-driven steamship built in Scotland in 1872. Based on the location of the wreck in the entrance channel, the USACE determined that data recovery of the *Manuela* was necessary to mitigate for adverse impacts of dredging.

During the initial mitigation of the *Manuela* by Panamerican in 2002, a second possible wreck location was identified 700 feet north of the *Manuela* site. Panamerican investigated the reported wreck location and documented their findings in an *Archaeological Diver Identification and Evaluation of Anomaly 6:7 in the Entrance Channel to San Juan Harbor, Puerto Rico* (Krivor 2003). As a result of this investigation, it was determined that portions of the *Cristóbal Colón* were represented in the wreckage remains. The *Cristóbal Colón* was an iron-hulled sidewheel steamer built in Scotland in 1865. Although damaged by previous dredging operations, the wreckage of the *Cristóbal Colón* was determined eligible for listing in the NRHP and recordation of the ship was determined as appropriate mitigation for adverse impacts of dredging.

The final cultural resources investigation within the San Juan Harbor Federal channel included the data recovery of the *Manuela* and the detailed recordation of the *Cristóbal Colón* and is documented in the report *Archaeological Data Recovery of the Iron-Hulled Vessel Manuela and* Documentation of the *Cristóbal Colón In the Entrance Channel to San Juan Harbor San Juan, Puerto Rico* (James et al. 2003). Both shipwrecks were removed from the entrance channel, the wreckage assessed and recorded, and artifacts preserved. After recordation the remains of both vessels were redeposited near the *Antonio López*, a National Historic Landmark seven miles west of San Juan. The wreck remains were arranged on the sea floor in a similar orientation to their original context in San Juan Harbor. The location of both the *Manuela* and the *Cristóbal Colón* was chosen to facilitate future dive trips and provide protection for the archaeological integrity of the *Antonio López*.

There are six historic properties listed in the NRHP that are located immediately adjacent to the San Juan Harbor Study area (Figure 2-8). These properties are located on the islet of San Juan overlooking the Harbor and include the *Castillo de San Felipe del Morro* portion of the San Juan National Historic Site (SJ0100029), *Faro del Castillo Morro* (SJ0200003), U.S. Post Office and Courthouse, *La Fortaleza* (SJ0100031), U.S. Custom House (SJ0200044), and the Old San Juan Historic District (*Distrito Histórico del Viejo San Juan*). In addition to being listed in the NRHP, the Old San Juan Historic District and *La Fortaleza* are National Historic Landmarks, *Castillo de San Felipe del Morro* is a National Historic Site, and *La Fortaleza* and San Juan National Historic Site are included in the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage List as an outstanding example of European developments in military architecture in the Caribbean from the sixteenth to twentieth centuries.

The San Juan National Historic Site was listed in the NRHP in 1966 and inscribed in the World Heritage List in 1983. The site consists of two large masonry forts (*San Felipe del Morro* and *San Cristóbal*), the north city walls, the majority of the south city walls, the San Juan Gate and various other associated structures and earthworks dating from the sixteenth through twentieth centuries. The *Castillo de San Felipe del Morro* is located on the western tip of the islet de San Juan, approximately 1,000 feet from the San Juan entrance channel. Construction on the fort began in 1539 and has been expanded, repaired, and modified to fulfill the military requirements of each century. A large rip rap embankment surrounds the perimeter of the site to protect the Fort from erosion.

Faro del Castillo Morro, or Puerto San Juan Light, is the oldest lighthouse still in existence and use in Puerto Rico. The San Juan Light was first constructed in 1846; however, due to deterioration the current lighthouse was built at its current location within the *Castillo de San Felipe del Morro* in 1876. The San Juan Light was listed in the NRHP in 1981.

La Fortaleza is the original fortification protecting San Juan Harbor. It was listed in the NRHP in 1966 and inscribed in the World Heritage List in 1983 along with the San Juan National Historic Site. La Fortaleza was constructed between 1533 and 1540 on the southern edge of the islet, approximately 0.5 miles south of the *Castillo de San Felipe del Morro*. The site originally consisted of a circular tower and four stone walls; a second tower was constructed at the end of the sixteenth century. After *Castillo de San Felipe del Morro* was constructed at a more strategic location at the entrance to San Juan Harbor, la Fortaleza was relegated to a positional of secondary defensive importance. The site has been the Puerto Rican gubernatorial residence since 1640. *La Fortaleza* is protected from erosion by a rip rap embankment.

The U.S. Post Office and Courthouse is located 200 feet north of the cruise ship basin. The building is a three-story, concrete structure which occupies a square block bounded by *Calle San Justo*, *Calle Tanca*, *Calle Commercio*, and *Calle Recinto Sur*. The building was constructed in 1914 and is significant example of American institutional architecture of the period. In 1940, a six-story annex was constructed on the south façade, representing one of the best examples of Vienna-School influenced architecture in Puerto Rico. The U.S. Post Office and Courthouse was listed in the NRHP in 1988 and continues to serve as the center of the Puerto Rico judiciary and postal systems.

The San Juan Custom House abuts the cruise ship basin on its east façade. The building was constructed in the Spanish-Colonial Revival style and consists of a first floor constructed in 1924 and a second floor build in 1927. The San Juan Custom House was listed in the NRHP in 1988 as an architecturally and

historically significant contribution to the first, transitional phase of the American Customs Service in Puerto Rico.

The Old San Juan Historic District (*Distrito Histórico del Viejo San Juan*) was originally listed in the NRHP in 1972 and consisted of the north-western triangle of the San Juan islet. The boundary was recently increased in 2012 to be bounded by Muñoz Rivera and Ponce de León Avenues, Paseo de Covadonga, and J. A. Corretejer and Recinto Sur Streets. The Old San Juan Historic District contains over 700 late sixteenth, seventeenth, eighteenth, and nineteenth structures associated with the development of this historically important seaport, seat of government, and commercial center of Puerto Rico.

Future Without-Project Condition

Without a project, the extensive cultural and historic resources of the San Juan Harbor area would continue to be protected under several Federal laws and regulations similar to the existing conditions descriptions. As a result of previous mitigation, no impacts to cultural or historic resources are anticipated from continued operations and maintenance dredging. The natural wind and wave climate will remain roughly the same with some potential changes related to sea level change. However, with the forecasted increase in vessel traffic, the number of vessel wakes and the associated impacts will increase over time. As the vessels get larger, wakes will become increasingly concentrated during high tides when their impacts would be greatest. Existing revetments and sea walls will continue to protect historic properties from erosional effects.

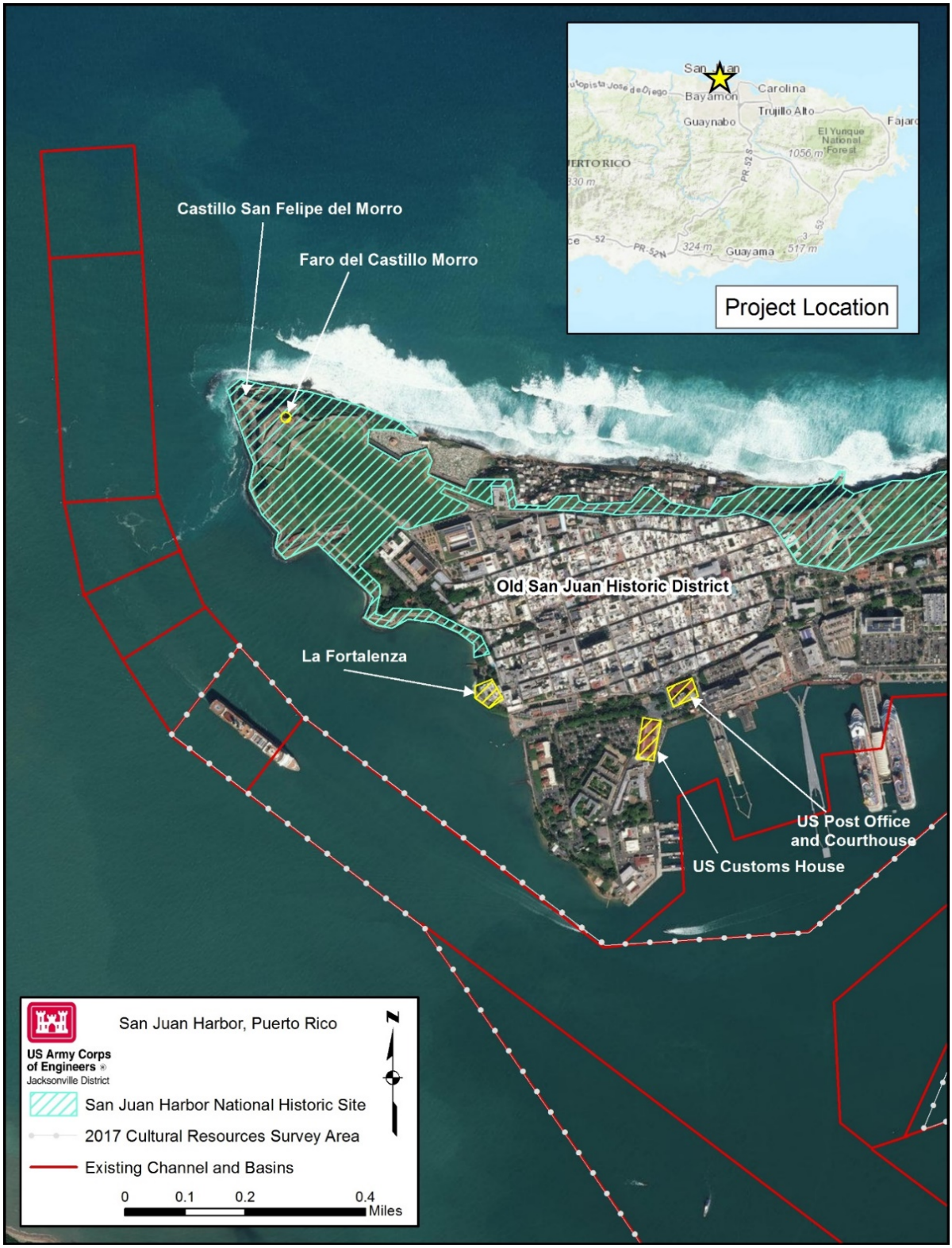

Figure 2-8: NRHP properties in the vicinity of San Juan Harbor

2.4.19 Aesthetics and Recreation

Existing Condition

Aesthetic resources are perhaps more difficult to define than aesthetics itself. USEPA (1973) stated the following:

"A. G. Alexander Baumgarten (1714-1762) is credited with coining the word AESTHETIC, in his work Aesthetica (dated 1750), to denote "that branch of science which deals with beauty" (Klien, 1966). Like beauty, then, the word has no clear and agreed-on definition that is operative-it remains a term that designates a vague concept…"

In the context of large infrastructure projects, aesthetics generally involves personal and subjective evaluations of the acceptability of visual scenes. The subject is often approached in terms of a "viewshed," which is the scene of the proposed project and consequences as viewed from various locations. Since the project involves a large landscape, this section will be addressed from a regional San Juan Harbor aspect.

San Juan Harbor is a historic seaport, and has been associated with vessels of increasing size for hundreds of years. A scenic setting is provided by the harbor and river and the numerous vessels common to these waters, including commercial and recreational boats as well as vessels calling on the Port. The estuarine environment provides opportunities for boating and fishing, as well as an escape from the faster pace of land-based activities. Several boat ramps and marinas are located in San Juan Harbor. The Port itself is situated in an urban/commercial setting.

Future Without-Project Condition

Regardless of the implementation of the proposed project, in the future without-project condition/No Action Alternative, larger vessels will call at the port. One potential effect on local aesthetics could be that larger vessels would call at the port in the future and those ships may be visible from farther away (albeit typically for a short interval of time in any given position). This shift to larger vessels is already occurring and will take place regardless of deepening. Apart from the shipping industry, other anthropogenic features have affected and continue to affect local aesthetics. These include roadways and railways, infrastructure, vehicular traffic, industrial complexes, and blighted properties. Dredge vessels and equipment used during operations and maintenance may temporarily affect aesthetics in San Juan Harbor, just as scaffolding and cranes temporarily obscure architectural features in an urban setting. There would continue to be temporary and minor impacts on recreational boating during continued maintenance dredging of the navigation channel but no more than there is now as the maintenance schedule is not expected to change.

2.4.20 Socioeconomics

The parameters used to describe the demographic and socioeconomic environments include trends in population, employment, and income distribution for the Commonwealth of Puerto Rico and the forty municipalities that make up the San Juan-Carolina-Caguas Metropolitan Statistical Area (MSA). Additional details may be found in the Economics Appendix.

Historical Population and Population Projections

The U.S. Census data indicates that the population of Puerto Rico increased from 1950 to 2000, a net increase of 1,597,907. This constitutes an average annual increase of 1.5%, or 31,958 per year during that period. The 2010 census shows a population of 3,725,789, a net loss of 82,821 or a 2.2% decline

from the 2000 census. A surge in the out-migration of its citizens explains much of this decline, with nearly one-third of those born in Puerto Rico living on the U.S. mainland in 2013.[2]

San Juan-Carolina-Caguas MSA

In all, there are 78 municipalities of the Commonwealth of Puerto Rico. The largest MSA is the San Juan-Carolina-Caguas MSA with a total population of 2,350,126 in 2010, approximately 63.0% of the total population of Puerto Rico. Approximately two out of every three people in Puerto Rico live within the San Juan-Carolina-Caguas MSA. In 2015 the population of the municipality of San Juan was 355,074, the most populous municipality in Puerto Rico.

Population Density

Puerto Rico is 10 times more densely populated than the United States as a whole. Based on the 2015 population estimate, population density in Puerto Rico is 988 people per square mile or 362 people per square kilometer. This makes Puerto Rico the fourth most densely populated state or territory in the United States. It is behind only Washington, District of Columbia (10,589 people per square mile); New Jersey (1,210 people per square mile); and Rhode Island (1,006 people per square mile).

Figure 2-9 presents, at a glance, the 2010 Census Profile for the U.S. Territory of Puerto Rico including population distribution by race, population distribution by sex and age, population density, and the decennial population from 1970 to 2010.

Employment and Income

The economy of Puerto Rico is relatively concentrated in (1) educational services, healthcare and social assistance services, and (2) retail trade. According to the U.S. Census 2011-2015 American Community Survey (ACS) 5-Year Estimates, Puerto Rico employment totaled 1,063,350 on average with over 37% of jobs attributable to these two sectors combined.

The San Juan-Carolina-Caguas MSA industry sectors yield employment distributions similar to those in Puerto Rico overall. Also of note, the arts, entertainment, and recreation, and accommodation and food services sector ranks fourth in terms of the percentage of people employed in the San Juan-Carolina-Caguas MSA, which is consistent with San Juan Harbor's prominence as a Caribbean cruise port and with the importance of tourism on the island. According to the U.S. Census Bureau's 2010-2014 ACS, the median household income in 2010-2014 for Puerto Rico was on average $19,686. Of the three municipalities directly adjacent to San Juan Harbor, both San Juan ($22,266) and Guaynabo ($34,450) had median household incomes greater than that of Puerto Rico overall, while the median household income in Cataño ($18,625) was less than that of Puerto Rico overall.

See the Economics Appendix for additional details on historical unemployment rates in the municipality of San Juan and for discussion of qualification for incorporation of unemployment benefits as part of NED benefits per ER 1105-2-100.

[2] Based on 2013 data from the United Nations and U.S. Census Bureau as reported by the Pew Research Center in the August 11, 2014 article entitled "Puerto Rican Population Declines on Island, Grows on U.S. Mainland" by D'Vera Cohn, Eileen Patten and Mark Hugo Lopez.

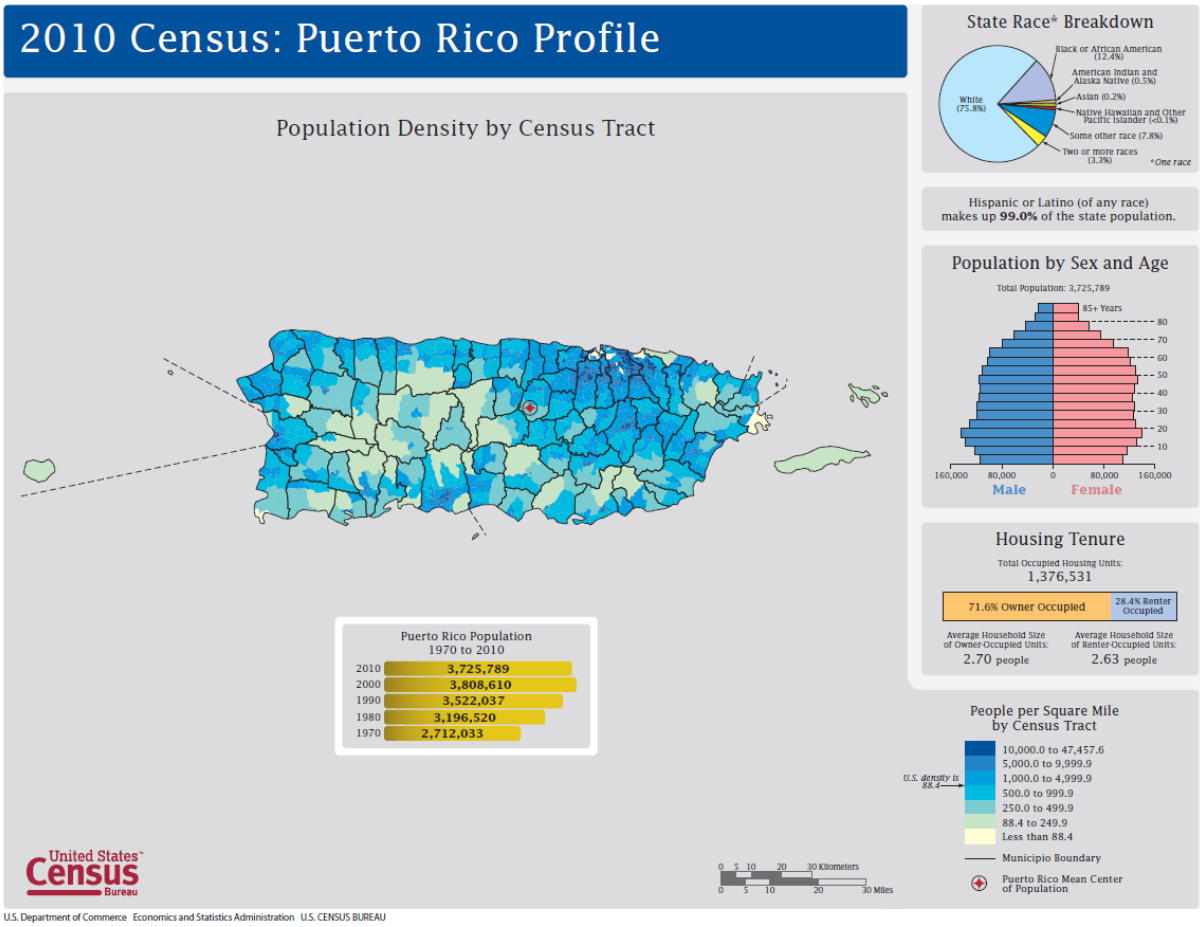

Figure 2-9: Commonwealth of Puerto Rico 2010 Demographic Profile (Source: United States Census Bureau, 2010 Decennial Census

Future Without-Project Condition

According to the statistics presented by the Puerto Rico Statistics Institute regarding U.S. Community Survey estimates, the population of Puerto Rico is expected to continue its downward trend in the period from 2010 to 2050. The decline in population is projected to reach 737,000 or 19.8% over the 40 year period. This constitutes an average annual decline of 0.5%, or 18,423 people per year. Given current information, significant changes in other socioeconomic variables in the future without-project are not expected.

2.4.21 Unique Characteristics

As far as unique characteristics of the geographic area, such as proximity to historical or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas, the greater San Juan Bay estuary contains habitat for corals, other hard grounds, sea grass and other SAV and mangroves which support (or potentially could support) associated sport/commercial fish, spiny lobster, fighting conch, and aquarium trade species. However, in the study area, only the proposed USCG Anchorage F expansion contains quality habitat. Extensive historic dredging in Condado Lagoon has left deep depressions or dredge holes which impair the lagoon's water quality and living resources. A cultural resources survey was conducted to identify any potential effects to unique cultural characteristics and is discussed further in Sections 2.4.18 and 5.4.18.

3.0 PLAN FORMULATION

The USACE plan formulation process identifies existing and anticipated problems and opportunities to develop planning objectives. It then identifies specific measures that could be combined to assemble sets of alternatives that 1) address the problems identified, 2) meet the planning objectives, and 3) avoid project constraints. These alternatives are then screened, carefully refined, and compared to each other in an iterative fashion to identify the alternatives that best balance the many factors to be considered in selecting alternatives that avoid project constraints. These alternatives are designed to be complete, effective, efficient, and acceptable to reasonably maximize net benefits while minimizing costs and adverse impacts.

To streamline the plan formulation process, the USACE applies risk-informed decision-making. Risk-informed decision-making aims to reduce the cost-shared study schedule and budget while still allowing the USACE to produce comprehensive feasibility reports that adequately support the recommendations. Risk-informed planning concentrates on eliminating non-essential activities, minimizing the collection of information that does not meaningfully influence the decisions or recommendations, and reporting only the pertinent, supporting, and required level of data. When appropriate, risk-informed planning also uses assumptions, best professional judgment, and/or estimates instead of acquiring new data to support the decision-making process after considering the relative likelihood, nature, and magnitude of the impacts to the overall decision and the associated environmental, social, and economic consequences.

To ultimately select a plan, the final array of alternatives are compared to each other from the perspectives of the NED, Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE) accounts to identify and recommend the alternative that provides the best and most balanced solution, as the Recommended Plan.

The four accounts were established in the economic and environmental principles and guidelines (P&G) approved in 1983 to facilitate the evaluation of management measures and display the effects of alternative plans. The NED account displays the plan with the greatest net economic benefit consistent with protecting the nation's environment; the EQ account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of alternative plans; the RED account displays changes in the distribution of regional economic activity (e.g., income and employment); and the OSE account displays plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation, and others. The Federal P&G require that the NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these criteria and discussed further in Section 3.4.3.

3.1 Problems, Opportunities, Objectives, and Constraints*

The first step in the planning process is the identification of problems, opportunities, and constraints. The identification and development of problems, opportunities, and constraints specific to San Juan Harbor resulted from internal discussions, public outreach (i.e. planning charrette, public meetings, release of Draft IFR/EA for public review, etc.), and communication with external stakeholders and resource agencies.

The NEPA scoping process played an important part in gathering information to help identify problems, opportunities, constraints, and stakeholder's, the public's, and agencies' concerns. A well-attended

planning charrette on November 4, 2015 and public meetings held November 5, 2015 and August 22, 2017 helped identify problems and opportunities. Resource agency representatives identified and located areas of environmental concerns on navigation charts. U.S. Coast Guard representatives provided a presentation detailing the location of groundings, collisions, and allisions within the harbor. The San Juan Bay Pilots identified navigation concerns including wind and wave challenges, bank suction effects, and difficult turns. Terminal operators provided information and letters on channel depth constraints of their existing fleet resulting in inefficient light loading of petroleum tankers. Petroleum deliveries to Puerto Rico and the San Juan metropolitan area, in particular, contribute greatly to the case for Federal interest, as there are two power plants, two airports, and Puerto Rico's most populous region all of which are heavily reliant on these imports.

3.1.1 Problems

A problem is an existing condition to be considered for change. As discussed, meetings and coordination with the PRPA, terminal operators, the San Juan Bay Harbor Pilots' Association, the USCG Sector San Juan, maritime interests, environmental resource agencies, and interested individuals provided valuable insight to existing problems and opportunities for improvements. The most important problems identified for San Juan Harbor are summarized as follows:

- Insufficient channel depths and widths.
    - Petroleum vessels (requiring more than 40 foot depths) are experiencing inefficiencies. These inefficiencies cause the transportation industry to light load large vessels, or use smaller, less efficient vessels to transport the cargo.
    - Depth-related problems are expected to be exacerbated by ongoing and forecasted shifts to the use of larger vessels, particularly for petroleum tankers.
- Potential transportation delays resulting from strong wind, wave, and current conditions.
    - Prevailing winds from the East at 25-30 knots make transiting the Bar Channel difficult by increasing the drift angle of the ships, which increases the effective beam or swept path of the ship.
    - Winds, waves, and currents at the Entrance (Bar) Channel cause ships to roll and heel, which increases the draft of ships.
    - As ships accelerate to negotiate wind, wave, and current conditions at the Entrance (Bar) Channel, squat and sinkage effects cause increased bow pressure and a shortened steering lever making turns difficult to control.

3.1.1.1 Insufficient Channel Depths and Widths

Restrictive Channel Depths

Feedback from stakeholders, combined with knowledge of the existing and the forecasted vessel fleet servicing San Juan Harbor, indicates that the most pressing problems are related to meeting the needs of the growing size and increasing depth requirements of petroleum vessels. These problems are causing transportation inefficiencies that will continue into the future, if they are not addressed. Transportation inefficiencies occur when channels and maneuvering areas do not fully accommodate the vessels using them. Currently, large vessels are constrained by insufficient channel depths and

under-sized turning areas and all vessels can be constrained by strong or unpredictable winds and currents or other conditions that affect operational maneuverability.

Puma Energy, in their November 4, 2015 Planning Charrette presentation, noted their medium range tankers light load to a 38-foot draft with two-feet of underkeel clearance as a result of the 40-foot channel depth which constrains those ships from loading to a draft of 42 feet with two feet of under keel clearance or a project depth of 44 feet.

Total Energy, in their November 16, 2015 letter, indicates the San Juan Harbor Federal channels do not allow fully loaded ships (medium range tankers) leading to 5% to 10% dead freight. Total Energy also requested increasing Federal channel depths from 40 to 44 feet.

Both of these depth-constrained terminals established a Federal interest for further evaluation. As a result, there are opportunities to decrease transportation costs and inefficiencies while bringing the forecasted goods in on fewer ships.

Furthermore, according to the harbor pilots, tankers and container ships experience squat effects on vessel maneuverability in the Army Terminal Channel.

Restrictive Channel Widths

- Restrictive navigation aids marking of channel widths make turns from Anegado Channel to Army Terminal Turning Basin difficult. Two groundings were reported in 2010 at the transition from Anegado Channel to Army Terminal Turning Basin due to this navigation restriction imposed by the placement of these aids to navigation within the Federal channel footprint.

- Harbor pilots indicated tankers and container ships experience bank (suction) effects along Army Terminal and Puerto Nuevo Channels.

- Restricted use of Cruise Ship Turning Basin East, limited depths restrict cruise ship maneuvering, resulting in multipoint turns requiring additional time.

3.1.1.2 Difficult Wind and Wave Conditions

The San Juan Bay pilots, USCG representatives, and other maritime interests identified areas of particular concern within San Juan Harbor. These areas include the Bar (Entrance) Channel, the transition from Anegado Channel to Army Terminal Channel, Army Terminal Channel itself, Puerto Nuevo Channel, and restricted turning basins for maneuvering cruise ships transiting through the San Antonio Channels to cruise ship terminals.

3.1.1.3 Limited Width in Turning Basins

The San Juan Bay pilots, USCG representatives, and other maritime interests identified restricted turning basins for maneuvering cruise ships transiting through the San Antonio Channel to cruise ship terminals. The Army Terminal Turning Basin was also identified as a restrictive turning basin for larger vessels transiting San Juan Harbor.

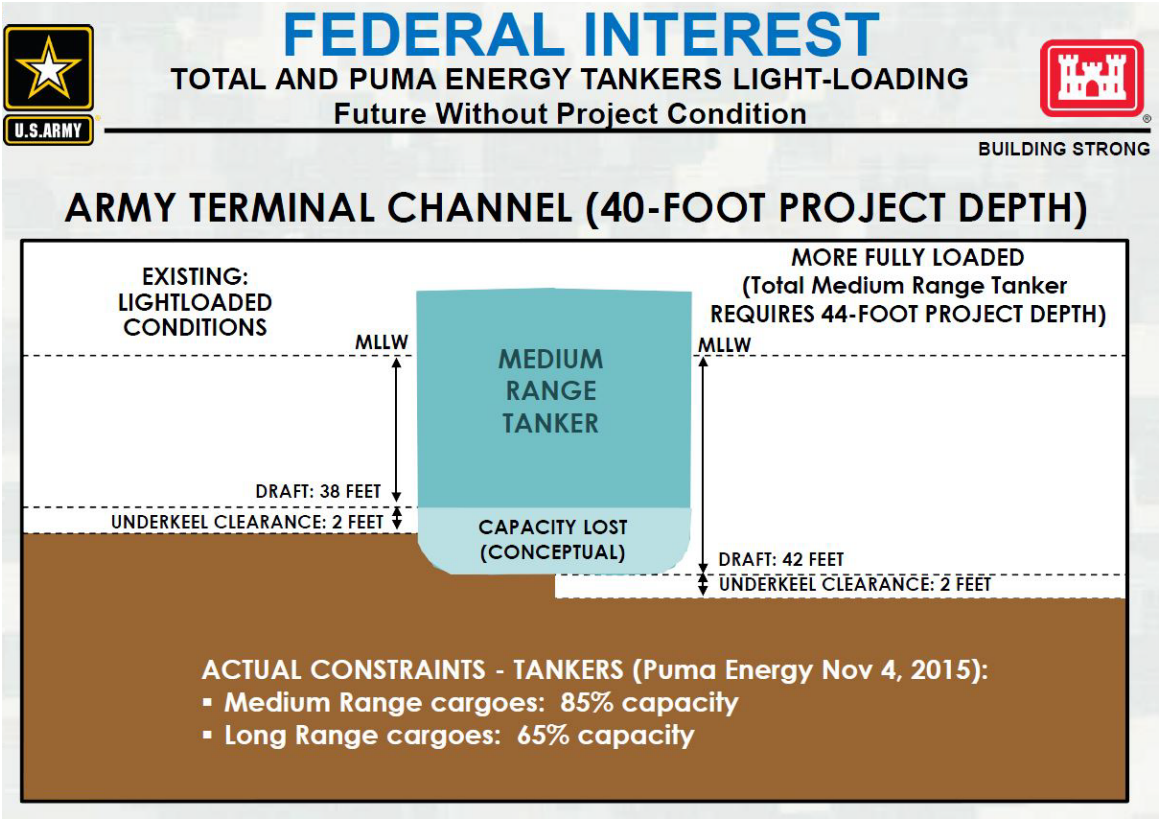

Figure 3-1: Light Loaded PUMA and TOTAL tankers conceptual lost capacity in existing and future without-project conditions

3.1.2 Opportunities

Opportunities focus on desirable future conditions and potential ways to address specific problems within the study area. The following opportunities were identified during the planning process and were evaluated over the 50-year period of analysis. These opportunities, realized through the implementation of measures (structural and/or non-structural), include:

- Transporting the forecast volume of fuels or goods into and out of the harbor on fewer, larger, more efficient vessels.
- Elimination or reduction of navigational restrictions and inefficiencies (i.e. channel width and depth limitations) to enable maritime carriers to realize the transportation economies of scale without adversely impacting their shipping operations.
- Facilitating navigation efficiency and maneuverability by ultimately reducing congestion.
- Realize power generation cost reduction benefits via the conversion from diesel to LNG.

3.1.3 Objectives

Planning objectives are summarized in statements that describe the desired results for solving or alleviating problems and realizing opportunities. These objectives must reflect the problems and opportunities and represent desired positive changes in comparison to the without-project conditions described in Section 2. The overall Federal objective related to water and related land resources

project planning is to contribute to NED, consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Water resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

The need for modifications to the existing navigation system in San Juan Harbor is generated by physical constraints and the associated inefficiencies that limit the system's ability to safely and efficiently serve the forecasted vessel fleet and process the forecasted cargo volumes. The purpose of this feasibility study is to identify and recommend a comprehensive set of navigation modifications that would reasonably maximize, consistent with protecting the Nation's environment, San Juan Harbor's contribution to net NED benefits by addressing those physical constraints and inefficiencies.

Developing specific, flexible, measurable, realistic, attainable, and acceptable objectives is critical to the success of the planning process. The study team worked with many stakeholders to develop a primary planning objective that also serves as the Purpose and Need statement for the NEPA process:

PRIMARY PLANNING OBJECTIVE/NEPA PURPOSE AND NEED STATEMENT.

To reasonably maximize San Juan Harbor's contribution to national economic development, consistent with protecting the Nation's environment, by addressing the physical constraints and inefficiencies in the existing navigation system's ability to efficiently serve the current and forecasted vessel fleet and process the forecasted cargo volumes.

For clarity, and to assist in applying this objective, the primary planning objective is based upon known problems and opportunities and considers the following objective statements:

- To reduce navigation transportation costs through San Juan Harbor and reduce regional power generation costs, ultimately contributing to NED over the 50-year period of analysis from 2026 to 2075.
- To develop an alternative that is environmentally acceptable and sustainable for the 50-year period of analysis from 2026 to 2075.
- To improve navigation maneuverability (alleviate congestion) by increasing Federal channel depths and widths, as well as turning basin widths, for existing and future fleets.

Contributions to the NED account represent the anticipated increase in the value of the national output of goods and services. In the case of navigation projects (such as San Juan Harbor), the increase in national output is in the form of reduced transportation costs (benefits). When people buy goods, the price includes the cost to have the goods transported from where they are produced to where they are sold. Where efficiencies are created, the lower cost of transporting the goods can be passed on to consumers in the form of lower prices. Efficiencies can also help promote exports. When goods made in the U.S. or Puerto Rico are transported more efficiently, they can be delivered to customers in other countries at a lower cost. This can make U.S. products more competitive and lead to greater employment in the continental U.S. or Puerto Rico. The USACE does not attempt to predict what portion of project benefits would accrue to consumers versus shipping companies or manufacturers. Attributing benefits to specific entities would be extremely complex and speculative. Instead, the

benefits are expressed in terms of transportation costs saved by all parties on all goods, whether they are imported or exported.

NED benefits are estimated by calculating the total costs to transport the forecasted cargo through the unmodified (without-project) harbor system and through each alternative scenario using the HarborSym Modeling suite of tools. Benefits for each alternative are calculated by subtracting the total transportation costs for that alternative from the total transportation costs for the same cargo under the without-project conditions. Net benefits are then calculated by subtracting the total costs to implement each alternative from the benefits that would result from implementing that alternative. Positive net benefits (where cost savings exceed implementation costs) are considered contributions to the NED account. NED benefits are normally expressed in terms of average annual net benefits that are calculated over the 50-year period of analysis. The calculations consider the timing of the expenditures and benefits by applying a discount rate that converts the dollar value of costs and benefits received at different time periods to present value.

NED benefits include origin-to-destination benefits, reduced congestions and turning time efficiencies, and power generation benefits. Origin-to-destination benefits are primarily derived "at-sea" based on the ability to utilize different vessels or to load more cargo onto them based on differing harbor condition scenarios. For deepening alternatives, most origin-to-destination benefits result from efficiencies related to the ability to use the additional draft to deploy larger, more efficient vessels and/or to transport more cargo on the same vessels and reducing the total number of trips needed to transport a given volume of cargo. Congestion reduction and turning time efficiency benefits are derived near and within the harbor and result from a reduction in transit times needed to navigate the harbor and turning basins. These benefits are normally smaller than the associated origin-to-destination benefits and are attributable to increased flexibility of harbor operations resulting from less concentrated traffic due to increased depths of available turning basins, which allows more access to deeper draft vessels and an expanded maneuvering area.

Power generation cost reduction benefits result from widening improvements of the Army Terminal Channel. The widening of Army Terminal Channel and the east and west flares to the Army Terminal Turning Basin allow for large LNG tankers to transit the harbor and be received at the proposed PREPA LNG berth in the Army Terminal Turning Basin. The existing channel dimensions restrict calls from world fleet vessels with beams greater than approximately 131 feet. Because the majority of LNG vessels available in the world fleet have beams exceeding this limit, channel widening would be necessary to reliably receive LNG vessels in San Juan Harbor. A conversion to LNG would provide a more efficient and cleaner burning fuel source than the bunker fuel and diesel fuel combination currently used to power the Palo Seco and San Juan Power Plants in San Juan, Puerto Rico. With LNG, the two power plants would be expected to produce the same amount of electricity as would be produced with diesel fuel but using fewer metric tons of fuel to do so.

3.1.4 Constraints

Constraints are resource, legal, or policy considerations that limit the actions that can be implemented to meet the study objectives. The plan formulation process strives to efficiently meet the study objectives without violating the constraints. The study-specific constraints include:

- Compliance with maritime safety requirements (e.g. USCG safety clearances);
- Avoid unacceptable impacts to important natural resources;

- Avoid unacceptable impacts to important cultural and historical resources; and
- Avoid unacceptable impacts to landside infrastructure.

3.2 Assumptions

To facilitate analysis and screening, this feasibility study utilized two sets of assumptions: (1) standard USACE deep draft navigation assumptions and (2) project-specific assumptions. The assumptions related to the future without-project conditions described in the USACE *Planning Guidance Notebook* (ER 1105-2-100) for all deep draft navigation feasibility studies include:

- Nonstructural measures within the authority and ability of port agencies, other public agencies, and the transportation industry to implement are assumed to occur. These measures consist of reasonably expected changes in management and the use of existing vessels and facilities on land and water. Examples are lightering, tug assistance, use of favorable tides, split deliveries, topping-off, alternative modes and ports, and transshipment facilities, such as the USCG's relocation of buoys to areas of existing deep water.
- Alternative harbor and channel improvements available to the transportation industry over the planning period include those in place and under construction at the time of the study, and those authorized projects that can reasonably be expected to be in place over the planning period.
- Authorized operation and maintenance is assumed to be performed in the harbors and channels over the period of analysis unless clear evidence is available that maintenance of the project is unjustified.
- In projecting commodity movements involving intermodal movements, sufficient capacity of the hinterland transportation and related facilities, including port facilities, is assumed unless there are substantive data to the contrary.
- A reasonable attempt should be made to reflect advancing technology affecting the transportation industry over the period of analysis. However, benefits from improved technology should not be credited to the navigation improvement if the technological change would occur both with and without the plan.

The following study-specific assumptions were also developed for the San Juan Harbor feasibility study:

- Without a Federal project, none of the channel deepening or widening measures would occur.
- The assumption of underkeel clearance required for a vessel will be based on actual practices, not on USACE clearance standards.
- The ODMDS will have sufficient capacity to meet the combined needs of the new work and 50 years of maintenance material.
- Separately, and as part of the future without-project condition, the USCG may re-designate the San Juan Harbor Anchorage Area "F" through its rule making process to include an expanded area and depths commensurate with the proposed adjacent deepening of the Anegado Channel.

- PREPA estimates conversion of their two power plants in San Juan to LNG will require 36 months from start (permitting final approval) to achieving commercial operational status. Details of the PREPA LNG conversion per a January 11, 2018 letter from them (*See* Appendix J) are as follows:

    - PREPA will pursue a public-private partnership (P3) for this project. The government will provide port, portside land, and necessary easements for the infrastructure and will start studies for design and permitting (PREPA will file the permit application to FERC). The P3 will be an agreement between PREPA and the private company, where the private company will engineer, design, construct, operate and own-to-transfer the maritime terminal for receiving, storing, and gasification of LNG. The private company shall provide the new dock and LNG unloading facilities, LNG transferring infrastructure (cryogenic pipeline, etc.), storage tank(s), gasifiers, and all related auxiliaries as well as gas transfer and supply lines. The anticipated term is currently estimated to be from a 15- to 20- year operation, where at the end of the term all the facilities and infrastructure title and ownership shall be vested upon the Government of Puerto Rico.

    - PREPA will purchase the LNG and the private company will unload, receive, store, gasify, and transfer natural gas to PREPA. Tolling fees shall compose of initial capital expenditure (CAPEX), maintenance CAPEX, operating expense (OPEX), and margin. It is estimated that the tolling fee will be in the range to $1.25 to $1.50 per million BTU's managed in the facilities.

    - PREPA's implementation schedule for the project is as follows:

Start procurement of the private company for the P3: April 2018
Permitting start date: April 2018 (detailed studies for filing)
Start conceptual design and required associated studies: May 2018
Anticipated establishment of P3 contract: March 2019
Detailed design start date: March 2019
Detailed design completed for all systems: September 2020
Permitting final approval: February 2021
Construction start date: April 2021
Construction end date/Commercial Operation: April 2024

3.3 Development of Management Measures

The first step of plan formulation involves identifying all potential management measures for the given problems. A management measure is a structural or non-structural action that can be implemented at a specific geographic site to address one or more planning objectives. The structural and non-structural measures evaluated for this study are outlined below.

3.3.1 Structural Measures

After iterative discussions with stakeholders, the USACE developed a set of widening and deepening structural measures to address the navigation problems. As previously discussed, navigation problems at San Juan Harbor are primarily related to: (1) insufficient Federal channel depths, (2) difficult currents and winds, and (3) restrictive channel widths and turning basins. The following basic structural measures were initially identified to meet the objectives/purpose and need of providing transportation

cost savings in San Juan Harbor: deepening channels and turning basins and widening channels. The refinement of these measures to meet the needs of specific reaches and terminals are described in subsequent paragraphs.

3.3.1.1 Deepening Measures

Deepening the channels would allow larger and deeper draft vessels, as well as the existing fleet of MR petroleum tankers, to utilize the harbor more efficiently through increased vessel loading. This measure was carried forward for detailed analysis based on the potential for significant transportation costs savings related to use of the harbor by the existing and forecasted vessel fleets.

3.3.1.2 Widening Measures

Vessel simulation analysis optimizes or refines the width components of proposed navigation features to improve efficiency and avoid adverse environmental impacts. Through coordination with the San Juan Bay Pilots' Association, the USCG, and other maritime interests, the USACE developed a set of widening measures based on experience and best professional judgment. The widening measures shown in Figure 3-2 provided an initial set of wideners for ship simulation testing to meet the project's objectives.

The USACE used the widening measures shown in Figure 3-2 to develop initial cost estimates, economic modeling, and impact analyses for the study, while ship simulation exercises with the San Juan Bay pilots continued at the Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi. Further economic analysis revealed a lack of transportation cost savings (benefits) for ships transiting to the Puerto Nuevo Channel container terminals. Evaluation of the existing Panamax container fleet showed a lack of width or depth constrained ships, which resulted in elimination of the widening and deepening measures for the Puerto Nuevo Channel and Turning Basin and Graving Dock Channel. The 50-foot widening measure for Graving Dock Channel received additional consideration, but a lack of information to verify the need for a wider channel to accommodate future LPG vessels resulted in removal of this widening measure from further evaluation.

Ship simulation verified the need to widen the Army Terminal Channel 100 feet as discussed in the Engineering Appendix. A 50-foot widening measure on each side of the channel helped to minimize potential environmental impacts and reduce dredging volumes. The LR2 Petroleum Product Tanker and the LNG Carrier required the 100-foot widening to access docks at terminals along Army Terminal Turning Basin.

3.3.1.3 Enlarging Turning Basins

Initially, enlargement of the Army Terminal Turning Basin and Puerto Nuevo Turning Basin received consideration to improve access to and from Puerto Nuevo Channel for container ships. As previously mentioned, evaluation of the existing Panamax container fleet showed a lack of width or depth constrained ships, ultimately resulting in elimination of the widening and deepening measures for the Puerto Nuevo Channel and Turning Basin, Graving Dock Channel, and the expanded transition from Army Terminal Turning Basin to Puerto Nuevo Channel. Ship simulation did confirm the need for construction of east and west flares for the Army Terminal Turning Basin to improve turning maneuverability for LR2 Tankers and LNG Vessels.

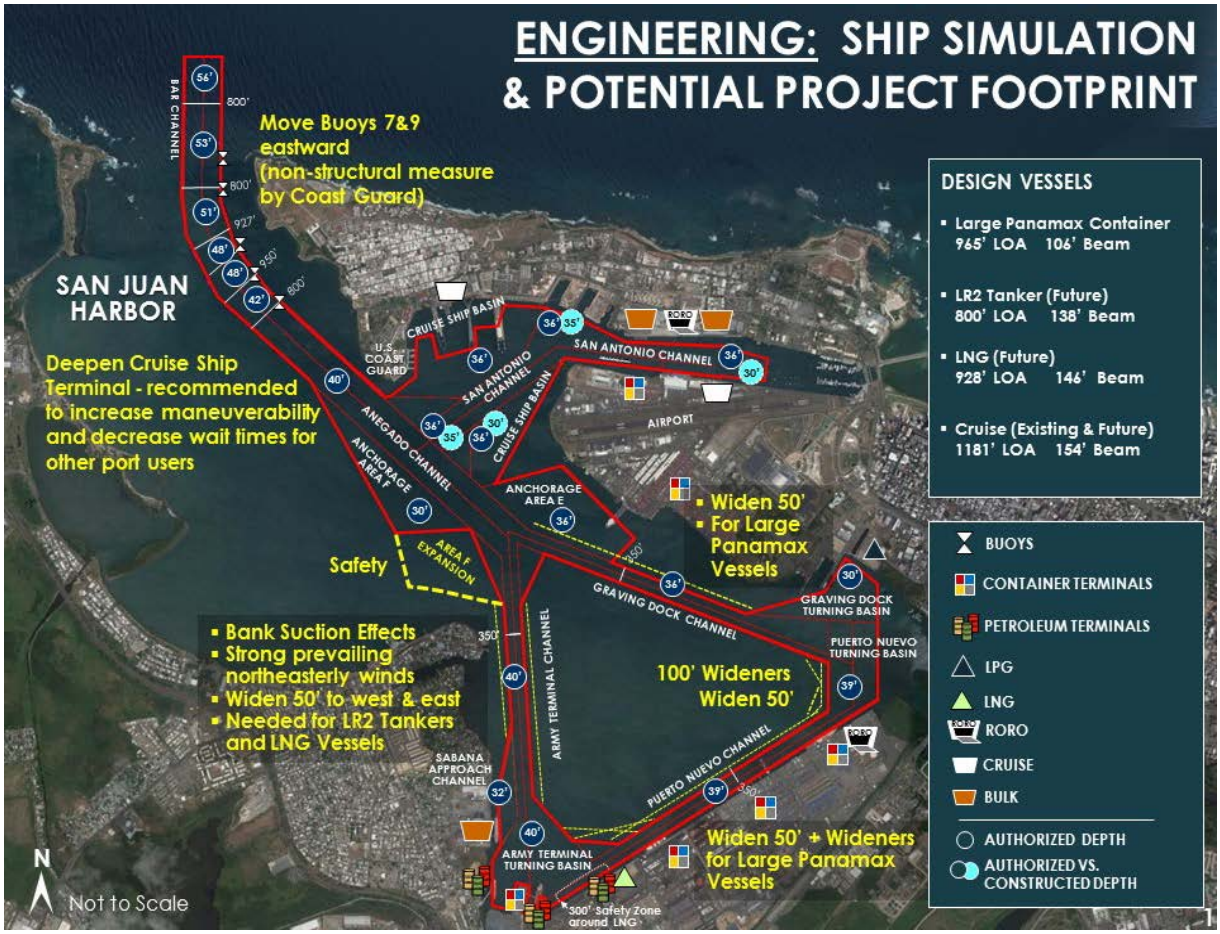

Figure 3-2: Widening measures

3.3.2 Nonstructural Measures

The following nonstructural management measures were identified to improve navigation in San Juan Harbor: additional tugs, additional trucking, offshore port, light loading of vessels to accommodate larger vessels under existing conditions, use of tides to transit large vessels under existing conditions, lightering, and designating and marking areas adjacent to the channel with natural depths that equal or exceed channel depths as widening measures.

3.3.2.1 Additional Tugs

Ship simulation exercises indicated ships "…had some difficulties entering or exiting the southern end of Army Terminal Channel near buoy G-7" (ERDC Ship Simulation Report, May 2017). While the ERDC recommended that "the corner by buoy G-7 should be flared," tugs already provide assistance (ERDC Ship Simulation Report, May 2017). The current operating practice makes use 6000 horsepower tractor tugs for maneuvering at Army Terminal Channel and Turning Basin and Graving Dock Channel and Turning Basin. *See* the Engineering Appendix, Attachment C, *ERDC Ship Simulation Report*.

The existing and future cruise ship fleet have no requirement for tug assist since cruise ships have bow and stern thrusters or use Azipods (a fixed pitch propeller mounted on a steerable gondola [pod] which contains the electric motor driving the propeller). Azipods or azimuth thrusters extend below the hull of the ship and have the capability to rotate 360 degrees or any horizontal angle (azimuth) making a

rudder unnecessary. The azimuth thrusters give ships better maneuverability than a fixed propeller and rudder system. The increased maneuverability provided by these propulsion units allows the Captain of the ship to turn and dock these vessels without tug assistance. For these reasons, additional tugs are not required.

3.3.2.2 Additional Trucking

Use of additional trucks to carry containers and petroleum products to provide the same amount of commodities throughout the hinterland served by San Juan Harbor would significantly increase truck traffic and congestion along the highway system, as well as adversely impact air quality by increasing emissions. Waterborne transportation continues to provide the most efficient and economical means of transporting goods from one location to another. Information related to transportation costs by various methods is provided in the Economics Appendix. This measure was eliminated from consideration based on a lack of economic efficiency and effectiveness and the wide range of adverse safety, social, and environmental impacts that generally result from moving cargo over highways instead of over waterways.

3.3.2.3 Offshore Port

An offshore port, if an environmentally acceptable location could be found and it could be built to withstand the wind and weather conditions, would likely decrease the number of larger vessels entering San Juan Harbor. But, it would increase the total number of vessels transiting the harbor. The commodities would be unloaded at the offshore port, temporarily stored, and then transferred to smaller vessels or barges for transportation to other marine terminals prior to being transferred again and then transported to their final destinations. While the existing harbor infrastructure may not need to be changed, it would still be needed and additional land-based infrastructure would be needed to support a less efficient system. For these reasons, an offshore port generally increases transportation costs and would likely require additional vessels or barges to carry the same amount of commodities. Such facilities are expensive to construct and maintain, and the existing harbor infrastructure would still be required. This measure was eliminated from consideration based on lack of economic effectiveness and efficiency.

3.3.2.4 Light Loading of Vessels

This measure limits the cargo-carrying capacity of vessels that enter the port. Existing cargo shippers experience increased operation costs due to light loading, vessel size limitations, and congestion delays. Larger vessels still enter the harbor, but cannot be loaded to their design draft. This increases transportation costs due to the additional transits required to bring in the same amount of material as a fully loaded petroleum product tanker, as well as the congestion and delays caused by the additional transits. This measure is already being implemented by the shipping industry, as needed. This measure is considered and addressed within the models used to forecast future harbor utilization under various scenarios. *See* the Economics Appendix for additional information.

3.3.2.5 Use of Tides

Tides range from about 1.11 to 1.57 feet. This is a relatively small tidal range and there is no indication from stakeholders that tide is used to allow vessels to load deeper than is possible at mean tide or that vessels routinely wait on tide at the harbor entrance. Furthermore, because the difference between the mean tide level at 0 feet and mean high water at 0.55 feet is less than a foot and because sailing draft data is often rounded to the nearest foot, any use of sum small tide would be very difficult to capture in the economic analysis. Thus tide is not considered a factor in the economic analysis.

3.3.2.6 Lightering

Lightering involves the process of transferring cargo between vessels of different sizes while at sea, usually between barges and bulk carriers or oil tankers. Prevailing winds from the east at 25 – 30 knots occur often with waves of eight feet or more. Those wind and wave conditions prevent consideration of lightering as a safe option for the transfer of petroleum products from one vessel to another. Lightering reduces a vessel's draft enough to enable it to enter a port that cannot accommodate large vessels. This measure was eliminated from consideration based on the combination of safety considerations and a lack of economic effectiveness and efficiency due to double handling of cargo.

3.3.2.7 Use Existing Deep Water to Widen Channels

Making use of naturally deep water outside existing channel limits provides a potential nonstructural measure. This nonstructural measure would relocate navigation buoys to widen the channel into areas with natural depths greater than 42 feet along the existing Entrance (Bar) Channel Reaches near buoys G5, G7, and G9. This would not require any dredging for the existing 42-foot project depth near buoy G7 and potentially no dredging for proposed deeper authorized depths where naturally deep water exists. Hydrographic surveys during the Preconstruction, Engineering, and Design (PED) phase will confirm available water depths for relocation of buoys in the Entrance Channel.

The areas considered for relocation of USCG Aids to Navigation (ATONs) include buoys G5, G7, and G9 (Figure 3-3) along the east side of the Entrance Channel and buoys R2 and G3 (Figure 3-4) at the north end of Army Terminal Channel. During ship simulation exercises the San Juan Bay Pilots' Association requested relocation of buoys G5, G7, and G9 about 50 feet to the east. The buoys presently lie either along the edge of the channel or within the channel.

The previous simulation study conducted at ERDC (Webb, 1993) recommended a funnel on the north end of the Army Terminal Channel to ease the turn from Anegado Channel. The funnel was constructed, but the buoys R-2 and G-3 were never moved to mark the widened turn. The USACE will request the USCG relocate the buoys R-2 and G-3 as shown in Figure 3-4.

3.3.2.8 No Action

The no action alternative is carried forward in the investigation for comparison purposes.

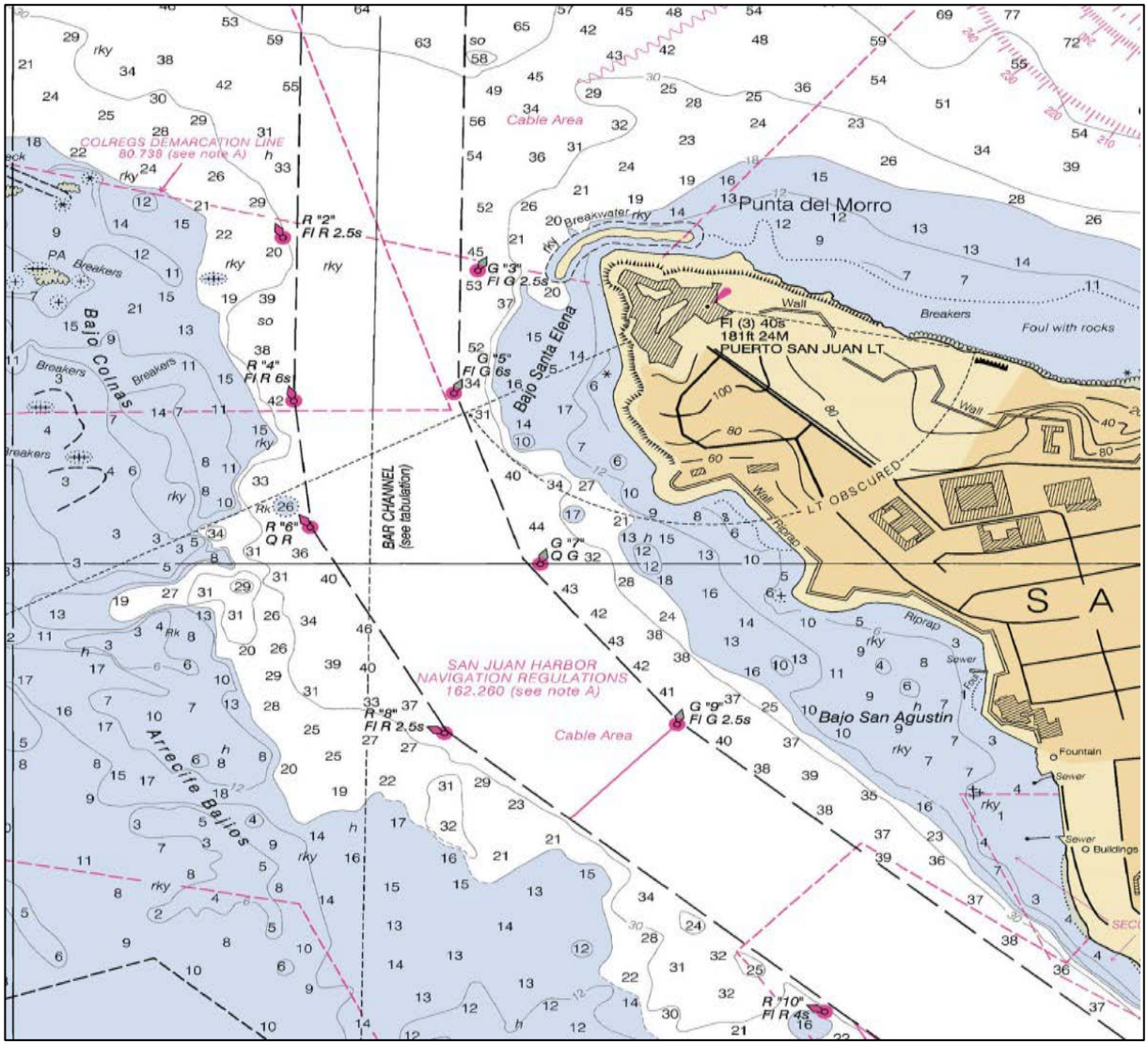

Figure 3-3: Nonstructural Measure – Relocate USCG buoys G5, G7, and G9 about 50 feet east to naturally deep water (Excerpt from 44th Ed, June 2011 of NOAA Chart 25670, Bahía De San Juan)

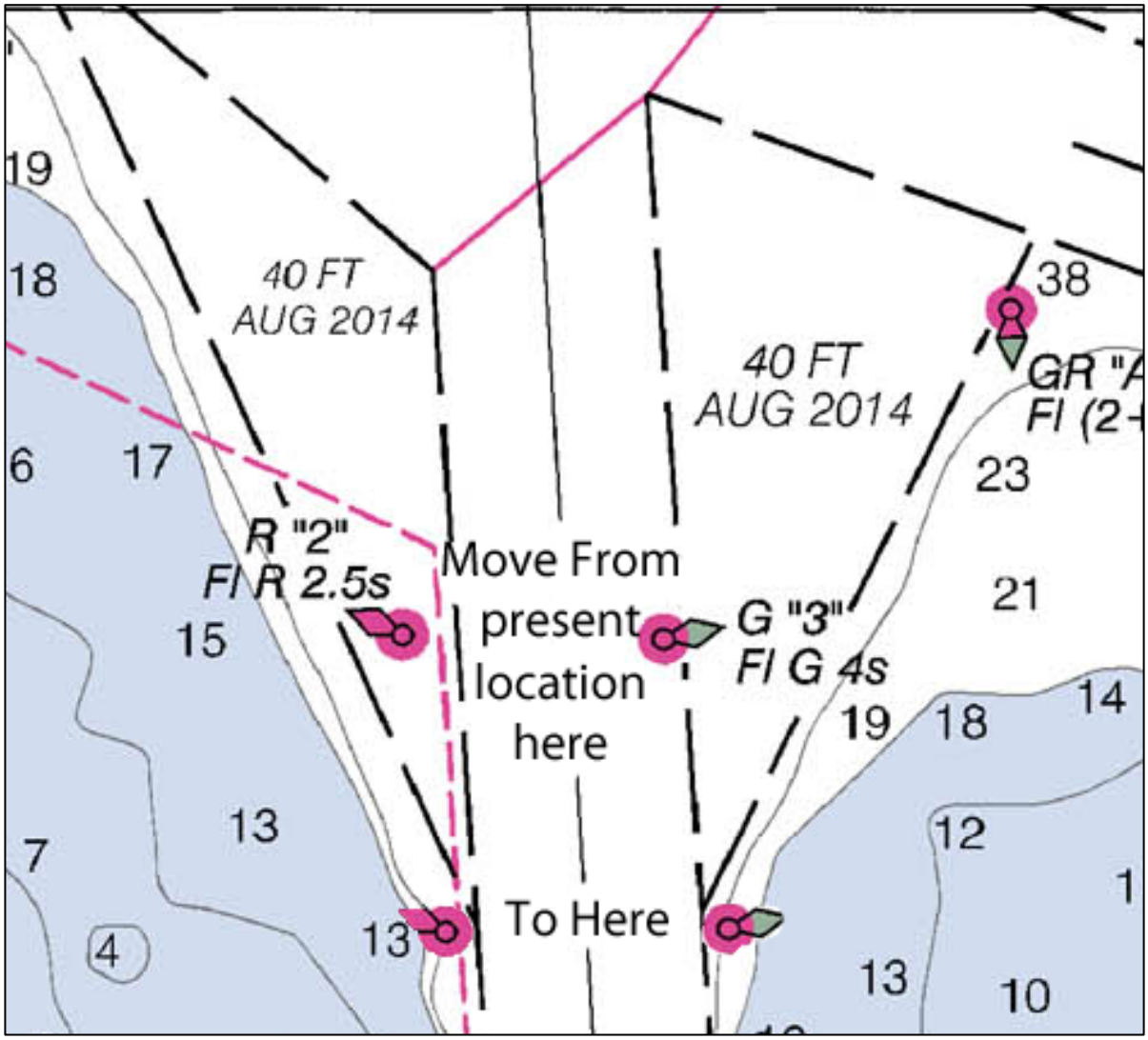

Figure 3-4: Nonstructural Measure – Relocate USCG buoy R2 and G3 to allow use of existing wideners (Excerpt from 44th Ed, June 2011 of NOAA Chart 25670, Bahía De San Juan)

3.4 Screening of Measures and Formulation of Alternatives

To simplify the screening of measures and formulation of alternatives, the USACE developed five economic modeling phases that are primarily based on groups of measures that would 1) Trigger a transition of fleet (like to the LR2 or larger LNG vessels), influenced by the physical factors affecting larger vessels (confirmed through ship simulation.); 2) Impact annual numbers of vessel calls; and 3) Improve maneuverability, effectively reducing import transportation costs.

These economic modeling phases are described below and illustrated in Figure 3-5.

Phase 1. Army Terminal Channel widening (50 feet on each side) at the existing 40-foot project depth to accommodate the transition of fleet to LR2 petroleum tankers & LNG design vessels

Phase 2. Deepening in 1-foot increments Cut-6 (43-47 feet), Anegado Channel (41-45 feet), Army Terminal Channel (41-45 feet) and Army Terminal Turning Basin (41-45 feet)

Phase 3. Deepen Graving Dock Turning Basin up to 45 feet (current depth is 30 feet) and Deepen Graving Dock Channel with 50-foot widening measure up to 45 feet (current depth is 36 feet)

Phase 4. Deepen Puerto Nuevo Channel with 50-foot widening and Turning Basin

Phase 5. Deepen San Antonio Channels and Cruise Ship Basin East to authorized 36-foot depth

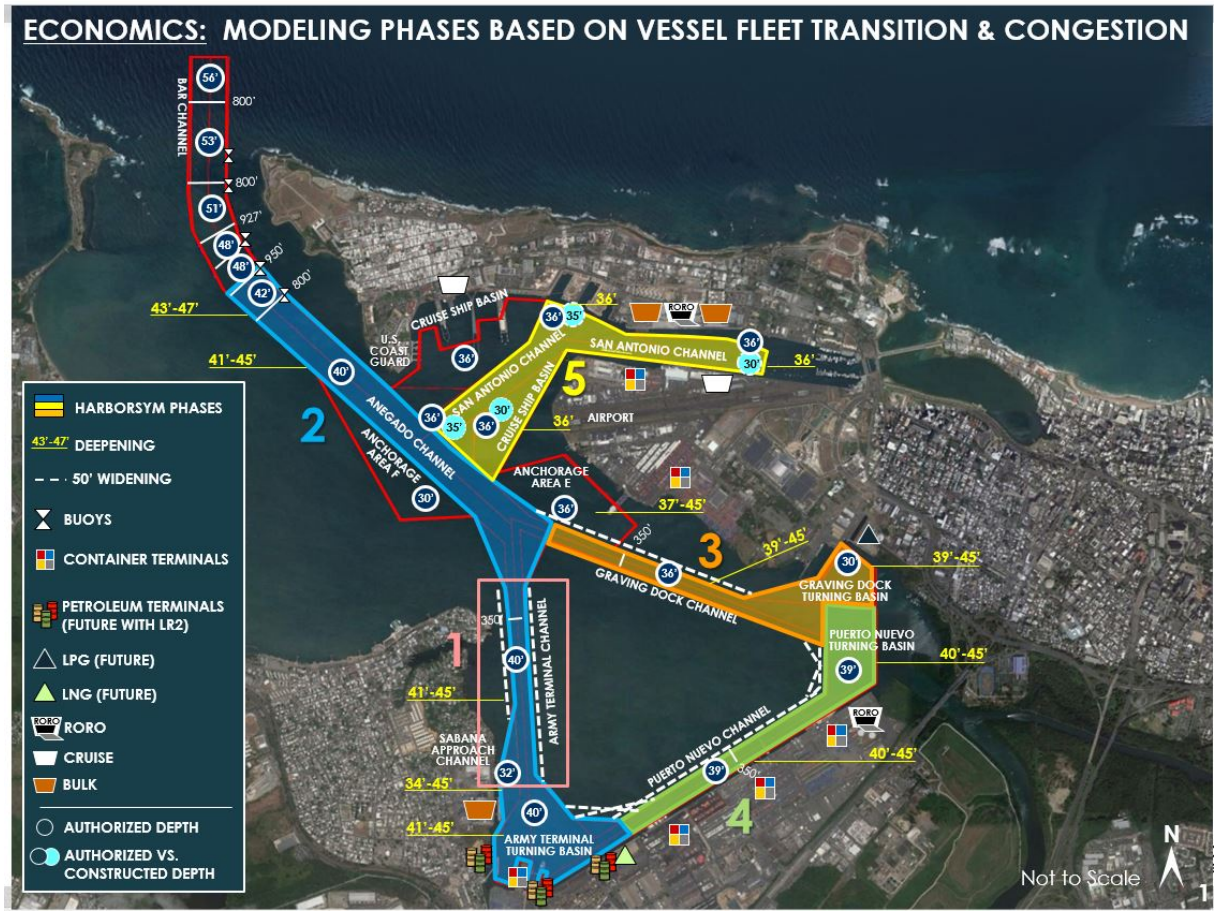

Figure 3-5: Economic modeling phases

3.4.1 Screening of Measures

The USACE assessed each measure for completeness, acceptability, efficiency, effectiveness, and technical, policy, or legal constraints to determine whether to retain it for consideration and formulation of alternatives.

Completeness. Extent to which the alternative provides and accounts for all necessary investments or actions to ensure realization of the planning objectives.

Effectiveness. Extent to which the alternative contributes to achieving the planning objectives.

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.

Acceptability. Workability and viability of the alternative with respect to acceptance by Federal and non-Federal entities and the public, and compatibility with existing laws, regulations, and public policies.

In thorough consideration of the four criteria from the 1983 P&G, preliminary alternatives are formulated and refined by combining, adapting, and scaling management measures. Tables 3-1 and 3-2 summarize the structural and non-structural measures retained, those measures eliminated from further consideration, and the reasons for the decisions. Through careful consideration, the USACE eliminated measures initially considered for modification from two of the five economic modeling phases, Phases 3 and 4, for the following reasons:

- Phase 3 would have modified the Graving Dock Channel and Graving Dock Turning Basin to a LPG Terminal. Throughout study development, necessary port user information for the Graving Dock Channel and Turning Basin segments failed to materialize in a timely manner to develop potential benefits, which resulted in elimination from further consideration.

- Phase 4, which would have modified the Puerto Nuevo Channel and Turning Basin, fell out of consideration based on a lack of need for modification or a lack of information to support deepening and widening. Based on evaluation of vessel call data, the vessels that utilize these terminals include ro-ro, container ships, and other vessels and are not currently depth-constrained at the existing authorized depths. Evaluation of historical sailing draft data for ships serving the Puerto Nuevo Channel terminals indicated a lack of depth constrained calls, which resulted in screening out the widening and deepening alternatives related to the Puerto Nuevo Channel and Turning Basin segment of Phase 4.

For additional details related to the screening out of Phases 3 and 4, see the Economics Appendix.

3.4.2 Formulation of Alternatives

Preliminary alternatives are formulated and refined by combining, adapting, and scaling management measures to best address the four criteria from the P&G. The USACE combined widening and deepening measures to form alternatives within the remaining economic modeling phases, Phase 1, Phase 2, and Phase 5.

In accordance with 40 CFR §1502.14, the USACE will "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives eliminated from detailed study, briefly discuss the reasons

for their having been eliminated." For this IFR/EA, a reasonable alternative is defined as an alternative that meets the objectives of the project and is under USACE jurisdiction to implement. A measure that could be implemented by others can be considered as long as it meets the objectives on its own or it can be a component of an alternative that meets the objectives in a way that is complete, effective, efficient, and acceptable.

3.4.3 Focused Array of Alternatives

Working with the PRPA, shipping industry experts, harbor pilots, the USCG, and other stakeholders, the USACE carried forward the following structural and nonstructural measures to develop alternatives within economic modeling Phases 1, 2, and 5:

- Nonstructural wideners
- Widening
- Deepening

Initially, the deepening measures included incremental depths from an existing project depth of 40 feet to 41, 42, 43, 44, and 45 feet MLLW within the harbor, with Cut-6 of entrance channel being two feet deeper. When the USACE combined the measures to assemble alternatives, the number of possible combinations resulted in over 100 possible deepening and widening alternatives. Evaluation of historical sailing draft data for ships serving the Puerto Nuevo Channel terminals indicated a lack of depth constrained calls, which resulted in screening out of the widening and deepening alternatives related to the Puerto Nuevo Channel and Turning Basin segment of Phase 4. Due to the lack of information from terminal operators from Graving Dock, USACE carried forward the remaining seven alternatives for further evaluation as shown in Table 3-1. Table 3-2 summarizes this alternative screening process. The no action alternative was carried forward in the investigation for comparison purposes.

The San Juan Harbor economic analysis of potential project benefits has two major components: (a) transportation costs savings measured using USACE's HarborSym model, and (b) reduction in power generation costs to the PREPA measured using dispatch run data provided by PREPA for its northern power plants. The benefits shown in Tables 3-3 and 3-4 represent transportation cost savings to petroleum tankers and LNG tankers transiting the Army Terminal Channel, and cruise ships utilizing the cruise ship terminals along the San Antonio Channels. Widening Army Terminal Channel for LNG tankers to provide liquefied natural gas for two San Juan area power plants resulted in power generation cost reduction benefits for Phase 1. The Economics Appendix provides a detailed analysis of the HarborSym modeling used to develop the transportation cost saving benefits. The Economics Appendix also provides a detailed explanation on the calculation of power generation cost reduction benefits, which are incorporated into the benefits for Phase 1 under "WITH LNG CONVERSION."

Table 3-1: Screening of Structural Measures

Measure	Description	Technical Constraints	Policy/Legal Constraints	Acceptability	Efficiency	Effectiveness	Completeness	Other	Retain?	Reason for screening out
Structural										
Phase-1	Widening channels									
1.1-1.2	Widen Army Terminal Channel 100 feet (from an existing width of 350 feet to a maximum width of 450 feet) at an existing depth of 40 feet.	Ensuring disposal capacity. Availability of dredges. Compliance with laws and regulations. etc.	None	Acceptable if it meets environmental laws and regulations and policies.	Improves efficiency by allowing larger wider beam vessels (LR2 and LNG) to transit the harbor	Effective in reducing transportation costs due to larger ships; Reduces power generation costs at San Juan power plants by allowing larger ships to transit Army Terminal Channel	Complete	Meets the planning objectives 1, 2, and 3, and the NEPA purpose and need	Yes	
Phase-2	Deepening channels									
2.1-2.5	Deepen at 1-foot increments a 100-foot widened Army Terminal Channel from 41 - 45 feet including reaches from Cut-6 to Army Terminal Turning Basin	Ensuring disposal capacity. Availability of dredges. Compliance with laws and regulations. etc.	None	Acceptable if it meets environmental laws and regulations and policies	Improves efficiency by allowing vessels to load deeper during harbor visits, which reduces total vessel transits	Effective in reducing transportation costs by allowing ships to draft deeper and reduce transits	Complete with addition of Phase 1 widening for Army Terminal Channel	Meets the primary planning objectives 1, 2, and 3, and the NEPA purpose and need	Yes	
Phase-3	Deepening channels									
12-13	Deepen Graving Dock Turning Basin at 1-foot increments from 30’ up to 39’ and Graving Dock Channel with 50-foot widening measure from 36’ up to 39 feet.	Ensuring disposal capacity. Availability of dredges. Compliance with laws and regulations. etc.	Economic justification	Not acceptable based on current lack of port user information to verify existing and future fleets require additional depth and width	Current port user information does not justify deeper depths or widths	Not effective since lack of information exists to justification transportation costs savings for deeper depths and additional channel width	Not complete without additional port user information to justify deepening and widening		No	Not economically justified without additional port user information to resolve the need for deeper draft LPG tankers
Phase-4	Deepening channels									
14.1-14.6	Deepen Puerto Nuevo Channel and Turning Basin from 39’ up to 45 feet and widen.	Ensuring disposal capacity. Availability of dredges. Compliance with laws and regulations. etc.	Economic justification	Not acceptable due to lack of depth constrained vessel calls	No improved efficiency since current channel depths and widths appear to meet existing and future fleet needs	No increased effectiveness since no reduction in transportation cost savings will result without the need for increased vessel draft	Not complete without vessel requirement for additional depth		No	Not economically justified without vessel requirement for additional depth
Phase-5	Deepening channels									
7.1-7.2	Deepen San Antonio Channels and Cruise Ship Basin East	Ensuring disposal capacity. Availability of dredges. Compliance with laws and regulations. etc.	None	Acceptable if it meets environmental laws and regulations and policies.	Improves efficiency by increasing underkeel clearance for cruise ships’ azimuth thrusters and expands maneuvering area for turns	Effective in reducing turning times and vessel operating costs	Complete	Meets the primary planning objectives 1, 2, and 3, and the NEPA purpose and need	Yes	

Table 3-2: Screening of Non-Structural Measures

Measure	Description	Technical Constraints	Policy/Legal Constraints	Acceptability	Efficiency	Effectiveness	Completeness	Other	Retain?	Reason for screening out
Non-Structural										
N-1	Additional tugs	USACE does not have the authority to require the use of more tugs	None	Acceptable if it meets safety requirements; but might increase congestion	Would not be cost efficient since existing fleet of tugs provides needed assistance	The current fleet of tugs provides required assistance as needed; no need for additional tug assistance required during ship simulation	Incomplete: additional tug assistance would not improve safety		No	Additional tugs not required during ship simulation; existing tug fleet meets safety requirements
N-2	Offshore port	Costs, Environmental conflicts, Limited opportunity to reduce inefficiencies	None	Acceptable if it meets environmental laws and regulations and policies	Not efficient due to double handling requirements	Off-Loading vessels is not reliable due to weather and wind conditions offshore.	Incomplete: Significant additional infrastructure required	May not be feasible to construct, expensive to operate and maintain, risks from storms, new and significant environmental impacts	No	Inefficient, incomplete, and outside USACE jurisdiction
N-3	Light loading of vessels	None	None	Acceptable if it meets safety requirements	Not efficient	Carrying less cargo per transit equates to increased transportation costs due to increased transit for delivery of the goods.	Incomplete:	This is the source of a portion of the potential cost savings.	No	Ineffective, outside USACE jurisdiction
N-4	Use of tide to transit larger vessels	Practical time limits to transit the harbor	None	Acceptable if it meets safety requirements	Not efficient	Delays cause increased transportation costs	Incomplete:	Lowers overall safety	No	Inefficient/ Tides range from about 1.11 to 1.57 feet; not significant enough for vessel operators to use
N-5	Lightering	None	None	Acceptable if it meets safety requirements	Not efficient	Not effective because it doesn't address the problem of transportation cost savings.	Incomplete:	Lowers overall safety	No	Inefficient/double handling of cargo and unsafe with prevailing wind and wave climate
N-6	Designate deep water areas for widening measures	Size, location and depth of natural conditions	None	Acceptable if it meets safety requirements	Efficient if necessary to meet objectives of project. Use of existing deep water to widen channel by relocating USCG buoys improves vessel transits and safety clearances	Effective in reducing potential for groundings during high wind conditions	Complete	Cost efficient	Yes	
N-8	No action	None	None	Unacceptable to users	Not Efficient	Not Effective	N/A	The port indicated that with current and future growth, this plan would hinder opportunities for port development. Carried forward to compare alternative plans.	Yes	

Table 3-3 presents the preliminary economic summary comparison for incremental deepening measures within economic modeling Phases 1, 2, and 5 under the future-with and without the proposed LNG conversion. The costs that factored into the figures in this table are rough order magnitude and do not include PED or construction management. The costs for Phase 1 includes an estimated $349,933,000 of associated costs for PREPA modifications of local service facilities to handle the LNG.

Table 3-3: Preliminary Economic Summary of Phases 1, 2, and 5.

ECONOMIC ANALYSIS SUMMARY			EXPECTED AAEQ NET BENEFITS & BCR			
			WITH LNG CONVERSION		WITHOUT LNG CONVERSION	
Phase	Description	Alternative	AAEQ NET BENEFITS	BCR	AAEQ NET BENEFITS	BCR
Phase-1	Army Terminal Channel (ATC)100-foot Widening @ Existing 40-foot Depth	100-foot Army Terminal Channel Widener	$ 59,045,000	5.4	$ 919,000	2.8
Phase-2	Deepen Cut-6 to 2' > Project Depth; Deepen Anegado, Army Terminal Channel & Turning Basin to the Limiting Project Depth	41 feet	$ (76,000)	0.8	$ (76,000)	0.8
		42 feet	$ 233,000	1.5	$ 233,000	1.5
		43 feet	$ 560,000	1.9	$ 560,000	1.9
		44 feet	$ 623,000	1.8	$ 623,000	1.8
		45 feet	$ 441,000	1.4	$ 441,000	1.4
Phase-5	San Antonio Channels & Cruise Ship Basin East Deepening	36 feet (assumes 43 feet ATC)	$ 1,117,000	4.7	$ 1,117,000	4.7
		36 feet (assumes 44 feet ATC)	$ 1,136,000	4.8	$ 1,136,000	4.8
Combined Plans	Cut-6 @ 45 feet, Anegado @ 43 feet; 100-foot Army Terminal Channel Widener @ 40 feet, 43-foot Army Terminal Channel Deepening; 36-foot San Antonio Channels & Cruise Ship Basin East Deepening		$ 60,650,000	5.2	$ 2,530,000	2.7
	Cut-6 @ 46 feet, Anegado @ 44 feet; 100-foot Army Terminal Channel Widener @ 40 feet; 44-foot Army Terminal Channel Deepening; 36-foot San Antonio Channels & Cruise Ship Basin East Deepening		$ 60,790,000	5.2	$ 2,670,000	2.6

Note: Only one mobilization/demobilization is included in this cost estimate for a mechanical clamshell dredge. These are ROM costs; PED and construction management are not included. Power generation cost reduction benefits included. FY18 price levels, FY18 discount rate of 2.75%, all dollar values rounded to the $1,000s.

The depth combinations that generated the highest net benefits, based on preliminary HarborSym Model results are highlighted in grey. The last row, in blue, combines phases with the greatest net benefits for a closer refinement in costs (Table 3-3). This process resulted in the identification of a focused array of alternatives for evaluation and identification of the NED. This focused array consists of Phase 1 widening of the Army Terminal Channel to the existing 40 foot depth, Phase 2 deepening between 43 feet and 44 feet-which would be the limiting project depth, and Phase 5 deepening improvements to 36 feet. From this focused array, costs were additionally refined to include another mobilization/demobilization of the hydraulic hopper dredge in addition to the mechanical dredge, and updated the unit costs for the dredged material. These refinements are displayed in Table 3-4.

Table 3-4: Focused Array Economic Summary

ECONOMIC ANALYSIS SUMMARY			EXPECTED AAEQ NET BENEFITS & BCR			
			WITH LNG CONVERSION		WITHOUT LNG CONVERSION	
Phase	Description	Measure	AAEQ NET BENEFITS	BCR	AAEQ NET BENEFITS	BCR
Phase-1	Army Terminal Channel (ATC) 100-foot Widening @ Existing 40-foot Depth	100-foot Army Terminal Channel Widener	$ 58,907,000	5.4	$ 781,000	2.2
Phase-2	Deepen Cut-6 to 2' > Project Depth; Deepen Anegado, Army Terminal Channel & Turning Basin	43 feet	$ 447,000	1.6	$ 447,000	1.6
		44 feet	$ 481,000	1.5	$ 480,000	1.5
Phase-5	San Antonio Channels & Cruise Ship Basin East Deepening	36 feet (assumes 43 feet ATC)	$ 1,183,000	6.0	$ 1,183,000	6.0
		36 feet (assumes 44 feet ATC)	$ 1,202,000	6.1	$ 1,202,000	6.1
Recommended Plan	**Cut-6 @ 46 feet, Anegado @ 44 feet; 100-foot Army Terminal Channel Widener, 44-foot Army Terminal Channel Deepening; 36-foot San Antonio Channels & Cruise Ship Basin East Deepening**		**$ 60,195,000**	**5.0**	**$ 2,075,000**	**1.9**

Note: FY18 price levels, FY18 discount rate of 2.75%, all dollar values rounded to the $1,000s.

As previously discussed, the four P&G Accounts, NED, RED, EQ, and OSE, were established to facilitate evaluation, comparison, and display potentially varying effects of alternative plans. The Federal Objective is to determine the alternative with that reasonably maximizes net benefits, while still protecting or minimizing impacts to the environment. The NED account displays changes in the economic value of the national output of goods and services. Under this account, the Recommended Plan generates the highest AAEQ net benefits ranging from about $60.2 million with a benefit-cost ratio (BCR) of 5.0 in the with LNG conversion economic analysis and a BCR of 1.9 in the without LNG conversion. In addition to the NED account, the RED, EQ, and OSE accounts can exhibit meaningful differences between alternatives considered.

With regard to the Recommended Plan, the OSE account includes the effects of the project on the population in the region. The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and maximize environmental quality in the project area to the extent practicable considering other criteria and planning objectives. More detailed descriptions of the analysis and impacts can be found in Section 5 of this report and in the Appendices. For the purposes of alternatives analysis, all action plans were compared to the future without-project condition (i.e. NEPA No Action), which factors in 50 years of sea level change (to 2075).

Throughout the screening process, the four P&G accounts were considered with the intent to identify those additional factors that could significantly contribute to the ultimate decision of plan selection. See Figure 3-6 for a summary on how the Recommended Plan addresses the four accounts.

Figure 3-6: Recommended Plan Summary of the Four Accounts

Throughout the development of the final array of alternatives the USACE coordinated with various resource agencies to identify the primary resources that could be impacted by the proposed alternatives. A summary table of environmental impacts for the focused array of alternatives, Including the No Action Alternative, is presented in Table 3-5.

Table 3-5: Summary of Environmental Impacts for Focused Array of Alternatives, Including the No Action Alternative (Environmental Quality Account)

Environmental Factor	No Action	41’	42’	43’	44’	45’
General Consequences	A greater increase in ship transits (compared to action alternatives) are predicted due to need for more ships to carry same amount of cargo. This results in greater risk to threatened and endangered species, and more air pollution. Year 2026 modeled to have 2,668 vessel calls.	Larger ships and slight decrease in ship transits predicted. Deepening would result in less risks to threatened and endangered species, some impacts to fish habitat. Year 2026 modeled to have less vessel calls.	Larger ships and slight decrease in ship transits predicted. Deepening would result in, less risks to threatened and endangered species, some impacts to fish habitat. Year 2026 modeled to have less vessel calls.	Larger ships and small decrease in ship transits predicted. Deepening would result in less risks to threatened and endangered species, some impacts to fish habitat. Year 2026 modeled to have less vessel calls.	Larger ships and small decrease in ship transits predicted. Deepening would result in less risks to threatened and endangered species, some impacts to fish habitat. Year 2026 modeled to have 2,648 vessel calls.	Larger ships and small decrease in ship transits predicted. Deepening would result in less risks to threatened and endangered species, some impacts to fish habitat. Year 2026 modeled to have 2,648 vessel calls.
Geology and Geomorphology	O&M of the Federal navigation channel will result in no effect on geology and geomorphology	Increased channel depth, but no real effect on geology and geomorphology	Increased channel depth, but no real effect on geology and geomorphology	Increased channel depth, but no real effect on geology and geomorphology	Increased channel depth, but no real effect on geology and geomorphology	Increased channel depth, but no real effect on geology and geomorphology
Tides	No impact to tidal range is predicted.	No impact to tidal range is predicted.	No impact to tidal range is predicted.	No impact to tidal range is predicted.	No impact to tidal range is predicted.	No impact to tidal range is predicted.
Currents	Currents will generally remain the same, but some changes could occur due to changing climate and weather patterns.	Currents will generally remain the same. Some areas of the harbor may experience a reduction in currents due to wider deeper channels.	Currents will generally remain the same. Some areas of the harbor may experience a reduction in currents due to wider deeper channels. The magnitude of these changes is slightly greater than the 41’ alternative.	Currents will generally remain the same. Some areas of the harbor may experience a reduction in currents due to wider deeper channels. The magnitude of these changes is slightly greater than the 42’ alternative.	Currents will generally remain the same. Some areas of the harbor may experience a reduction in currents due to wider deeper channels. The magnitude of these changes is slightly greater than the 43’ alternative.	Currents will generally remain the same. Some areas of the harbor may experience a reduction in currents due to wider deeper channels. The magnitude of these changes is slightly greater than the 44’ alternative.
Sea level change (SLC) / water levels	The historical SLC rate would cause water surface elevation to increase by approximately 0.34 feet over the 50 year period of analysis (represented as the year 2075). SLC could cause impacts to existing infrastructure including overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas.	SLC would not significantly impact the performance of the Federal navigation project as there are no associated emergent general navigation features.	SLC would not significantly impact the performance of the Federal navigation project as there are no associated emergent general navigation features.	SLC would not significantly impact the performance of the Federal navigation project as there are no associated emergent general navigation features.	SLC would not significantly impact the performance of the Federal navigation project as there are no associated emergent general navigation features.	SLC would not significantly impact the performance of the Federal navigation project as there are no associated emergent general navigation features.
Land Use	O&M of the Federal navigation channel will result in no effect on land use.	Temporary effect in construction areas, otherwise no effect.	Temporary effect in construction areas, otherwise no effect.	Temporary effect in construction areas, otherwise no effect.	Temporary effect in construction areas, otherwise no effect.	Temporary effect in construction areas, otherwise no effect.
HTRW	HTRW has not been encountered during O&M dredging.	The dredging of virgin material is not anticipated to encounter HTRW and sediment evaluations support this expectation.	The dredging of virgin material is not anticipated to encounter HTRW and sediment evaluations support this expectation.	The dredging of virgin material is not anticipated to encounter HTRW and sediment evaluations support this expectation.	The dredging of virgin material is not anticipated to encounter HTRW and sediment evaluations support this expectation.	The dredging of virgin material is not anticipated to encounter HTRW and sediment evaluations support this expectation.
Wetlands	O&M of the existing Federal navigation channel has no effect on wetlands.	Dredging operations would not affect existing saltwater wetlands.	Dredging operations would not affect existing saltwater wetlands.	Dredging operations would not affect existing saltwater wetlands.	Dredging operations would not affect existing saltwater wetlands.	Dredging operations would not affect existing saltwater wetlands.
Water Quality	Maintenance dredging and ODMDS disposal cause temporary turbidity increases during construction but no long-term impacts have occurred due to the Federal project.	Construction dredging and disposal (including ODMDS and Condado lagoon) would cause temporary increases in turbidity; Operations would maintain 10 NTU above background standard or temporarily shutdown; No long-term impacts anticipated.	Construction dredging and disposal (including ODMDS and Condado lagoon) would cause temporary increases in turbidity; Operations would maintain 10 NTU above background standard or temporarily shutdown; No long-term impacts anticipated.	Construction dredging and disposal (including ODMDS and Condado lagoon) would cause temporary increases in turbidity; Operations would maintain 10 NTU above background standard or temporarily shutdown; No long-term impacts anticipated.	Construction dredging and disposal (including ODMDS and Condado lagoon) would cause temporary increases in turbidity; Operations would maintain 10 NTU above background standard or temporarily shutdown; No long-term impacts anticipated.	Construction dredging and disposal (including ODMDS and Condado lagoon) would cause temporary increases in turbidity; Operations would maintain 10 NTU above background standard or temporarily shutdown; No long-term impacts anticipated.

Air Quality	Greatest impact to air emissions due to more vessels needed to deliver same amount of cargo.	Reduction in vessel related emissions compared to FWOP. The alternative will have a temporary minor increase in emissions related to the construction of the project.	Reduction in vessel related emissions compared to FWOP. The alternative will have a temporary minor increase in emissions related to the construction of the project compared to the 41' alternative.	Reduction in vessel related emissions compared to FWOP. The alternative will have a temporary minor increase in emissions related to the construction of the project compared to the 42' alternative.	Reduction in vessel related emissions compared to FWOP. The alternative will have a temporary minor increase in emissions related to the construction of the project compared to the 43' alternative.	Reduction in vessel related emissions compared to FWOP. The alternative will have a temporary minor increase in emissions related to the construction of the project compared to the 44' alternative.
Threatened and Endangered Species (Dredging/Long term)	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect	KEY for acronyms: NE=No Effect, MANLAA=May Affect, Not Likely to Adversely Affect, MALAA=May Affect, Likely to Adversely Affect
Nassau Grouper	O&M would continue to operate under the most up-to-date South Atlantic Regional Biological Opinion.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.
Scalloped Hammerhead Shark	O&M would continue to operate under the current South Atlantic Regional Biological Opinion.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would result in NE to the species.
Loggerhead Sea Turtle	Would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.
Leatherback Sea Turtle	O&M would have NE to this species.	Construction dredging and ODMDS or Condado lagoon disposal would have NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would have NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would have NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would have NE to the species.	Construction dredging and ODMDS or Condado lagoon disposal would have NE to the species.
Hawksbill Sea Turtle	O&M would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species. Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.
Green Sea Turtle	O&M would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Hopper dredging MALAA the species; Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species; Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species; Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species; Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.	Hopper dredging MALAA the species; Other dredge types MANLAA and ODMDS or Condado lagoon disposal would have NE to the species.
Blue Whale	Would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.
Sei Whale	Would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.
Fin Whale	Would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.
Sperm Whale	Would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.

Humpback Whale	O&M would continue to operate under the current South Atlantic Regional Biological Opinion. Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.	Dredging would have NE; Vessel transportation during construction MANLAA but is discountable; Protective measures would be implemented.
Antillean Manatee	O&M would continue to implement protective measures = MANLAA	Construction dredging and ODMDS or Condado disposal MANLAA the manatee; Protective measures would be implemented.	Construction dredging and ODMDS or Condado disposal MANLAA the manatee; Protective measures would be implemented.	Construction dredging and ODMDS or Condado disposal MANLAA the manatee; Protective measures would be implemented.	Construction dredging and ODMDS or Condado disposal MANLAA the manatee; Protective measures would be implemented.	Construction dredging and ODMDS or Condado disposal MANLAA the manatee; Protective measures would be implemented.
Elkhorn Coral	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA ; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Staghorn Coral	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Pillar Coral	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Rough Cactus	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Lobed Star Coral	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Mountainous Star Coral	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Boulder Star	O&M would operate under the current South Atlantic Regional Biological Opinion; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)	Construction dredging MANLAA; ODMDS or Condado lagoon disposal would have no effect; Protective measures would be implemented. (turbidity monitoring)
Marine Mammals	Future maintenance dredging may impact marine mammals. Protective measures would be implemented.	Dredging and disposal may impact marine mammals. Protective measures would be implemented. Impact would be temporary and isolated to the dredging and disposal areas during the construction phase.	Dredging and disposal may impact marine mammals. Protective measures would be implemented. Impact would be temporary and isolated to the dredging and disposal areas during the construction phase.	Dredging and disposal may impact marine mammals. Protective measures would be implemented. Impact would be temporary and isolated to the dredging and disposal areas during the construction phase.	Dredging and disposal may impact marine mammals. Protective measures would be implemented. Impact would be temporary and isolated to the dredging and disposal areas during the construction phase.	Dredging and disposal may impact marine mammals. Protective measures would be implemented. Impact would be temporary and isolated to the dredging and disposal areas during the construction phase.
Essential Fish Habitat	Temporary impacts from construction related turbidity.	Temporary impacts from construction related turbidity.	Temporary impacts from construction related turbidity.	Temporary impacts from construction related turbidity.	Temporary impacts from construction related turbidity.	Temporary impacts from construction related turbidity.
Birds	No impacts from continued operations and maintenance of the existing Federal navigation channel.	No effect is anticipated from construction; Beneficial use options may positively affect bird foraging habitat in Condado lagoon.	No effect is anticipated from construction; Beneficial use options may positively affect bird foraging habitat in Condado lagoon.	No effect is anticipated from construction; Beneficial use options may positively affect bird foraging habitat in Condado lagoon.	No effect is anticipated from construction; Beneficial use options may positively affect bird foraging habitat in Condado lagoon.	No effect is anticipated from construction; Beneficial use options may positively affect bird foraging habitat in Condado lagoon.

Benthic Resources	Complete removal of benthic infauna and epifauna will occur with every maintenance dredging event, followed by a recovery.	Complete removal of benthic infauna and epifauna followed by a recovery; Not anticipated to be different from performing maintenance dredging.	Complete removal of benthic infauna and epifauna followed by a recovery; Not anticipated to be different from performing maintenance dredging.	Complete removal of benthic infauna and epifauna followed by a recovery; Not anticipated to be different from performing maintenance dredging.	Complete removal of benthic infauna and epifauna followed by a recovery; Not anticipated to be different from performing maintenance dredging.	Complete removal of benthic infauna and epifauna followed by a recovery; Not anticipated to be different from performing maintenance dredging.
Hardbottom Habitat	O&M of the existing Federal navigation channel will have no additional effect on undisturbed hardbottom habitats in the area.	Construction dredging and ODMDS or Condado lagoon disposal would have no effect on undisturbed hardbottom habitats in the area.	Construction dredging and ODMDS or Condado lagoon disposal would have no effect on undisturbed hardbottom habitats in the area.	Construction dredging and ODMDS or Condado lagoon disposal would have no effect on undisturbed hardbottom habitats in the area.	Construction dredging and ODMDS or Condado lagoon disposal would have no effect on undisturbed hardbottom habitats in the area.	Construction dredging and ODMDS or Condado lagoon disposal would have no effect on undisturbed hardbottom habitats in the area.
Invasive Species	O&M of the existing Federal navigation channel will have no additional effect on invasive species; However, the No Action results in an even greater number of vessels predicted to call on the Port.	This alternative will not cause additional threats from invasive species; Regulations will help control aquatic invasive species.	This alternative will not cause additional threats from invasive species; Regulations will help control aquatic invasive species.	This alternative will not cause additional threats from invasive species; Regulations will help control aquatic invasive species.	This alternative will not cause additional threats from invasive species; Regulations will help control aquatic invasive species.	This alternative will not cause additional threats from invasive species; Regulations will help control aquatic invasive species.
Environmental Justice	O&M of the existing Federal navigation channel will have no effect on EJ communities.	The alternative is not anticipated to have a disproportionately high and adverse impact on low income or minority communities from construction and/or secondary effects.	The alternative is not anticipated to have a disproportionately high and adverse impact on low income or minority communities from construction and/or secondary effects.	The alternative is not anticipated to have a disproportionately high and adverse impact on low income or minority communities from construction and/or secondary effects.	The alternative is not anticipated to have a disproportionately high and adverse impact on low income or minority communities from construction and/or secondary effects.	The alternative is not anticipated to have a disproportionately high and adverse impact on low income or minority communities from construction and/or secondary effects.
Noise	O&M of the existing Federal navigation channel will have no additional effect on noise in the Harbor. However, the No Action results in an even greater number of vessels predicted to call on the Port.	Minor adverse impacts to aquatic species due to displacement; Temporary and minor impact to human populations due to the construction of project.	Minor adverse impacts to aquatic species due to displacement; Temporary and minor impact to human populations due to the construction of project. Slightly longer than 41' alternative.	Minor adverse impacts to aquatic species due to displacement; Temporary and minor impact to human populations due to the construction of project. Slightly longer than 42' alternative.	Minor adverse impacts to aquatic species due to displacement; Temporary and minor impact to human populations due to the construction of project. Slightly longer than 43' alternative.	Minor adverse impacts to aquatic species due to displacement; Temporary and minor impact to human populations due to the construction of project. Slightly longer than 44' alternative.
Aesthetics	O&M of the existing Federal navigation channel will have no effect on area wide aesthetics. However, the No Action results in an even greater number of vessels predicted to call on the Port.	No effect to area wide aesthetics; Larger ships will transit more efficiently through the port; Not out of character for the San Juan area.	No effect to area wide aesthetics; Larger ships will transit more efficiently through the port; Not out of character for the San Juan area.	No effect to area wide aesthetics; Larger ships will transit more efficiently through the port; Not out of character for the San Juan area.	No effect to area wide aesthetics; Larger ships will transit more efficiently through the port; Not out of character for the San Juan area.	No effect to area wide aesthetics; Larger ships will transit more efficiently through the port; Not out of character for the San Juan area.
Coastal Barrier Resources	O&M of the existing Federal navigation channel will have no effect on CBRA zones.	No effect to CBRA Zones as a result of improvements.	No effect to CBRA Zones as a result of improvements.	No effect to CBRA Zones as a result of improvements.	No effect to CBRA Zones as a result of improvements.	No effect to CBRA Zones as a result of improvements.
Cultural and Historic Resources	O&M of the existing Federal navigation channel will have no effect on historic properties.	No effect on historic properties.	No effect on historic properties.	No effect on historic properties.	No effect on historic properties.	No effect on historic properties.

4.0 RECOMMENDED PLAN*

This section provides a detailed description of the Recommended Plan developed and selected through the plan formulation process. The details discussed in this section include plan components, design and construction considerations, operations and maintenance, dredged material placement, costs, benefits, risk and uncertainty, Non-Federal Sponsor's (NFS) view, Environmental Operating Principles (EOPs), and the USACE Campaign Plan. The Recommended Plan represents the project in the impacts analysis for Section 5 of this IFR/EA. The assumed channel widening and turning basin sizes represent the maximum anticipated sizes based on the best professional judgment of harbor pilots and ship simulation testing to allow design vessels to safely and efficiently utilize the terminals.

The USACE process for selecting an alternative begins at the district and NFS level and expands, with product development, to incorporate the division and headquarters levels through a series of reviews and approvals, and at the same time allows for feedback and suggestions from resource agencies. For Congressionally authorized projects, such as this, the final agency decision maker is the Secretary of the Army through the ASA (CW).

The navigation improvements included in the Recommended Plan respond to local needs and desires as well as the economic and environmental criteria used to screen, evaluate, select, and refine measures and alternatives. If implemented, the Recommended Plan would handle the current and forecasted vessel fleets and cargo volumes with fewer delays and less congestion and damages than under the No Action Alternative while avoiding all unacceptable adverse environmental impacts.

4.1 Description of the Recommended Plan

4.1.1 General Navigation Features

General navigation features include channels, jetties or breakwaters, locks and dams, basins or water areas for vessel maneuvering, turning, passing, mooring or anchoring incidental to transit of the channels and locks. General navigation features also include dredged material management areas and sediment basins.

No expansion or deepening of the Entrance Channel is included in the Recommended Plan, as the risks are very low that additional Bar Channel depth will be required. As a contingency, during PED the USACE, in coordination with the San Juan Bay Pilots, will verify the adequacy of the existing Bar Channel depths by evaluation of vessel squat tables to confirm adequate underkeel clearance in the anticipated future with-project condition and through use of existing available technology, such as a CADET vertical ship motion study. Deepening starts with Cut-6, which has an additional 2 feet of depth for wind and wave allowances for ship squat effects, and continues through Anegado Channel, Army Terminal Channel to Army Terminal Turning Basin. Widening only occurs along Army Terminal Channel. Widening and deepening of the inner harbor channels serve petroleum product tankers, LNG tankers, cruise vessels, containerships, bulk/general cargo carriers, roll-on/roll-off ships and barges.

Starting from the entrance of San Juan Harbor, the Recommended Plan:

- Deepens Cut-6 of the Bar Channel to 46 feet to maintain the existing 2-foot squat and wave allowance.
- Deepens the Anegado Channel, Army Terminal Channel, and Army Terminal Turning Basin to 44 feet to support petroleum product tankers.
- Widens the Army Terminal Channel by 100 feet, effectively increasing the channel width from 350 feet to 450 feet, supporting petroleum tankers and LNG vessels.

- Provides eastern and western flares at the intersection of the Army Terminal Channel and the Army Terminal Turning Basin.
- Deepens the San Antonio Approach Channel, San Antonio Channel, San Antonio Channel Extension, and Cruise Ship Basin East to the authorized 36 foot depth to resolve inefficiencies for vessels transiting these channels, primarily cruise vessels. Federal interest and economic justification to construct to this authorized depth have been confirmed through this study.
- Furthermore, the plan includes a 1,050-foot extension east of the San Antonio Channel in order to accommodate the terminal operators' needs for additional depth in this portion of the Harbor.

- Dredged Material Placement Options
  - Base Plan - Place dredged material at the existing ODMDS.
  - Beneficial use of dredged material to include the filling of dredged holes in Condado Lagoon to restore SAV habitat was evaluated.

Figure 4-1 of this section provides the details of the proposed changes and illustrates the general locations of the major features. Figures 3-3 (non-structural measure) and 3-4 (non-structural measure) in Section 3 provide more detailed descriptions and locations of the Recommended Plan features.

Figure 4-1: Recommended Plan

4.1.2 Lands, Easements, Rights of Way, and Relocation Considerations

The Recommended Plan's navigation improvement features do not require acquisition of real estate interests. As the project has a connection to commerce and navigation, the Government will exercise its rights under navigation servitude for those features, if necessary. The base plan dredged material management option is the approved ODMDS. The project footprint has been verified by appropriate telephone, cable, and utility organizations to confirm there are no required relocations for utilities in

conjunction with the Federal navigation project expansion, as discussed in the Engineering Appendix. An extensive search for utilities was performed by the USACE Jacksonville District Engineering Division personnel in 1998 prior to the last deepening project completed in 2000, and correspondence with stakeholders has not revealed any development since that time. Thus there are no relocations required.

4.1.3 Local Service Facilities

The associated costs for local service facilities are approximately $350 million for infrastructure improvements associated with PREPA's conversion to LNG and $2,054,000 for berths at facilities, which benefit from the deeper channel. These costs are 100% non-Federal and are not included in the project first costs of the Recommended Plan.

4.1.4 Relocation of Aids to Navigation (ATONs)

The USCG Sector San Juan plans to move buoys G5, G7, and G9 to areas of existing deep water outside of the Federal channel limits, which allows widening of the Entrance Channel reaches from Cuts 4 – 6 without deepening (Figure 3-3). Another non-structural measure involves the USCG relocation of buoy R2 and G3 to allow use of existing wideners (Figure 3-4).

4.1.5 Mitigation*

The intent of compensatory mitigation is to replace the ecological function and services lost as a result of unavoidable impacts. Based on evaluation of existing surveys and preliminary benthic surveys conducted for this study, the Recommended Plan is not anticipated to result in direct or indirect impacts to resources of concern (SAV/hardbottom/hard corals). The closest mapped hardbottom habitat (colonized pavement) is 457 meters from the closest dredge cut (Cut-6) and Acroporid coral DHC is approximately 762 meters north of Cut-6. For evaluation purposes, the USACE, Jacksonville District uses 150 meters for estimating the indirect impact zone adjacent to the limits of construction dredging. Therefore, impacts to listed corals from dredging and dredged material transport related turbidity are not anticipated. Additional benthic surveys will take place prior to construction to confirm these separation distances remain accurate. Cultural resource investigations included a background investigation and cultural resources remote sensing survey of the San Juan Harbor channel APE in consultation with the Puerto Rico SHPO and the Instituto de Cultura Puertorriqueña. No cultural resources were identified within the footprint of the Recommended Plan.

4.2 Effects from Hurricanes Maria and Irma on the Recommended Plan

The 2017 hurricane season was an active one for the Caribbean and destruction was widespread, especially in Puerto Rico. Two major hurricanes impacted the Commonwealth; Hurricane Irma on September 7, 2017 and then Hurricane Maria on September 20, 2017. The impacts from these two storms were widespread across Puerto Rico. The power infrastructure was severely impacted by Hurricane Irma. Impacts experienced from the passage of Hurricane Maria triggered an island-wide power outage. The publically-owned utility authority, PREPA, is in the process of restoring the permanent power grid and through this process is making necessary infrastructure improvements.

Although these storms caused billions of dollars in damages across Puerto Rico, the devastating storm impacts did not impact the quantitative analysis of this study. These storms do, however, impact the overall importance of the recommended navigation improvements to the people of Puerto Rico. The Recommended Plan did not change following the passage of Hurricanes Irma and Maria, the benefits of the navigation improvements continue to justify the costs. Nonetheless, in the context of hurricane recovery, Federal interest in the Recommended Plan has broadened. Even though the study authority for

the Recommended Plan falls under a non-disaster authority, it complements the efforts of the many Federal agencies, including the USACE, facilitating the recovery of Puerto Rico through cost sharing, grants, loans, technical assistance, and more. The Recommended Plan in and of itself supports the National Recovery Framework calling for the Nation to seek means to best restore, redevelop, and revitalize the health, social, economic, natural and environmental fabric of the community - and to build a more resilient Nation – by rebuilding stronger, smarter and safer.

The widening improvements of the Recommended Plan accommodate larger LNG vessels and larger petroleum tankers (LR2), supporting the potential for lower power generation costs and more efficient transportation of petroleum products. These energy and fuel-related commodities impact every sector of the economy – making this project one of the most critical projects, economically, for the island. In addition, the island's conversion to LNG fosters improvements in air quality by burning cleaner fuel in power plants and reducing emissions – a step forward in complying with USEPA's MATS.

Per conversations with PREPA, the utility authority still plans to convert the San Juan area power plants to LNG post-Hurricanes Irma and Maria. The conversion plan is outlined in a letter provided by PREPA to SAJ Planning and Policy Division in January 2018, several months after the occurrence of Irma and Maria. Risk and uncertainty surrounding PREPA's LNG conversion plan is discussed in Section 4.5 *Risk and Uncertainty*.

4.3 Dredging and Dredged Material Management

Construction of the Recommended Plan is estimated to generate approximately 2.2 million cubic yards (cy) of dredged material. The Recommended Plan is the base plan and is expected to place all dredged material at the existing ODMDS located about two miles northwest of the Entrance Channel. As outlined in the Dredged Material Management Plan (DMMP) – Preliminary Assessment, the ODMDS has sufficient capacity to handle current O&M material, new work material, and any additional maintenance material generated from this project. Additionally, the DMMP Preliminary Assessment contains a summary of potential beneficial use sites evaluated for this IFR/EA – which are also discussed later in this section.

4.3.1 Construction Methodology

The type of dredging equipment considered for a particular construction contract depends on various parameters such as the type and amount of material, depth of the channel, access and distance to placement site, wave energy environment, availability and condition of equipment, environmental windows, etc. Ultimately, the contractor, selected through the contracting process, determines the construction methodology.

Based on available core borings for San Juan Harbor, the material to be dredged would not require blasting and consists primarily of sand and clay, with limited areas of a less dense limestone. For the widening and deepening efforts, a potential contractor might use a hydraulic cutterhead dredge, hopper dredge, or mechanical excavator.

For planning and cost estimating purposes of the Recommended Plan, the USACE assumed that a mechanical clamshell dredge would be used in combination with a hydraulic hopper dredge for construction. The mechanical dredge would be used within the limits of the Federal channels and in tight corners or berthing areas. Material from these reaches would be placed in a scow or on a barge for transport to the ODMDS. A hopper dredge is anticipated to be used to remove unconsolidated overburden material from within the limits of the Federal channel and new construction widening measures. Material would be transported to the ODMDS in accordance with the USEPA-approved SMMP.

Since dredging equipment does not typically result in a perfectly smooth and even channel bottom, a drag bar, chain, or other item may be pulled 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. Detailed descriptions on types of dredging equipment, including mechanical-clamshell, hydraulic hopper, and cutterhead dredges, can be found in Engineer Manual, (EM) 1110-2-5025, *Engineering and Design - Dredging and Dredged Material Disposal.*

4.3.2 Operations and Maintenance (O&M) Considerations

Maintenance dredging usually involves a clamshell and bottom dump barge taking the material to the ODMDS, as current practices documented in the DMMP. Maintenance dredging would utilize the same placement area as used for existing conditions; the duration and frequency of dredging events would be within the range occurring under current conditions. O&M dredging would generally occur about every five to seven years with a clamshell dredge and bottom dump barge, taking approximately 155,000 cy of material to the ODMDS located northwest of the navigation channel. It is estimated that the Recommended Plan would increase O&M quantities by approximately 15,000 cy a year (*See* the Engineering Appendix).

4.3.3 Beneficial Use Placement Options

Since the early 1990's, Congressional actions have placed a considerable emphasis on beneficially using dredged material. Statutes, such as the WRDAs of 1992, 1996, 2000, 2007, and 2016, demonstrate that beneficial use is a Congressional priority. The USACE has encouraged the use of dredged material for beneficial use through such regulations as 33 CFR Part 335, ER 1105-2-100, ER 1130-2-520, and Policy Guidance Letter No. 56. ER 1105-2-100, paragraph E-15a.(1)(d) states it is Corps policy "that all dredged material management studies include an assessment of potential beneficial uses for environmental purposes, including fish and wildlife habitat creation, ecosystem restoration and enhancement and/or hurricane and storm damage reduction."

Opportunities for beneficial use of dredged material exist in the project vicinity. In accordance with ER 1105-2-100, the USACE evaluated several beneficial use opportunities as a part of this project (Figure 4-2). These different dredged material management options were coordinated with the environmental resource agencies to discuss potential setbacks or resource challenges. The details and screening of these sites is outlined below.

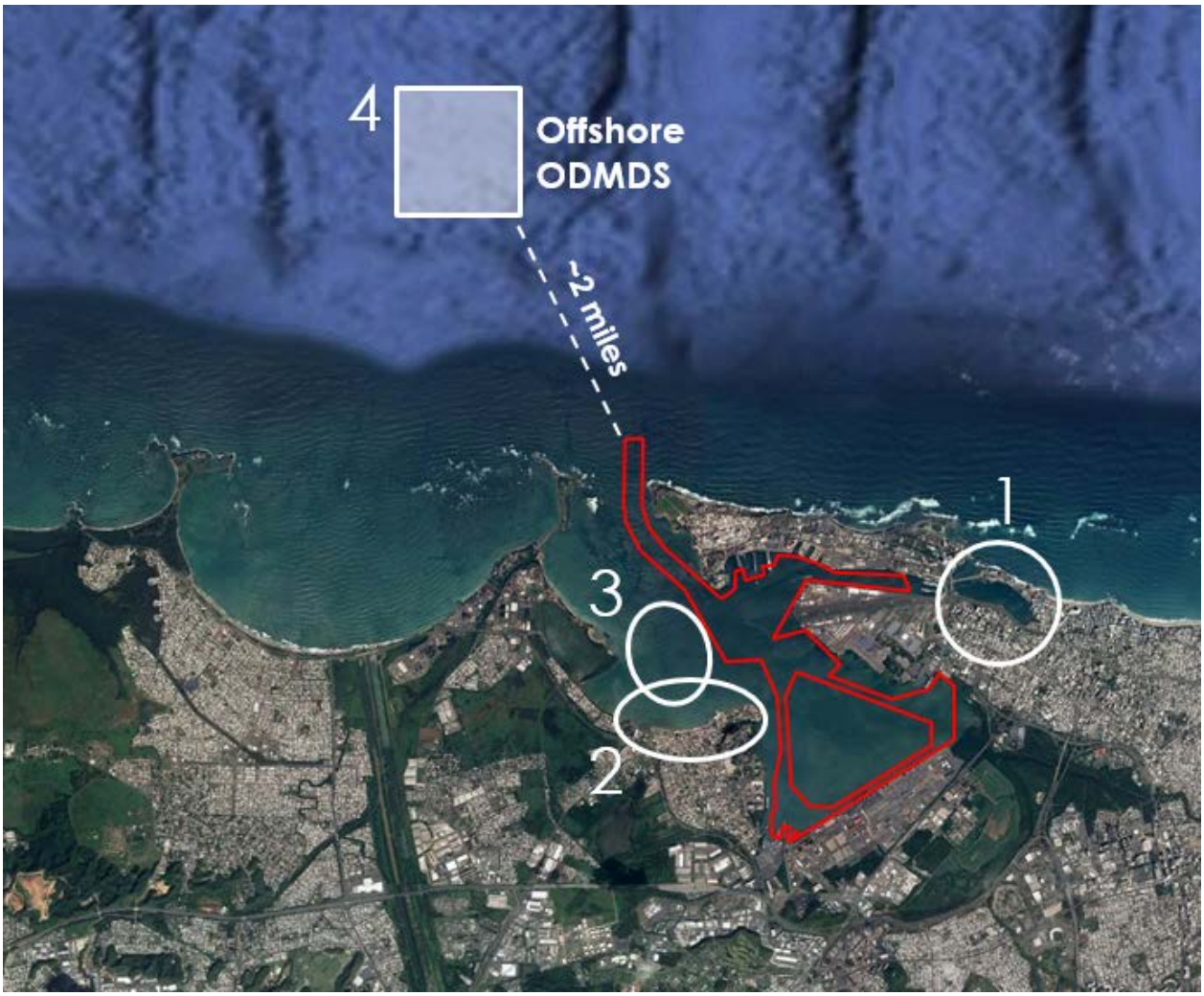

Figure 4-2: Beneficial Use Placement options evaluated 1) Filling of Dredged Holes in Condado Lagoon, 2) Cataño Living Shoreline, 3) Open-water Dredged Material Management Area, (existing location for maintenance material), 4) ODMDS

Option 1. This beneficial use option consists of taking approximately 230,000 cy of dredged material from the San Antonio Channels and Cruise Ship Basin East to Condado Lagoon to fill dredged holes facilitating seagrass habitat restoration. The construction method estimated for Option 1 makes use of a clamshell dredge and bottom dump barge. This option requires a pump-out from the bottom dump barge for placement in Condado Lagoon resulting in a $2.8 million dollar increase in costs, as compared to taking the same amount of material to the ODMDS. According to an October 2011 report, *The Hydrodynamics of the Condado Lagoon*, prepared for the San Juan Bay Estuary Program by the Caribbean Oceanography Group and Tetra Tech, Condado Lagoon (south of Ashford Avenue bridge) is not a high energy environment. Circulation is largely wind driven and material placed in the artificial depressions would remain there except for very fine particles. Under a "98% exceedance wind event," material too fine to remain stable (less than 0.21-0.46mm) would be re-suspended. Therefore, dredged material containing fine grained particles less than 0.21-0.46mm would require capping if used to restore Condado Lagoon.

Informational meetings were held with Estuario Programma de San Juan Bahia (San Juan Bay Estuary Program) and Para La Naturaleza (For the Nature) in May and July of 2017 to identify whether there was a potential interest in cost sharing for the restoration of seagrass habitat in Condado Lagoon. Both agencies expressed interest and requested additional information to make an informed budgetary decisions. Ultimately, due to the study schedule, the fact that the beneficial use is not the least cost, the PRPA's position to not cost-share in any incremental costs above the base plan for beneficial use, and the lack of a cost-sharing non-Federal partner at the point of preparation of this final IFR/EA, beneficial use in Condado Lagoon is not being pursued at this time as part of the Recommended Plan. However, costs have been prepared and cost apportionment tables are included in this decision document, if, in the future during PED or construction, a non-Federal sponsor is identified to cost-share 65% Federal/35% non-Federal in the incremental costs above the base plan, authority is granted for the USACE to cost-share in the beneficial use, and there is Federal funding to do so.

Example cost apportionment of incremental costs above the base plan for the beneficial use of dredged material in Condado Lagoon:

Type of Work	Estimated Cost	Cost-Share	Estimated Federal Share	Estimated Non-Federal Share
Mob/Demob*	$ 600,000	65/35	$390,000	$210,000
Transport & Placement**	$ 1,100,000	65/35	$682,000	$385,000
Turbidity Controls***	$600,000	65/35	$390,000	$210,000
Monitoring****	$400,000	65/35	$260,000	$140,000
Total			$1,722,000	$945,000

NOTES:
FY18 Price Levels
*Mob/demob: mobilization/demobilization of any additional equipment required for the beneficial use above what is required for the base plan
**Transport & Placement (including sandy capping material): Additional transportation & placement costs above the base plan. Assumes hydraulic unloading from San Antonio Channels and Cut-6 to Condado Lagoon placement location. Capping material, with higher sand content, is assumed to be coming from Cut-6 for this estimate. Approximately 25% of the material transported would be used for capping. For the purposes of this estimate, all material is assumed to be coming from the Federal navigation project. If additional capping material is needed, La Esperanza would be the most-likely source and would likely cost more-those costs are not incorporated into this estimate.
***Turbidity: Costs for Turbidity controls (turbidity curtains) not required for the base plan
****Monitoring: Monitoring plan, ESA observer, and turbidity monitoring that is not required for the base plan

Option 2. This beneficial use option evaluated involves the development of a new Dredged Material Management Area (DMMA) located in open water west of Anchorage Area F. This option costs about $9 million more than taking the 2.2 million cubic yards of material from the entire project to the ODMDS. The costs do not include the containment that would be required nor the turbidity controls and monitoring. Ultimately, Option 2, the DMMA, dropped out from further consideration as there are environmental resources (SAV) present in this vicinity that were identified through bathymetric surveys. The avoidance and minimization of impacts to these existing resources was enough to eliminate this beneficial use option from further evaluation

Option 3. Option 3 proposed to beneficially use dredged material for a living shoreline to protect the Cataño shoreline from wind generated waves, which cause erosion. The idea for Option 3 was generated from a letter the USACE received from the Municipality of Cataño expressing concern over the wind and wave energies damaging their shoreline. Option 3 costs approximately $13 million more than the base plan and this estimate does not include the required material (rock, concrete structural units, etc.) for the structures, nor the turbidity controls and monitoring, which would only increase the costs. In addition to

environmental resources (hardbottom habitat) identified in this vicinity where impacts to these resources would need to be avoided, Option 3 also dropped from further consideration as there is not anticipated to be enough rock generated from the plan for the shoreline structures. Therefore, the only beneficial use of dredged material option that remains viable is the restoration of seagrass habitat in Condado Lagoon by filling the dredged holes up to depths of 12 to 15 feet.

Option 4 (Base Plan). The least cost, engineeringly-feasible, and environmentally acceptable dredged material management option is to transport all dredged material from channel deepening and widening improvements to the approved ODMDS by dump scows or hopper dredges– this represents the base plan within the Federal Standard.

Table 4-1 provides a comparison of costs for the four different dredged material placement options. Section 204 of WRDA 1992 (P.L. 102-580) defines these incremental costs associated with construction of a beneficial use project for the protection, restoration, and creation of aquatic and ecologically related habitats, identifies as costs solely limited to construction costs in excess of those costs necessary to carry out the dredging for construction, operation, or maintenance of the authorized navigation project in the most cost effective way, consistent with economic, engineering, and environmental criteria. Section 207 of WRDA 1996 (P.L. 104-303) authorizes the use of a disposal method that is not the least cost option if the incremental costs are reasonable in relation to the environmental benefits for navigation projects, subject to certain requirements.

Table 4-1: Cost Comparison for Dredged Material Management Options

	Dredged Material Placement Location	Volume of Construction Dredged Material to be placed @ Each Location	Incremental Costs above Base Plan
Option 1	Fill Dredged Holes	230,000 cy	(+) ~ $2.8M
Option 2	DMMA	2,200,000 cy	(+) ~ $9M
Option 3	Living Shoreline	2,200,000 cy	(+) ~ $13M
Option 4	ODMDS (Base Plan)	2,200,000 cy	

4.4 Detailed Cost Estimates and Benefits of the Recommended Plan

The Cost Engineering and Risk Analysis Appendix contains detailed information on the development of project costs, cost assumptions, and the associated risks that factored into the contingency. The Economics Appendix includes detailed discussions of the transportation cost savings and benefit analysis, including the power generation cost reduction benefits category.

4.4.1 Project Costs and Benefits

Once the NED plan was determined, a detailed cost estimate was developed. The cost estimate includes a narrative, a summary cost, and a detailed cost showing quantity, unit cost, and the amount for contingencies for each cost item. The USACE Cost Engineering incorporated a 31% contingency for the NED Plan based on a Class 4 project (early conceptual technical information). See the Cost Engineering and Risk Analysis Appendix. The costs of the non-construction features of the project are also included in the cost estimate.

The project costs were prepared using the Micro-Computer Aided Cost Engineering System (MCACES), the construction cost (including PED, local service facilities, and aids to navigation) is $ $403,975,000 with the LNG conversion and $57,158,000 without the LNG conversion. The IDC is estimated to be $1,207,000 and is the same with or without the LNG conversion. The AAEQ costs range from $2,281,000 (without LNG conversion) to $15,172,000 (with LNG conversion). The AAEQ net benefits for the Recommended Plan range from $2,041,000 to $60,097,000 (with LNG conversion) and the BCR ranges from 1.9 (without LNG conversion) to 5.0 (with LNG conversion) at the Federal Water Resources Discount Rate (FY18) of 2.75% remaining economically justified under either scenario.

Table 4-2 presents the economics for the Recommended Plan. The column entitled "with LNG conversion" includes the power generation cost reduction benefits in the analysis attained through the LNG conversion, and the column entitled "without LNG conversion" excludes the power generation cost reduction benefits from the analysis – they are the exact same plan, only the economics differ.

Table 4-2: Average Annual Equivalent (AAEQ) benefits and costs for the Recommended Plan

FY2018 Price Levels - Cost Estimate 2/28/18	RECOMMENDED PLAN	
50-Year Period of Analysis / 2.75 % Discount Rate		
Average Annual Equivalent (AAEQ) Benefits and Costs		
	WITH LNG CONVERSION	*WITHOUT* LNG CONVERSION
AAEQ COSTS		
Economic Investment	$15,008,000	$2,117,000
Increased O&M for Dredging	$164,000	$164,000
Total AAEQ Costs	$15,172,000	$2,281,000
AAEQ BENEFITS		
Transportation Costs Savings	$1,612,000	$4,315,000
Unemployment Benefits	$7,000	$7,000
Power Generation Costs Reduction	$73,650,000	$0
Total AAEQ Benefits	$75,269,000	$4,322,000
AAEQ NET BENEFITS	$60,097,000	$2,041,000
BENEFIT-COST RATIO (at 2.75% FY18 Discount Rate)	5.0	1.9

NOTE: All values rounded to the $1,000s, includes Interest During Construction.

Transportation cost savings are, however, greater in the without LNG conversion economics scenario due, in part, to the fact that vessel operating costs of LNG vessels exceed those of petroleum tankers (Figure 4-3). This effectively means that the annual transportation costs of delivering fuel used by PREPA in power generation to the two San Juan power plants is lower when the fuel being delivered is diesel and is being carried on petroleum tankers, rather than when the fuel being delivered is LNG being carried on LNG vessels. This increase in annual transportation costs from the without-project condition to the with-project condition for vessels servicing PREPA offsets a portion of the transportation cost savings attributable to vessels that do not service PREPA. Thus, when the transportation costs of supplying fuel to PREPA and other terminal operators stays constant rather than increasing, the average annual transportation cost savings are greater, as they are not being diminished by using vessels with higher vessel operating costs. The following figure illustrates how the transportation cost savings were developed in both scenarios, with the LNG conversion and without the LNG conversion.

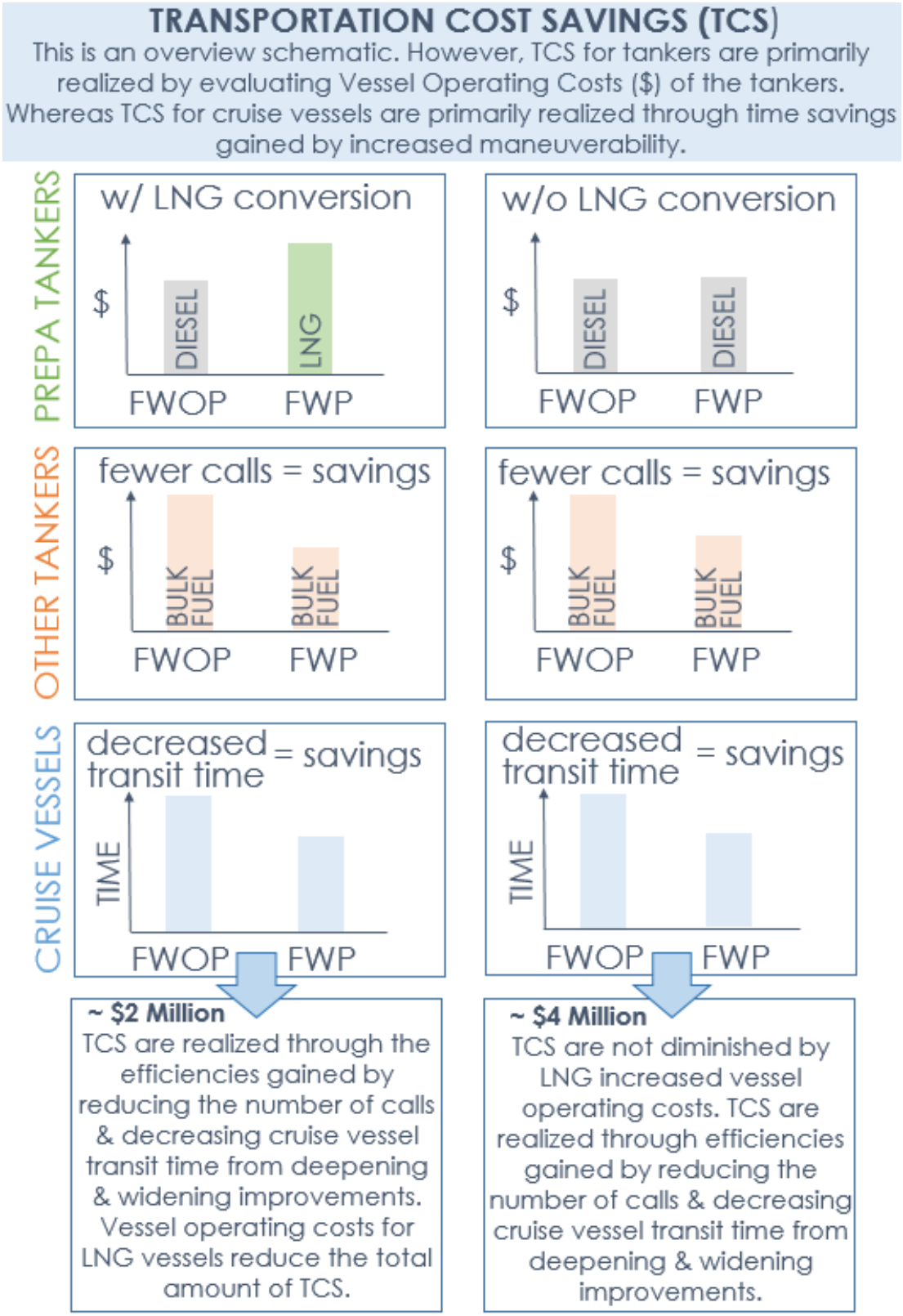

Figure 4-3: Transportation Cost Savings Diagram

4.4.2 Cost Apportionment

The WRDA of 1986 (Public Law 99-662), as amended, specifies cost apportionment by project purpose for deep draft navigation projects. Federal participation in navigation projects is limited to sharing costs for design and construction of GNF consisting of breakwaters and jetties, entrance and primary access channels, widened channels, turning basins, anchorage areas, locks, and dredged material management areas with retaining dikes. Table 4-3 shows the cost sharing summary for the NED plan with the LNG conversion and Table 4-4 shows the cost sharing summary for the NED plan without the LNG conversion.

Per Section 101(a) of WRDA 1986, as amended, non-Federal cost sharing for general navigation features varies according to the channel depth. For a commercial navigation project with project depths greater than 20 feet but not in excess of 50 feet, the non-Federal share for the construction of GNF is 25%. This percentage applies to mitigation and other work cost shared the same as GNF.

Non-Federal interests are responsible for and bear all costs for acquisition of necessary lands, easements, rights-of-way and relocations (LERR), terminal facilities, and dredging berthing areas and interior access channels to those berthing areas.

Section 101(a) of WRDA 1986, as amended, also requires the non-Federal sponsor pay an additional amount equal to 10% of the total construction cost for GNF. The additional 10% of the GNF costs, less the amount of LERR credit afforded to the sponsor for the value of LERR, can be paid by the non-Federal sponsor over a period not to exceed 30 years, with interest. However, in this case, there is no LERR adjustment credit since the sponsor has no related costs.

Per Section 101(b) of WRDA 1986, as amended, operation and maintenance of the GNF are a 100% Federal responsibility.

The ATON are a 100% Federal responsibility of the USCG.

Costs presented in Tables 4-3 and 4-4 are the Project First Costs ("Constant Dollar Basis") from the second column of the Total Project Cost Summary (TPCS) spreadsheet (*See* the Cost Engineering and Risk Analysis Appendix). The USACE regulations require use of the Constant Dollar Cost estimate at current price levels, not including inflation, for feasibility reports and Chief's Reports. The Constant Dollar Cost serves as the basis for the cost of the project for authorization and represents the Project First Cost. Project First Cost include PED costs, construction management costs, construction costs of the GNF with both Federal and non-Federal in-kind contributions, as applicable, LERR values, and contingencies determined through the Cost and Schedule Risk Analysis (CSRA).

The Total Project Cost is also calculated. This is the Federal Navigation Project's Constant Dollar Cost fully funded with escalation to the estimated midpoint of construction and is estimated to be $62,209,000. This number is the provided for use in financial planning, as it contains information regarding the overall cost-sharing obligations used for development of partnership agreements.

Table 4-3: Federal and Non-Federal Cost Apportionment for the Recommended Plan (with LNG conversion)

FEDERAL/NON-FEDERAL COST APPORTIONMENT - WITH LNG CONVERSION October 01, 2017 Price Levels (FY 2018)			
	Total Cost	**Federal Share**	**Non-Fed Share**
GENERAL NAVIGATION FEATURES (GNF)	>20' to 50'	75%	25%
Mobilization & Demobilization (Clamshell)	$3,350,000	$2,512,000	$837,000
Standby Time (Mechanical Clamshell)	$234,000	$175,500	$58,500
Mobilization & Demobilization (Hydraulic Hopper)	$2,744,000	$2,058,000	$686,000
Standby Time (Hydraulic Hopper)	$349,000	$261,750	$87,250
~Economic Modeling Phase 1~			
Widen ATC 100' @ Existing 40' (Cut 8)	$7,389,000	$5,541,750	$1,847,250
~Economic Modeling Phase 2~			
Deepen Cut 6 @ 46'	$742,000	$556,500	$185,500
Deepen Anegado (Cut 7) @ 44'	$6,762,000	$5,071,500	$1,690,500
Deepen and Widen ATC 100' @ 44' (Costs only for deepening/widening improvements > 40')	$8,475,000	$6,356,250	$2,118,750
Deepen ATTB @ 44' (Cut 8)	$7,352,000	$5,514,000	$1,838,000
ATTB East & West Flares @ 44'	$1,354,000	$1,015,500	$338,500
~Economic Modeling Phase 5~			
Deepen SAAC @ 36' (Cut 18)	$494,000	$370,500	$123,500
Deepen SAC @ 36' (Cut 18)	$2,849,000	$2,136,750	$712,250
Deepen SAC Extension @ 36' (Cut 20)	$596,000	$447,000	$149,000
Deepen CSBE @ 36' (Cut 22)	$2,346,000	$1,759,500	$586,500
Sea Turtle Non-Capture Trawl Sweeping	$39,000	$29,250	$9,750
Real Estate Administrative Costs	$66,000	$49,500	$16,500
Preconstruction, Engineering, & Design	$4,619,000	$3,464,250	$1,154,750
Construction Management (S&A)	$4,282,000	$3,211,500	$1,070,500
TOTAL GNF	$54,041,000	$40,530,750	$13,510,250
SUBTOTAL PROJECT FIRST COSTS	$54,041,000	$40,530,750	$13,510,250
10% OF NED GNF NON-FEDERAL**	$0	-$5,404,100	$5,404,100
NON-FEDERAL CONSTRUCTION COSTS (LOCAL SERVICE FACILITIES)			
Berthing Area Dredging (COD / Total Terminals) @ 44'	$611,000	$0	$611,000
Berthing Area Dredging (PUMA Terminal) @ 44'	$446,000	$0	$446,000
Berthing Area Dredging (PREPA Terminal) @ 44'	$747,000	$0	$747,000
PREPA LNG Facility Modifications	$348,024,000	$0	$348,024,000
TOTAL NON-FEDERAL LOCAL SERVICE FACILITIES	$349,829,000	$0	$349,828,000
	$0		
USCG AIDS TO NAVIGATION (100% USCG FEDERAL COST)	$105,000	$105,000	$0
	$0		
TOTAL PROJECT COSTS	$403,975,000	$40,636,000	$363,338,000

* ATC= Army Terminal Channel, ATTB=Army Terminal Turning Basin, SAC=San Antonio Channel, SAAC=San Antonio Approach Channel, CSBE=Cruise Ship Basin East

**The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 1986.

Table 4-4: Federal and Non-Federal Cost Apportionment for the Recommended Plan (without LNG conversion)

FEDERAL/NON-FEDERAL COST APPORTIONMENT - WITHOUT LNG CONVERSION October 01, 2017 Price Levels (FY 2018)			
	Total Cost	**Federal Share**	**Non-Fed Share**
GENERAL NAVIGATION FEATURES (GNF)	>20' to 50'	75%	25%
Mobilization & Demobilization (Clamshell)	$3,350,000	$2,512,000	$837,000
Standby Time (Mechanical Clamshell)	$234,000	$175,500	$58,500
Mobilization & Demobilization (Hydraulic Hopper)	$2,744,000	$2,058,000	$686,000
Standby Time (Hydraulic Hopper)	$349,000	$261,750	$87,250
~Economic Modeling Phase 1~			
Widen ATC 100' @ Existing 40' (Cut 8)	$7,389,000	$5,541,750	$1,847,250
~Economic Modeling Phase 2~			
Deepen Cut 6 @ 46'	$742,000	$556,500	$185,500
Deepen Anegado (Cut 7) @ 44'	$6,762,000	$5,071,500	$1,690,500
Deepen and Widen ATC 100' @ 44' (Costs only for deepening/widening improvements > 40')	$8,475,000	$6,356,250	$2,118,750
Deepen ATTB @ 44' (Cut 8)	$7,352,000	$5,514,000	$1,838,000
ATTB East & West Flares @ 44'	$1,354,000	$1,015,500	$338,500
~Economic Modeling Phase 5~			
Deepen SAAC @ 36' (Cut 18)	$494,000	$370,500	$123,500
Deepen SAC @ 36' (Cut 18)	$2,849,000	$2,136,750	$712,250
Deepen SAC Extension @ 36' (Cut 20)	$596,000	$447,000	$149,000
Deepen CSBE @ 36' (Cut 22)	$2,346,000	$1,759,500	$586,500
Sea Turtle Non-Capture Trawl Sweeping	$39,000	$29,250	$9,750
Real Estate Administrative Costs	$66,000	$49,500	$16,500
Preconstruction, Engineering, & Design	$4,619,000	$3,464,250	$1,154,750
Construction Management (S&A)	$4,282,000	$3,211,500	$1,070,500
TOTAL GNF	$54,041,000	$40,530,750	$13,510,250
SUBTOTAL PROJECT FIRST COSTS	$54,041,000	$40,530,750	$13,510,250
10% OF NED GNF NON-FEDERAL**	$0	-$5,404,100	$5,404,100
NON-FEDERAL CONSTRUCTION COSTS (LOCAL SERVICE FACILITIES)			
Berthing Area Dredging (COD / Total Terminals) @ 44'	$611,000	$0	$611,000
Berthing Area Dredging (PUMA Terminal) @ 44'	$446,000	$0	$446,000
Berthing Area Dredging (PREPA Terminal) @ 44'	$747,000	$0	$747,000
TOTAL NON-FEDERAL LOCAL SERVICE FACILITIES	$1,804,000	$0	$1,804,000
	$0		
USCG AIDS TO NAVIGATION (100% USCG FEDERAL COST)	$105,000	$105,000	$0
	$0		
TOTAL PROJECT COSTS	$55,950,000	$40,636,000	$15,314,000

* ATC= Army Terminal Channel, ATTB=Army Terminal Turning Basin, SAC=San Antonio Channel, SAAC=San Antonio Approach Channel, CSBE=Cruise Ship Basin East

**The Non-Federal Sponsor shall pay an additional 10% of the costs of GNF of the NED plan, pursuant to Section 101 of WRDA 1986.

4.4.3 Project Schedule and Interest during PED/Construction

Project schedules and durations may vary depending on several factors, particularly the time required to obtain Congressional authorization and appropriation. Other areas of schedule uncertainty include the availability of dredging equipment to complete the work in compliance with environmental requirements and delays due to unexpected severe weather conditions. These uncertainties factor into the calculation of the IDC.

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 NED 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. The PED durations are included in the IDC, as well as the construction durations. The current construction schedule assumes authorization of the project in a future WRDA. Assuming Congress provides funding subsequently to authorization of the project, the proposed schedule of activities would follow resulting in benefits starting in the base year of the proposed project. The IDC was computed with the Federal Water Resources Discount Rate (FY18) of 2.75%. Total PED and construction duration includes 40 months with the PED activity taking about 24 months and the construction taking about 16 months (1 year, and 4 months). Table 4-5 summarizes the PED and construction activities for the Recommended Plan. The IDC amounts to $1,207,000 and includes PED plus construction.

Table 4-5: Approximate PED and construction durations used to compute IDC for the NED

Description	Duration in Months	Cumulative Months
Division Engineer's Transmittal (S = PED Start)	0	S
Design Agreement*	3	S+3
Plans and Specifications	12	S+15
Project Partnership Agreement (PPA) Initiated	4	S+19
Advertise (Contingent upon funding) Contract	2	S+21
Award Contract	3	S+24
Construction Start (C = Construction Start)	0	C
Construction Complete	16	C+16

*Assumes standard model agreement

4.4.4 Financial Analysis of Non-Federal Sponsor's Capabilities

The non-Federal sponsor, the PRPA, concurs with the financial responsibility as it pertains to the cost sharing, as outlined in Table 4-3. Current policy requires the non-Federal sponsor to document their ability to pay through submission of a self-certification of financial capability as described in CECW-PC memorandum dated June 12, 2007. The Correspondence Appendix contains this certification and letter of support for the Recommended Plan.

4.5 Risk and Uncertainty

Risk and uncertainty relating to project benefits exists in the potential fluctuation of the Federal interest rate, changes in vessel operating costs, and deviations from vessel or cargo forecasts. Risks associated with interest rates, vessel and cargo forecasts, and vessel operating costs are discussed further in the Economics Appendix. Risks pertaining to project construction, including cost and schedule risks for the Recommended Plan, are discussed in the Cost Engineering and Risk Analysis Appendix. Uncertainties pertaining to the power generation cost reduction benefits resulting from the conversion to LNG by PREPA are discussed below.

Risks and Uncertainty Surrounding Proposed LNG Investment

The Recommended Plan is the same regardless of the economic scenario. However, there is a level of uncertainty surrounding the proposed LNG. In order to account for this uncertainty, the economic analysis and plan formulation used two distinctive sets of Future With-Project (FWP) condition assumptions resulting in a range of possible project benefits. The two scenarios considered are the following:

1) Assume San Juan area power plants will convert from the use of diesel fuel for power generation in the future without-project condition to the use of LNG for power generation if a Federal navigation project is constructed. Include power generation cost reduction benefits as a project benefit.
2) Assume San Juan area power plants will maintain use of diesel fuel both with and without a Federal navigation project. Do not include power generation cost reduction benefits as a project benefit.

This uncertainty related to the LNG conversion matters from an analysis perspective because it produces uncertainty as to whether power generation cost reduction benefits, the source of the majority of project benefits, will actually be realized if a Federal navigation improvement project is implemented. As previously mentioned, a conversion to LNG is assumed to occur only if a Federal navigation project, including widening of Army Terminal Channel, is constructed due to width limitations of the existing channel prevents the larger, more economical, and readily available in the world fleet LNG vessels from calling on San Juan. Based on input from the PREPA, the relatively low price of LNG compared to diesel, and the widespread use of LNG in power generation across the world, it seems that a transition to LNG is a reasonable future assumption. However, the transition to LNG will require a significant monetary investment in LNG infrastructure on the part of PREPA and/or some private entity. The combination of PREPA's 2017 bankruptcy, frequent changes to plans including a 2018 announcement by the Governor of Puerto Rico calling for privatization of PREPA, and the damage caused by Hurricanes Irma and Maria have created a climate of uncertainty surrounding if and when the LNG investment and conversion will occur.

There is a level of uncertainty surrounding PREPA's conversion to LNG and the timing of the conversion. PREPA has outlined plans that include entering into a P3 to finance the construction of LNG infrastructure (e.g. storage tanks, pipelines, etc.) adjacent to San Juan Harbor and to operate the regasification facility. PREPA's timeline for creating the P3 starts April 2018 with a contract established with a private company in March 2019. Consequently, information on whether the P3 has been established and whether the conversion is proceeding according to the timeline occurs following the submission of the Chief's Report, hence the level of uncertainty and development of the two economic scenarios. Even with the uncertainty surrounding the LNG conversion, the consequence of PREPA not converting to LNG by the project base year of 2026, and instead maintaining use of diesel fuel in power generation in the San Juan area plants is low from a planning perspective. The Recommended Plan is economically justified at the Federal Water

Resources Discount Rate (FY18) of 2.75% in either economic analysis, with BCRs ranging from 1.9 (without LNG conversion) to 5.0 (with LNG conversion). Regardless of which scenario actually occurs, the Recommended Plan remains the same, the exact same Federal navigation improvements are proposed. The Federal Investment also remains the same. However, a level of uncertainty remains when considering future budgeting of Federal funds for design and construction since the higher AAEQ net benefits and BCR resulting from the with LNG conversion economic analysis would likely increase the project's budgetary priority above what it would be if the without LNG conversion economic analysis and BCR are used. To address this uncertainty, progress of PREPA's LNG conversion will be assessed prior to any USACE budgetary actions.

In addition to consideration of both economics scenarios outlined above in plan formulation, sensitivity analyses were conducted to estimate the benefits associated with the conversion to LNG occurring between one and five years after the Federal navigation project base year. Project BCRs ranged from 4.2 (convert to LNG five years after project base year) to 4.8 (convert to LNG one year after project base year).

The following risks related to the LNG conversion and the Recommended Plan are also acknowledged but were not quantified as part of economic analysis:

- Variation in the price spread over time between LNG and diesel fuel
- Use of methods other than those proposed in the current study to supply LNG to the northern coast of Puerto Rico
- Use of alternative fuels
- Changes in power generation technology and/or EPA policy between now and conversion to LNG

See the Economics Appendix for additional discussion of these analyses and associated risks and uncertainties.

5.0 IMPACTS OF THE RECOMMENDED PLAN*

This section explains how the Recommended Plan, as described in the previous section, would affect the economic conditions, the navigation system components, and the environmental resources in the study area. The section headings are organized to mirror the relevant resources presented in Section 2 of this report. Please refer to Table 3-5 for a summary of environmental impacts analyzed for the focused array of alternatives, including the no action alternative.

5.1 General Setting*

Neither the future without-project/No Action Alternative nor the proposed project would change the current general setting within the project area.

The proposed project would not directly affect land use, including by the conversion of additional natural areas to urban use. The analysis supporting this conclusion considered the existing throughput capacity estimated for the San Juan Harbor, which includes landside constraints. The proposed navigation channel improvements are not directed at increasing the capacity of the harbor to process cargo, but rather at enabling the port to do so more efficiently. The economic analysis determined that the channel improvements would only result in cargo transiting through the San Juan Harbor more efficiently and did not conclude that the project would result in an increase in total cargo that transits the harbor. Therefore, the project would have no material effect on the conversion of additional natural area. The project would also not result in any landside transportation changes since the commodities entering the port are not anticipated to change with or without the project.

The dredging templates lie entirely within the water column of San Juan Harbor. The project does not include dredging of any upland or wetland areas. Maintenance dredging under the no-action alternative, as well as new work project dredging, places dredged material in the San Juan ODMDS, an action that does not affect land use. Any beneficial use options, if implemented, would not impact land use. Lastly, the project will not require an upland staging area because all construction-related activities will take place on the water utilizing barges.

5.2 Economic Conditions

Transportation cost savings result primarily from the more efficient use of the existing petroleum product fleet loading deeper with an anticipated partial transition to larger LR2 tankers and from the increased maneuverability of cruise vessels, which together result in reduced vessel calls and reduced congestion in the harbor.

5.2.1 Trade Volume

Because Puerto Rico is an island, waterborne commerce is crucial to meeting inhabitants' and visitors' needs, with everything from food and household supplies for daily use to petroleum products used to generate electricity and to power vehicles moving through the Commonwealth. With 78% of all non-petroleum and non-coal cargo passing through Puerto Rico was shipped to/from San Juan Harbor, while about 35% of all petroleum and coal handled on the island passed through the port. According to the U.S. Energy Information Administration (EIA), approximately 80% of the energy used in Puerto Rico comes from petroleum with the transportation and electric power sectors being the island's top petroleum

products as of 2014.[3] Because Puerto Rico neither produces nor refines crude oil, all petroleum consumed on the island must be imported.[4]

In addition to cargo throughput, a significant number of cruise passengers pass through San Juan Harbor each year. This includes passengers participating in cruises that begin and end in San Juan (homeport passengers) and passengers participating in cruises for which San Juan is a stop on the cruise itinerary (transit passengers). Table 2-2 of the Economics Appendix shows that over the period from 2009-2015 the highest and second highest number of passenger movements occurred in the two most recent years for which data is available, 2015 and 2014, respectively, suggesting the industry is currently strong and growing in San Juan Harbor.

As an island, Puerto Rico relies on waterborne commerce to meet the needs of residents and visitors to the island. Thus, San Juan Harbor receives calls by vessels of all types and sizes carrying all types of cargo. The island's Caribbean location paired with the tourist attractions found in Old San Juan have led to many annual cruise calls to San Juan Harbor as well. The Economics Appendix provides summary data on the estimated frequency of vessel calls by vessel type in 2014 based on Waterborne Commerce Statistics Center data, which summarizes historical call counts for cruise vessels and cargo vessels by arrival draft based on information provided by the San Juan Bay Pilots. Because the channel depths throughout the harbor vary widely with only 30 feet of depth in the Graving Dock Turning Basin up to 40 feet in the Army Terminal Turning Basin, identification of potentially constrained calls requires additional information about the terminal for which these vessels are bound. Discussion of which vessels and terminals were determined to be depth-constrained and potentially benefitting is provided in the Existing Condition Operations and Navigational Constraints section that follows.

5.2.2 Port Hinterland and Clients

Being an island, Puerto Rico relies heavily on waterborne commerce to supply its food, manufactured goods, fuels, and nearly all items needed to power the economy and sustain the island's inhabitants and visitors. Waterborne commerce also facilitates the movement of goods off of the island, including goods produced in Puerto Rico and goods being transshipped through Puerto Rico. The economic drivers are manufacturing, primarily pharmaceuticals, textiles, petrochemicals, and electronics; followed by the service industry, notably finance, insurance, real estate, and tourism.

Puerto Rico has been experiencing an economic depression for 11 consecutive years, starting in 2006 after a series of negative cash flows and the expiration of Section 936 of the U.S. Internal Revenue Code (26 U.S.C. § 936) that applied to Puerto Rico. Section 936 was critical for the economy of the island as it established tax exemptions for U.S. corporations that settled in Puerto Rico and allowed its subsidiaries operating on the island to send their earnings to the parent corporation at any time, without paying Federal tax on corporate income.

[3] Source: U.S. Energy Information Administration (EIA) website (https://www.eia.gov/state/print.php?sid=RQ#30) -U.S. Energy Information Administration, International Energy Statistics, Petroleum, Consumption, Puerto Rico, Total Petroleum Consumption, Quadrillion Btu, 2009-13; U.S. Energy Information Administration, International Energy Statistics, Total Energy, Total Primary Energy Consumption, Puerto Rico, 2008-12; U.S. Energy Information Administration, International Energy Statistics, Puerto Rico, Petroleum, Consumption, Total Petroleum Consumption and individual products, quadrillion Btu, 2010-14.

[4] Source: U.S. EIA website (https://www.eia.gov/state/print.php?sid=RQ#30) - U.S. Energy Information Administration, Puerto Rico Territory Energy Profile, Data, Reserves & Supply, and Imports & Exports, accessed March 8, 2016; U.S. Energy Information Administration, International Energy Statistics, Petroleum, Total Imports of Refined Products, Puerto Rico, 2008-13.

Puerto Rico is poorer than the poorest state of the United States, with 45% of its population living below poverty. Unemployment is more than twice the U.S. average.

Approximately 2 million people live in the San Juan metropolitan area and about half of the 3.5 million residents of Puerto Rico live and work in this Metropolitan Statistical Area (MSA). San Juan is also the manufacturing, tourism, and financial center of Puerto Rico.

In 2015, over 50% of all waterborne commerce taking place on the island passed through San Juan Harbor. In the same year, approximately 78% of all non-petroleum and non-coal cargo passing through Puerto Rico was shipped to/from San Juan Harbor, while about 35% of all petroleum and coal handled on the island passed through the port. *See* Figure 5-1.

Triple-deck barges towed by ocean-going tugs and Panamax container ships bring consumer goods in and out of Puerto Rico from Jacksonville and throughout the Caribbean. Figure 5-2 provides an overview of the San Juan Harbor port facilities and the major commodities associated with each terminal.

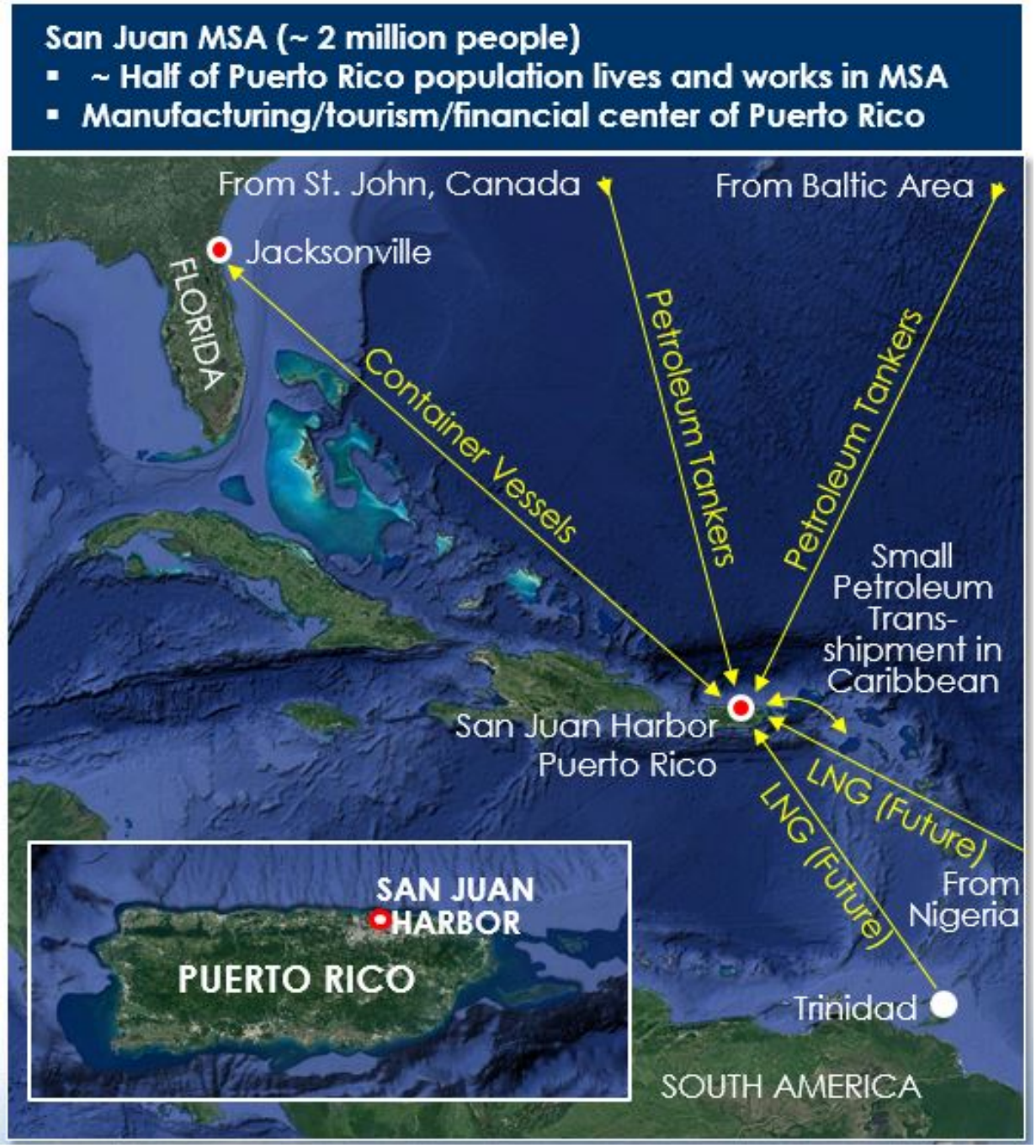

Figure 5-1: Port Hinterland and Clients

Figure 5-2: San Juan Harbor and commodities

5.2.3 Fleet Characterization

According to the EIA, approximately 80% of the energy used in Puerto Rico comes from petroleum with the transportation and electric power sectors being the island's top consumers of petroleum products as of 2014.[5] Because Puerto Rico neither produces nor refines crude oil, all petroleum consumed on the island must be imported.[6] Petroleum tankers calling San Juan typically call docks in the Army Terminal Turning Basin area of the channel where the federally constructed channel depth is 40 feet. Based on information received from port users and historical vessel call data, the two principal constraints existing in San Juan Harbor and impacting the operations of petroleum tankers are:

- the current 350-foot width of the Army Terminal Channel and
- the current 40-foot depth in the Anegado and Army Terminal Channels.

[5] Source: U.S. Energy Information Administration (EIA) website (https://www.eia.gov/state/print.php?sid=RQ#30) -U.S. Energy Information Administration, International Energy Statistics, Petroleum, Consumption, Puerto Rico, Total Petroleum Consumption, Quadrillion Btu, 2009-13; U.S. Energy Information Administration, International Energy Statistics, Total Energy, Total Primary Energy Consumption, Puerto Rico, 2008-12; U.S. Energy Information Administration, International Energy Statistics, Puerto Rico, Petroleum, Consumption, Total Petroleum Consumption and individual products, quadrillion Btu, 2010-14.

[6] Source: U.S. EIA website (https://www.eia.gov/state/print.php?sid=RQ#30) - U.S. Energy Information Administration, Puerto Rico Territory Energy Profile, Data, Reserves & Supply, and Imports & Exports, accessed March 8, 2016; U.S. Energy Information Administration, International Energy Statistics, Petroleum, Total Imports of Refined Products, Puerto Rico, 2008-13.

The width constraint prevents a partial transition of fleet from the existing Medium Range (MR) and Long Range 1 (LR1) tankers to include some calls by Long Range 2 (LR2) tankers. The depth constraint impacts the existing fleet of MR tankers and LR1 tankers, many of which must light load to be able to use the channel at its current 40 foot depth. The depth constraint would also impact LR2 tankers which, assuming the channel width issue were addressed and these vessels were able to call San Juan, would be required to light load significantly. Table 5-1 outlines the MR, LR1, and LR2 tanker classes and existing channel constraints faced by each. The next three subsections provide details of the two aforementioned constraints as they pertain to the MR, LR1, and LR2 tanker classes.

Table 5-1: Existing Channel Constraints Experienced by Petroleum Tankers (all dimensions in feet)

Existing Channel Constraints Experience by Petroleum Tankers (all dimensions in feet)

Tanker Description	DWT range	LOA		Beam		Design Draft		Can call San Juan under existing conditions?	Constrained by channel:
		Min	Max	Min	Max	Min	Max		
MR	35-55K	570.7	654.7	88.6	105.9	34.45	44.29	Yes	Depth
LR1	55-85K	700	796.6	105.7	131.2	38.55	48.23	Yes	Depth
LR2	85-130K	748	869	134.8	150.9	37.99	55.02	No - limiting factor is channel width	Width and Depth

MR dimensions come from fleet of 40K and 50K DWT tankers that called San Juan from 2010-2015 (WBC Statistics Center and San Juan Bay Pilots' Log).
LR1 dimensions come from fleet of 60K, 70K, and 80K DWT tankers that called San Juan's Puma_COD dock from 2010-2014 (WBC Statistics Center).
LR2 dimensions come from world fleet of 85K to 130K DWT tankers with beams >131 feet. Out of over 1000 vessels in the world fleet, only 4 have beams <131 feet. Beam of > 131 feet was used as the criteria of identifying LR2 vessels of relevance to this study because it defines the constraining factor.

Furthermore, the existing petroleum fleet must currently light load due to the existing Army Terminal Channel depth of 40 feet again demonstrating the transportation inefficiencies present in San Juan today and expected to continue into the future. Additionally, cruise vessels have priority over all cargo vessels, which can sometimes lead to cargo vessel delays on arrival.

The Army Terminal Channel width is the limiting factor here as the current width can only accommodate the smallest LNG and combination gas tankers in world fleet, of which there are a limited number and by which a relatively frequent call would be required to meet PREPA's demand. Currently inefficiencies exist in power generation in Puerto Rico. PREPA experiences increased power generation costs in northern power plants due to inability to reliably bring LNG by ship to its proposed San Juan Harbor terminal given the world fleet of available LNG tankers.

San Juan Harbor is a popular cruise port and serves as a homeport location for Royal Caribbean as well as a transit stop for many of the cruise industry's major companies, including Royal Caribbean, Disney, Celebrity, Norwegian, Carnival, and Crystal cruise lines.

5.3 Navigation Environment*

5.3.1 Navigation History

For details on the navigation history, please refer to section 2.3.1

5.3.2 Navigation Configuration and Dimensions

The configuration and dimensions of the Recommended Plan are detailed in the Plan Formulation Section (Section 3). Key details of the Recommended Plan are shown in the Figure 4-1. Table 5-2 summarizes the with-project dimensions.

Table 5-2: Future With-Project Dimensions

General Navigation Feature	Depth (Feet)	Width (Feet)	Length (Nautical Miles)
Bar (Entrance) Channel	56-46	800 - 950	0.91
Anegado Channel	44	800	1.19
Army Terminal Channel	44	450	0.90
Army Terminal Turning Basin	44	1450-Diameter	
Puerto Nuevo Channel	39	350	0.9
Puerto Nuevo Turning Basin	39	1000-Diameter	
Graving Dock Channel	36	350	1.21
Graving Dock Turning Basin	30	750-Diameter	
San Antonio Channels	36	500 - 900	1.22
Cruise Ship Turning Basin East	36	Varies	

5.3.3 Port Facilities

The port would continue improvements to the existing PREPA Terminal and berthing area and Army Terminal Turning Basin petroleum product terminals. The port would also realize immediate benefits in repairing, upgrading, and expanding their existing facilities.

5.3.4 Dredged Material Management

5.3.4.1 Process and Schedule

The transfer of Federal channel dredged material from the proposed project would not significantly differ from that for the future without-project condition (primarily comprising transfer of material for O&M dredging) with the exception of potential beneficial use of dredged material options.

O&M and new construction dredged material would continue to be placed in the ODMDS. See Section 4.3 for material quantities and other beneficial use of dredge material placement options. The USACE will continue evaluation of other potential beneficial uses of dredged material during the PED phase as discussed in paragraphs 4.3.3.

5.3.4.2 Use of Upland Placement Sites

No upland dredged material management sites exist for San Juan Harbor material placement.

5.3.4.3 Use of ODMDS

The existing ODMDS has capacity for the new work material and existing and future O&M material. Use of the San Juan ODMDS will not differ from current operations with the proposed new construction project. See Section 4.3 for additional information on the ODMDS.

5.4 Environmental Conditions*

5.4.1 Wind and Wave Climate

Puerto Rico's wind regime is characterized by two principal factors: diurnal land and sea breezes, and persistent 10 ms^{-1} northeasterly trade winds. Because of the duration and strength of these winds, the San Juan coastline is wave dominated, subject to open ocean waves formed by the trade wind system and to large swell formed by North Atlantic storms. Since the San Juan Harbor entrance channel is sufficiently deep and no new construction dredging is required there, the Recommended Plan is not expected to affect the average expected wave climate in this area nor the inner harbor.

Erosion of shorelines within San Juan Harbor is affected by a variety of external factors including tides and sea level change, currents, vessel wakes, tropical and subtropical storms, and shoreline changes (hardening, i.e. riprap). San Juan Harbor is transited by many vessels each year. As waves (wakes) produced by vessels travel outward from the sides of vessels, they would contact shorelines if there is not a long enough distance for the waves to dissipate beforehand. The size of waves created by vessel movement is affected by the size and horsepower of the vessel, shape of vessel hull, direction of tidal current, speed of travel, and shape of the channel.

During the NEPA scoping process, various entities wanted to understand how the project may influence the wave climate in the harbor and potential erosion to surrounding shorelines. During high tide, waves would impact regions higher on the shore. The period of high tide, corresponding to the period of transit of large vessels, is therefore of interest at Cataño. This is largely attributable to the largest wakes from vessel wakes in the harbor being associated with Panamax class vessels since they transit the harbor at the highest speeds of all vessel classes. Time averaged energy over a day would be the same with and without-project.

Since the and other action alternatives reduce the number of vessel calls, The instantaneous energy will be increased for the larger ships, however with the proposed project the number of vessel calls will be

reduced. As there is a potential for larger ship wakes due to increased horsepower, there will be overall less calls. Once the ship wake energy is integrated over time, the future with-project scenario (larger ships, increased horsepower, reduced number of calls) is equal to the current without-project condition (smaller ships, smaller wake, less horsepower, no reduction in number of calls). As ships enter the harbor at the Bar Channel the vessels have already started slowing down to make the turn from Cuts 3, 4, and 5 to Cut-6 and Anegado Channel. At Anegado Channel cruise ships must slow down more (to almost dead slow) to make the turn to the San Antonio Channel and a full stop at the cruise ship terminals. Commercial ships in transit to Army Terminal Channel, Graving Dock Channel, and Puerto Nuevo Channels slow to almost dead slow to allow harbor tugs to make up alongside in the Anegado Channel to assist with the transit to Army Terminal Channel, Graving Dock Channel, or Puerto Nuevo Channel. At dead slow the commercial ships produce little to no wake. Due to the need to slow down upon entering the Bar Channel for turns, for tugs to make up alongside and assist the ships to a full stop at terminals, these ships produce little or no vessel wakes and have almost negligible impacts on shoreline erosion. The prevailing easterly winds, which can reach speeds of up to 25-30 knots, primarily result in producing a wave climate causing erosion along the Cataño shoreline.

Since there are no proposed changes to the outer Bar Channel, it is not anticipated that wave propagation will be an issue for with the Recommended Plan any more than for the existing project, nor will the relatively small changes to the project affect the wave climate. Additionally, the economic analysis indicates that fewer total vessels would call on San Juan Harbor in the future with-project condition compared to the future without-project condition (No Action Alternative).

Overall, erosion of San Juan Harbor shorelines is controlled predominantly by wind waves and tidal currents. The relative infrequency of cargo vessel wakes compared with wind waves makes them a minor factor contributing to shoreline changes and erosion. Deepening the Federal navigation channel would reduce the shoreline impact of vessel wakes by reducing the number of vessels and increasing the range of tides during which vessels can transit the harbor. Therefore, the deeper alternatives have a progressively smaller vessel wake impact on surrounding shorelines. Vessel wake impacts to shorelines decreased with increasing depth and the future without-project condition (or No Action Alternative) had the greatest predicted impact to surrounding shorelines in the Harbor.

5.4.2 Tides

Changes in water surface elevation between the proposed project and the future without condition are not anticipated.

5.4.3 Currents

Some areas of the navigation channel may experience a reduction in current speed as a result of the channel deepening and widening. However, anticipated minor changes are not expected to have a significant impact on vessel maneuverability.

5.4.4 Relative Sea Level Change

Relative sea level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that the sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future SLC on design, construction, operation, and maintenance of Federal projects, the USACE has guidance in ER 1100-2-8162 and Engineer Technical Letter (ETL) 1100-2-1 (USACE 2013a, 2014).

As discussed in the Engineering Appendix, relative SLC was calculated using the USACE SLC Curve Calculator which is available at: http://www.corpsclimate.us/ccaceslcurves.cfm. This Calculator uses the methodology described in ER 1100-2-8162, *Incorporating Sea Level Changes in Civil Works Programs* (USACE 2013a) and relies on authoritative data from NOAA. ER 1100-2-8162 also provides both a methodology and a procedure for determining a range of SLC estimates based on global sea level change rates, the local historic sea level change rate, the construction (base) year of the project, and the design life of the project. Three estimates are required by the guidance, a baseline estimate representing the minimum expected SLC, an intermediate estimate, and a high estimate representing the maximum expected SLC. ER 1100-2-8162 provides a detailed explanation of the procedure, equations employed, and variables included to account for the eustatic change, as well as site specific uplift or subsidence to develop corrected rates http://www.publications.usace.army.mil/.

Based on historical sea level measurements taken from NOS gauge 9755371 at San Juan, Puerto Rico, the historic SLC rate (e+M) was determined using the SLC Curve Calculator at http://www.corpsclimate.us/ccaceslcurves.cfm. At San Juan, Puerto Rico Gauge 9755371, the mean sea level trend updated for 2016 is 2.08 mm/year (0.006824 feet/yr) with a 95% confidence interval of +/- 0.43 mm/year (0.00141 feet/yr) based on monthly mean sea level data from 1962 to 2016 which is equivalent to a change of 0.68 feet in 100 years (*See* Engineering Appendix; Figure 1, Figure 2, Figure 3). For this study, after having consulted with SLC experts throughout the USACE Climate Change Community of Practice, it was decided to use the updated and most conservative value of 0.006824 +/- 0.00141 feet/yr to determine impacts due to SLC (https://tidesandcurrents.noaa.gov/sltrends/sltrends.html). Tidal datums and extreme water levels for Gauge 9755371 for San Juan, Puerto Rico are shown in the Engineering Appendix – Figure 8.

The project base year, the year in which benefits are expected to begin accruing, is specified as 2026 with a 50 year economic project life. Engineering Appendix – Tables 2 and 3 show the Relative Sea Level Change Projections and the Estimated Relative Sea Level Change Projections from 2018 to 2118, respectively for every five years, starting from the study completion year of 2018. Figure 6 and Figure 7 show the Relative Sea Level Change Projections (beginning in 1992) and the Estimated Relative Sea Level Change Projections from 2018 to 2118, respectively, for three levels of projected future sea level change during the life of the project. It is noted that Engineering Appendix – Table 3 and Figure 7 show the relative differences in the water level between the start and end dates for the USACE scenarios, which is calculated using Eq. 3 from ER 1100-2-8162. This accounts for the difference in start time (2018) and 1992, the origin of the estimates. Both the table and the graph start at zero in the project study completion year. Associating this with a particular datum is not possible unless an assumed rate/curve is used to transfer the datums developed for the current National Tidal Datum Epoch (NTDE) to the project start year. The SLC Curve Calculator tool and the generated table and graph from the Calculator simply shows the change in height during the project's life.

Using the calculator and given that FEMA elevations are referenced to LMSL (PRV02), the 1% AEP with no waves could impact the lower BFE at Puerta de Tierra between 2045 (high scenario) and 2090 (intermediate scenario). The time to impact will be sooner than these estimates if waves are considered. Based on the FEMA maps, adverse impacts exist today under 1% AEP conditions and likely more frequent events as well.

Potential impacts of rising sea levels include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. A potential positive impact of rising sea levels on the project is a reduction in required maintenance due to increased depth in the channel, but this is not quantified. In

general, the regional SLC (baseline, intermediate, and high) scenarios did not significantly impact the alternatives considered in this study, as the differences in the projections did not meaningfully influence the selection of one alternative over another. While there may be small increases in tidal surge and penetration, these would be expected for all alternatives. Given that 1) there are no associated emergent Federal GNF which would need to be redesigned to account for SLC and greater wave loading and 2) because a small region of San Juan Harbor infrastructure is tied to the FEMA BFE which could be impacted between 2045 and 2090.

While there is expected to be a small increase in tidal surge and penetration for all three scenarios (baseline, intermediate, and high), the structural aspects of the project will be either unaffected or can be adapted to accommodate the change.

5.4.5 Geotechnical

Geotechnical investigations were conducted throughout the years for deepening projects, and maintenance dredging. Thus, a variety of historic data that includes borings logs, and wash probe data are available, dating back to 1972. Various historic borings reach below the recent maximum dredging depth, and are viable to evaluate the subsurface conditions of the proposed project. However, for the construction phase, additional investigations will be required to characterize unknown areas, as well as to characterize materials at greater depths.

In 1990, wash probes in San Juan Harbor were performed to define top of either rock or soil materials impenetrable at water pressures of up to 80 psi. These include: (a) 11 wash probes at 300-foot intervals along a survey line, 750 feet off the centerline of the Bar Channel; (b) 124 wash probes at 300-foot intervals along the Anegado, Army Terminal, Puerto Nuevo, Graving Dock, San Antonio Approach, and San Antonio Channels; (c) 41 wash probes on a grid pattern of 300 and 600-foot intervals in both the Army Terminal Turning Basin, and the Graving Dock Turning Basin; (d) 40 wash probes on a grid pattern of 300, 450, and 900-foot intervals northwest of, and within Anchorage Area E. In early 1991, an additional 48 wash probes were drilled at 100-foot intervals at survey lines 300 to 750 feet west off the Bar Channel's centerline. Drilling depths for the wash probes range from -35 to -55 feet. *See* Engineering Appendix–Table 6 for summary of wash probe data.

A total of 57 borings were drilled in San Juan Harbor during 1990-91 exploration program. Eleven borings at the southern end of the Anegado Channel were drilled at 500-foot-intervals along the side slopes of the channel. A 2,000-foot-interval along the same side of the channel was adapted during the main boring stage in 1991. Forty-six borings were performed during this operation.

In 1994, 37 borings were performed in San Juan Harbor. Eleven borings were drilled in the Army Terminal Channel, 17 borings in the Bar Channel area, one boring was performed in the Graving Dock Channel, and nine borings were drilled in the Puerto Nuevo Channel.

In 2000, 30 borings were drilled. One boring was drilled in the Anchorage Area F, and two in Anchorage Area E. Nine were performed in the San Antonio Channel, and 17 were performed in the Cruise Ship Basins East and West. One boring was drilled in the Puerto Nuevo Channel.

The majority of the historic core borings were drilled using a 5-foot drive sampler. More recent core borings were obtained using the standard 140lb hammer with 30-inch drop and the Standard Penetration Test (SPT) method. Wash probes were performed by washing through a 2-inch sampler to either project depth or refusal (i.e. impenetrable material at pressures of up to 80 psi).

Data used for analysis is summarized in Engineering Appendix – Tables 5 and 6 and depicted in Figures 15 through 26. Boring logs and laboratory results available are provided in Attachment B.

Materials Encountered. The majority of the core borings reveal soft clay (CL) and stiff plastic clay (CH). Sand and gravel mixes were also encountered (i.e. SM, SC, and GC). Some hard limestone and sandstone were also encountered. Core boring logs, wash probes, and various laboratory results, including grain size analysis and suspended sediment-time curves are included in Engineering Appendix– Attachment B.

A summary of encountered materials expected for the various alternatives being evaluated are summarized in Section 2.4.5 and the Engineering Appendix – Table 8. Alternatives with greatest degree of uncertainty due to lack of boring information include the Cruise Ship Basin East deepening and widening of the Army Terminal Channel.

Unconsolidated materials could be removed utilizing conventional dredging methods. Any soft to moderately hard rock could be excavated with a large rock cutter head hydraulic pipeline, or a large backhoe dredge. While hard rock has been encountered in the Harbor, it has not been field verified in detail in areas within the tentative selected plan alternatives. Further geotechnical investigation during the PED phase would be required to verify current assumptions.

Limestone can be found at depths varying from 40 feet to more than 100 feet Hard rock interlayered with clays were found during the last widening of the Army Terminal Channel. For cost estimating purposes for this deepening project, materials to be dredged are assumed to be soft clay, clay and sand, with some occurrence or outcropping of rock. Furthermore, it is assumed that blasting would not be required due to most rock being removed during the last deepening event, which was limited to the entrance of the channel. However, uncertainty exists due to lack of geotechnical information. Particularly, borings along the Army Terminal Channel and Turning Basin show the occurrence of rock. Therefore, the need for blasting will be further evaluated during the PED phase.

Shoaling Rates

In order to assess changes to O&M resulting from proposed channel modifications, the increase in channel shoaling was predicted as a result of increasing channel dimensions of the project features. *See* Plates from the Engineering Appendix for details. The average annual shoaling rate for each navigation channel was calculated for the time period from 1994 to 2012 using USACE dredging records. Channel dimensions were calculated for the present-condition and were calculated for the post-project condition. Shoaling estimates for the post-project condition were calculated by prorating the historic average annual shoaling rate based upon the percent increase in channel volume (Engineering Appendix – Table 4).

A Sediment Trend Analysis (STA) was performed in 2002 by GeoSea Consulting (Canada) Ltd. for San Juan Harbor (Engineering Appendix, Attachment A). The analysis delineated regions of the harbor where the sediment transport regimes were described as: Dynamic Equilibrium, Net Accretion, Net Erosion, and Total Deposition, which are denoted in the last column of the Engineering Appendix – Table 4. In addition, the STA analysis detailed the different regions of the harbor and the processes that lead to the particular transport regime.

Cut-6 in the San Juan Outer region is subject to the accreting trends into the harbor entrance that suggest the channel is subject to infilling.

Anegado Channel, San Antonio Approach Channel, and Anchorage Area F are in the San Juan Central region which is a transport environment that is characterized by increasing mud content as sediments are

transported from the outside into the harbor. The trends extend from the northwest area of the Anegado Channel to the region where the dredged channel bifurcates forming the Graving Dock and Army Terminal Channels.

Cruise Ship Basin East, San Antonio Channel, and San Antonio Extensions are in the San Antonio Channel region. STA analysis showed that through the San Antonio channel, there is westward transport down the channel as it meets with the Anegado Channel. It appears likely that the trends are driven by flow out of the Laguna del Condado, which is also accessible to sedimentation from the Atlantic. The very eastern part of the San Antonio Channel region which includes the San Antonio Channel Extensions shows Total Deposition behavior and is filled with fine-grained sediments (Engineering Appendix – Figure 9).

Army Terminal Channel and Army Terminal Turning Basin are in the San Juan Inner region. The sediments in the area are generally muddy (pure mud and sandy mud). The transport regime shows that infilling occurs into the channels from the shallow flats bounding the channels. All navigation channels in the San Juan Inner region are in the Total Deposition regime. It is also very likely that sediment infilling the Army Terminal Channel also comes from the bay directly south of Punta Cataño.

The total additional annual shoaling that is expected due to the Recommended Plan is approximately 15,000 cy/yr. *See* the Engineering Appendix for additional discussion on shoaling.

5.4.6 Water Quality

Water quality can be affected by the proposed project directly or indirectly and temporarily. Direct, temporary effects on water quality may occur during dredging operations (project construction); increased turbidity is primary among these effects. Long term effects are not anticipated. The USACE will obtain a WQC in accordance with Section 401 of the CWA (33 U.S.C. §1341) and will adhere to the conditions of this certification as a commitment of this project.

The proposed channel deepening would not increase the salinity concentrations in San Juan Harbor which are at marine levels or higher due to evaporation. However, dredging operations are likely to have a temporary and minor impact to water quality nearby the dredge plant. The proposed project would have dredges operating in various areas of the channel for roughly one year.

Hopper dredges are also often associated with increased turbidity from their overflow discharges. The suction drag arms of the hopper dredge hydraulically remove sediment from the dredged site and discharge the material into storage hoppers on the dredge. During filling, fine sediments (primarily silt, clays, and fine sands) are allowed to wash overboard (overflow) to maximize the load of sediment for transport to the placement area. This overflow process is one source of turbidity plumes and sedimentation generated by the hopper dredge. Hitchcock and Drucker (1996) summarized values for material lost through the overflow process on a typical 4,500 ton hopper dredge operating in United Kingdom (UK) waters. Results from this study indicate that during an average loading time of 290 minutes, 4,185 tons of dry solids are retained as cargo, while 7,973 tons of dry solids are returned overboard from overflow. Sand sized particles fall directly to the seabed and are reduced to background levels over a distance of 200 to 500 meters (m) and smaller silt-sized particles have a typical settling velocity of 0.1 to 1.0 millimeters per second (mm/s) and are reduced to background values of 2 to 5 milligrams per liter (mg/l) over a similar distance. According to Neff (1981 and 1985), concentrations of 1000 mg/l immediately after discharge decreased to 10 mg/l within 1 hour. The minimal impact of settling particles from hopper dredge turbidity plumes was further supported by a study from Partech (1982), which found

that the initial hopper dredge overflow concentrations of 3,500 mg/l were reduced to 500 mg/l within 50 meters.

The distance that sediment plumes may extend is dependent upon the type of dredge, how it is operated, currents, and the nature of the sediments within the dredged area. A study performed by Newell and Siederer (2003) in the UK (high current velocities) showed that, in most cases, coarse material up to sand-size particles settles within 200 to 600 meters of the point source of discharge, depending on depth of water, tidal velocity, and the velocity of flow from the discharge pipe. During hopper dredging operations in the Baltic, Gajewski and Uscinowicz (1993) noted that the main deposition of sand from hopper dredge overflow was confined to distances within 150 meters on each side of the dredge. This study further supported that the initial sedimentation associated with overflow material behaves like a density current where particles are held together by cohesion during the initial phase of the sedimentation process and are mainly confined to a zone of a few hundred meters from the discharge chutes. According to a plume dispersion model developed by Whiteside et al. (1995) (based on field study measurements obtained while hopper dredging in Hong Kong waters), the contours for sediment deposition remain as a narrow band extending for approximately 100 meters on each side of the vessel, consistent with that recorded by Gajewski and Uscinowicz. As a component of the sedimentation associated impacts to hardbottom from hopper dredging in adjacent sand sources offshore of Bal Harbor, Florida, Blair et al. (1990) recorded elevated sediment levels at about 335 meters (1,100 feet) from the sand source. For the proposed project, hopper dredging could take place in San Juan Harbor and would consist of mostly clay (Engineering Appendix – *Geotechnical*).

For cutterhead suction dredges, turbidity is only generated at the seafloor by the cutterhead where sediment suspension occurs during the process of removing sediments from the seafloor. However, sediments are usually confined to the immediate vicinity of the cutterhead and do not reach the sea surface (LaSalle et al. 1991). Studies performed by D. F. Hayes (1986) on a hydraulic cutterhead dredge operating in Savannah Harbor indicated that average suspended sediment concentrations within 488 meters (1,600 feet) of the dredge were generally raised less than 200 mg/l in the lower water column and less than 100 mg/l and 50 mg/l in the middle and upper water column, respectively.

During a past maintenance dredging project in San Juan Harbor between 3 March and 25 April 2007, dredge compliance turbidity readings averaged 8.4 NTU while background readings averaged 5.4 NTU. There were no exceedances of the 10 NTU Puerto Rico coastal water standard.

A WQC was issued to the USACE for disposal of dredged material associated with the project by EQB on January 14, 2015 (Appendix K). This WQC covers the discharge of dredged material into the Condado lagoon artificial depressions. As discussed above a new WQC will be sought from EQB for the new dredging areas after completion of this IFR/EA. Per the process in Puerto Rico, the FONSI with accompanying NEPA documents will be submitted to the OGPe after signature/approval for another round of public and agency coordination. Once the OGPe approves the project by letter, that letter and the CZMA consistency concurrence is submitted to the EQB who will then issue the WQC.

5.4.7 Wetlands and Submerged Aquatic Vegetation

The USACE has determined that dredging operations for the proposed project would not directly affect existing mangrove wetlands or SAV. In addition, temporary indirect effects from elevated turbidity levels during construction are also not anticipated since these resources are greater than 150 meters from the deepening and widening of the channel. Therefore, the proposed San Juan Harbor expansion would have negligible effects on existing mangrove wetlands and SAV in San Juan Harbor.

5.4.8 Hardbottom Habitat

As discussed in Section 2.4.8, hardbottom habitat is present adjacent the entrance channel and along the north coast. The USACE has determined that dredging operations for the proposed project would not directly affect existing hardbottom habitat. In addition, temporary indirect effects from the deepening and widening of the channels from elevated turbidity levels during construction and dredged material transport to the ODMDS are also not anticipated due to the distances between these resources and construction (>150m). The May 29, 2018 Biological Opinion states that, "NMFS concludes that the proposed action is not likely to adversely affect leatherback sea turtles, sperm, sei, blue, and fin whales, elkhom, staghom, pillar, rough cactus, mountainous star, lobed star, and boulder star corals, scalloped hammerhead sharks, Nassau grouper, and designated critical habitat for elkhom and staghom corals. NMFS also concludes that the proposed action may adversely affect but is not likely to jeopardize the continued existence of green, loggerhead, and hawksbill sea turtles."

Indirect Impacts

Indirect impacts to hardbottom habitats near the dredging area would be due in large part to any turbidity resulting from the dredging of material from the entrance channel and any subsequent sedimentation that could occur. These impacts could result in sub-lethal effects (injury, decreased fecundity, etc.) on the macroinvertebrate community. Recent USACE consultations under Section 7 of the ESA (16 U.S.C. §1536) with the NMFS for two projects in Miami-Dade County concluded that the effects of sedimentation on the adjacent threatened coral, *Acropora cervicornis*, would be insignificant since the rates of sedimentation documented in a similar offshore dredging project were within the bounds of sedimentation documented to occur naturally. The NMFS concluded that due to this sedimentation rate and a proposed 400-foot buffer between the dredging area and the threatened corals, the effects on the coral would be "insignificant" (NMFS 2009, NMFS 2011).

Adjacent the Entrance Channel (within 150 meters) there is no previously mapped hardbottom/coral reef habitat that could experience minor temporary stress due to increased sedimentation. In fact, the closest previously mapped hardbottom habitat (colonized pavement) is 457 meters from the closest dredge area (Cut-6) and Acroporid coral DCH is approximately 762 meters north of Cut-6. SAJ USACE uses 150 meters as the estimated indirect impact zone adjacent to the limits of construction dredging for evaluation purposes. This indirect impact zone was based on a review of the results of in-water coral sedimentation monitoring associated with the 1980-1981 Port Everglades deepening project (CSA 1981) and Key West dredging project in 2004 (CSA 2006). In addition, in their USEPA consultation document for the ODMDS SMMP, NMFS stated: "NMFS believes that impacts to sea turtle refuge and foraging habitat, listed corals, and ESA-designated coral critical habitat from leakage of dredged materials from vessels in transit to the ODMDS will be discountable (F/SER31:LC)." Therefore, indirect impacts to hardbottoms and coral reefs from turbidity and sedimentation as a result of construction activities are not anticipated.

5.4.9 Essential Fish Habitat

The proposed project is not anticipated to adversely affect EFH including hardbottom habitat and SAV but will adversely affect estuarine water column and softbottom habitat. Considering the abundance of estuarine water column and soft bottom habitat within San Juan Harbor, the impact is not anticipated to significantly adversely affect EFH or federally managed fisheries in Puerto Rico.

Effects of the proposed project include death and injury of fishes and forage during construction dredging operations and subsequent maintenance dredging operations. Direct removal of softbottom habitats will occur as well as indirect impacts due to temporary changes in water quality. The below list summarizes potential effects of the proposed project on EFH and managed species:

- Directly affecting mortality or injury of individual fishes (adults, subadults, juveniles, larvae, and/or eggs, depending on species, time of year, location, etc.) due to dredge equipment during construction (various areas of the channel for approximately one year) and maintenance dredging (an effect temporary in duration). No one area would experience an extended duration of effects.
- Indirectly affecting foraging behavior of individuals through production of turbidity at construction/maintenance dredging sites (an effect temporary in duration).
- Indirectly affecting movements of individuals around/away from dredging sites due to construction equipment and related disturbed benthic habitats (an effect temporary in duration).
- Indirectly affecting foraging and refuge habitats by removal of benthic habitat (i.e. softbottom) (an effect temporary in duration); new softbottom is created due to dredging.

These dredging related impacts would occur on a temporary scale. As noted, the effects would only be felt in the area of dredging activity which would not be taking place at all locations at all times. Individually or in sum, the above are not anticipated to significantly adversely affect managed species or EFH. An EFH Assessment is incorporated into this integrated document in Sections 2 and 5 and has been coordinated with NMFS during the public review of the Draft IFR/EA (*See* Section 6.8).

5.4.10.1 Other Marine/Estuarine Habitats

Dredging activities can impact benthic assemblages either directly or indirectly and may vary in nature, intensity, and duration depending on the project, site location, and time interval between dredging operations. Direct catastrophic impacts include physical removal or smothering by the settlement of suspended materials (Morton 1977; Guillory 1982). Recovery in dredged sites occurs by four basic mechanisms: remnant (undredged) materials in the sites, slumping of materials with their resident fauna into the site, adult immigration, and larval settlement. Remnant materials, sediments missed during the dredging operation, act as sources of "seed" populations to colonize recently removed sediments. Suspended materials may also interfere in the feeding, respiration or reproduction of filter feeding benthos and nekton (Sherk and Cronin 1970). Though initial loss of benthic resources are likely, quick recovery between six months (McCauley et al. 1977; Van Dolah et al. 1979; Van Dolah et al. 1984; and Clarke and Miller-Way 1992) to two years (Bonsdorff 1980; Ray 1997) is expected. Therefore, benthic communities are not anticipated to be significantly affected except for the short term affect resulting from sediment removal during project construction.

5.4.10 Protected Species

A summary of the effects determinations for threatened and endangered species as a result of the proposed project is in Table 5-3. The USACE determined that the proposed project, "may affect, but is not likely to adversely affect" (MANLAA) scalloped hammerhead shark, Nassau grouper, giant manta ray, leatherback sea turtles, Antillean manatee, sperm, sei, blue, or fin whales, elkhorn, staghorn, pillar, rough cactus, lobed star, mountainous star or boulder star corals, nor will the project adversely modify DCH for Acroporid corals. During project construction, dredging operations "may affect" green and hawksbill sea turtles only if a hopper dredge is used for construction. Project plans have been refined to minimize potential effects to the extent feasible. A biological assessment evaluating these determinations was sent to the NMFS on July 14, 2017 initiating consultation under Section 7 of the ESA and NMFS provided a final Biological Opinion on May 29, 2018 (Section 6.7) attached in Appendix F.

5.4.10.1 Fish (Nassau Grouper, Scalloped Hammerhead Shark, and Giant Manta Ray)

Considering the overlaps of various life stages in distribution within the proposed project area and subsequent risk of take relative to dredging operations, this section considers the impacts of the proposed

project to scalloped hammerhead shark (SHS), Nassau grouper (NG), and Giant manta ray (GMR) together. Potential direct and indirect impacts associated with dredging that may adversely impact these species include entrainment and/or capture of adults, juveniles, larvae, and eggs by dredging and trawling activities, short-term impacts to foraging and refuge habitat, water quality, and sediment quality, and disruption of migratory pathways.

Hopper dredges have not been known to take any of these species. In addition, hopper dredges are used within known shark, grouper, and manta ray habitat in Florida and the southeast U.S. but have not been known to directly impact adult, juvenile, and larval SHS, NG, and GMR species through entrainment in the draghead. Therefore, hopper dredging impacts to these species are discountable.

Impacts to SHS, NG, and GMR as a result of cutterhead and clamshell dredges have also not been documented. Given the mobility of these species, the lack of a suction field from mechanical dredging, and the small area of active dredging by a bucket during each load, the likelihood of mechanical dredging practices to incidentally take SHS, NG, and the GMR is discountable.

Table 5-3: Summary of Effect Determination for Threatened and Endangered Species.

Proposed Activity/ Route to Effect	Effects Determination																	
	Sea Turtles				*Whales*				*Stony Corals*							*Fishes*		
	Leatherback	Green (North Atlantic DPS)	Hawksbill	Loggerhead (western north Atlantic)	Sperm	Sei	Blue	Fin	Elkhorn	Staghorn	Pillar	Rough cactus	Mountainous Star	Lobed Star	Boulder Star	Giant Manta Ray	Scalloped Hammerhead shark	Nassau Grouper
Hydraulic Hopper Dredge	NE	MALAA	MALAA	MALAA	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE
Hydraulic Cutterhead Dredge	NE	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE
Mechanical Dredge	NE	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE
Bed Leveling	NE	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE
Turbidity and Sedimentation		NE	NE	NE	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE
Transportation - hopper; tug/scow/barge	NE	NE	NE	NE	MANLAA - discountable	MANLAA - discountable	MANLAA - discountable	MANLAA - discountable	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Material placement (ODMDS or Restoration Site)	NE	NE	NE	NE	MANLAA - discountable	MANLAA - discountable	MANLAA - discountable	MANLAA - discountable	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Trawling	MANLAA - discountable	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	MANLAA - discountable	MANLAA - discountable	MANLAA - discountable
Dredge Lighting	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Critical Habitat	-	NE	NE	-	-	-	-	-	NLAM	NLAM	-	-	-	-	-		-	-

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5.4.10.2 Sea Turtles

Construction Related Effects

Although the overall impacts to sea turtles from dredging activities are relatively small and continues to decrease, the USACE and the dredging industry are committed to the continued pursuit of efforts to further reduce dredging impacts on sea turtles. Current conservation measures implemented by the USACE to reduce impacts to sea turtles during hopper dredging operations are discussed in Section 6 of this report (Environmental Compliance). The following sections summarize specific effects from various components of construction.

Hopper Dredging

Hopper dredges include 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 placement location and releases the dredged material into a designated underwater placement site by opening doors on the hopper bottom or in some cases the vessel is designed to split open longitudinally. The impacts (lethal and many non-lethal impacts are restricted by the "take" provisions in the ESA to sea turtles by hopper dredges was first identified as a problem in the late 1970's and in Puerto Rico three species of threatened or endangered sea turtles could potentially be impacted – loggerhead, green, and hawksbill. However, Puerto Rico is currently not included in the SARBO so hopper dredges have not been used there previously. NMFS concurs with USACE that there is a low possibility of adverse effect to leatherbacks and the impact is discountable, but that hopper dredging is likely to adversely affect loggerheads, greens and hawksbills.

Hydraulic Cutterhead

The potential impacts of hydraulic cutterhead dredging on sea turtles was considered by NMFS in their 1991, 1995, and 1997 SARBO, as well as the 2003 (revised in 2005) Gulf of Mexico Regional Biological Opinion (GRBO), for USACE hopper dredging activities. Under each Biological Opinion the NMFS determined that cutterhead pipeline dredging may affect but is not likely to adversely affect sea turtles. In contrast to hopper dredges, pipeline dredges are relatively stationary and therefore act on only small areas at any given time. In the 1980s, observer coverage was required by the NMFS at pipeline outflows during several dredging projects deploying pipeline dredges along the Atlantic coast. No turtles or turtle parts were observed in the outflow areas. Additionally, the USACE's SAD office in Atlanta, Georgia, charged with overseeing the work of the individual USACE Districts along the Eastern Seaboard from North Carolina through Florida, provided documentation of hundreds of hours of informal observation by USACE inspectors during which no takes of listed species were observed. Additional monitoring by other agency personnel, conservation organizations or the general public has never resulted in reports of turtle takes by pipeline dredges (NMFS 1991).

Mechanical Dredging

The impacts of mechanical dredging operations on sea turtles were previously assessed by the NMFS (NMFS 1991; NMFS 1995; NMFS 1997; NMFS 2003) in the various versions of the SARBO and the 2003 (revised in 2005) GRBO. The 1991 SARBO states that "clamshell dredges are the least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of such an occurrence are extremely low…" (NMFS 1991). NMFS also determined that "(o)f the three major dredge types, only the hopper dredge has been implicated in the mortality of endangered and threatened sea turtles." This determination was repeated in the 1995 and 1997 SARBO's (NMFS 1995

and 1997). There has been no new information which concludes there is an increased risk of sea turtle take by clamshell dredges since the 1991, 1995, and 1997 SARBO's were issued by NMFS.

Dredge Turbidity Plume

Mechanical and hydraulic hopper dredges could be used throughout the project area. Turbidity may be generated when the full bucket travels through the water column to the surface and is emptied into an adjacent barge. However, turbidity within the open water system will quickly dissipate due to currents, wind and wave action. In addition, turbidity will be monitored and if exceeds authorized levels in the WQC (>7NTU above background) the activity causing the exceedance will cease until levels return to normal background.

Dredge Lighting

The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. Though hatchlings use directional brightness of a natural light field (celestial sources) to orient to the sea, light from artificial sources interferes with the natural light cues resulting in misdirection (Witherington and Martin 2003). Female sea turtles approaching nesting beaches and neonates (i.e., hatchlings) emerging from nests and exiting their natal beaches, may be adversely affected by lighting associated with dredges and equipment operating in the nearshore (0-3 nm) environment. For dredging vessels, appropriate lighting is necessary to provide a safe working environment during nighttime activities on deck (i.e. general maintenance work deck, endangered species observers, etc.). In compliance with the USACE Safety and Health Requirements Manual (USACE 2011), a minimum luminance of 30 lm/ft^2 is required for outside work performed on board the dredge during nighttime dredge operations. In order to reduce potential disorientation effects on female sea turtles approaching the nesting beaches and sea turtle hatchlings making their way seaward from their natal beaches, while still adhering to minimum luminance requirements, light emanating from offshore equipment would be minimized through reduced wattage, shielding, lowering, and/or use of low pressure sodium lights to the extent practicable. Shielded low-pressure sodium vapor lights have been identified by the USFWS as the best available technology for balancing human safety and security, roadway illumination, and endangered species protection. They provide the most energy efficient, monochromatic, long-wavelength, dark sky friendly, environmentally sensitive light of the commercially available street lights and would be highly recommended for all lights on the beach or on offshore equipment (Gallagher 2006).

Trawling

Although currently not a practice within Puerto Rico, modified shrimp trawling equipment and techniques are used to capture and relocate threatened and endangered sea turtles from hopper dredging sites to decrease the potential for entrainment of sea turtles in the drag arms. Provided NMFS includes relocation trawling in the new SARBO, USACE may use this technique as a risk management tool to limit takes, if necessary during future O&M projects. With respect to trawling and sea turtle interactions, the effects of trawling during capture and handling can result in raised levels of stress hormones. Based on past observations obtained during similar research-trawling for turtles, these effects are expected to dissipate within a day (Stabenaua and Vietti 1999). Routinely, when a sea turtle is captured, and before it is released, the turtle is tagged to help determine recaptures and a tissue sample is taken for genetic analysis by NMFS scientists.

Handling of any sea turtles captured in the trawls would be limited to NMFS approved and permitted observers who will be handling sea turtle species and adhering to the terms and conditions of any

Biological Opinion and any potential permit conditions to ensure the safety of the turtles, it is expected that trawling, capture, tagging and release activities would have minimal and insignificant effects on the animals. All animals would be handled with care, kept moist, protected from temperature extremes during sampling, and returned to the sea as quickly as possible in accordance with the sea turtle handling criteria included in the NMFS' Final Biological Opinion dated May 29, 2018 (Appendix F).

Conservation Measures for the Proposed Project

The USACE will use the following conservation measures outlined below during the construction of the proposed project (described in detail in Appendices F and G):

- Use of a rigid draghead deflector
- Inflow/overflow screening
- Endangered species observers
- Use of National Dredging Quality Management (DQM) and Operations and Dredging Endangered Species System (ODESS) Programs
- Coordination with Sea turtle community of practice

Long Term Effects

Impacts to sea turtles were evaluated based upon effects of the project on food supply, habitat, and life period. The proposed project is not likely to adversely affect benthic food supply and these effects are expected to be temporary in nature. Even though initial loss of benthic resources is not likely, quick recovery, between 6 months (McCauley et al. 1977; Van Dolah et al. 1979; Van Dolah et al. 1984; and Clarke and Miller-Way 1992) to 2 years, (Bonsdorff 1980; Ray 1997) is expected. A small increase in turbidity and some suction from dredging activities may affect some species of aquatic organisms or vegetation that loggerheads may feed on. These sediment disturbance impacts are expected to be minimal in nature and are not expected to have a measurable effect on water quality beyond the frequent natural increases in sediment load.

5.4.10.3 Whales

Construction Related Effects

All five of the species of large whales being considered under this assessment, the sperm, sei, blue, fin and humpback whale, may be present offshore San Juan Harbor and in the ODMDS. However, the Humpback is perhaps the most likely especially during winter migrations (January-mid-March). Direct and indirect impacts from dredging operations and dredge plants are similar for mechanical or hydraulic type dredges.

Impacts from dredging operations have the potential to occur offshore during a dredge plant's transit to and from the ODMDS but such interactions are rare. The USACE expects that dredging operations would have a minimal effect on whales. Additionally, a review of the NMFS large whale strike database does not indicate any records of large whale vessel strikes associated with any dredging equipment in Puerto Rico. The dredge crew and contractors will be required to abide by NMFS's *Southeast Region Vessel Strike Avoidance Measures and Reporting for Mariners*, per the ODMDS SMMP, and all dredges will be required to have NMFS-approved endangered species observers aboard, in accordance with the pertinent BO.

Noise generated from the dredging equipment has the potential to harm marine mammals, including large whales. Although behavioral impacts are possible (i.e. a whale changing course to move away

from a vessel), the number and frequency of vessels present within a given project area is small and any behavioral impacts would be expected to be minor. Furthermore, for hopper dredging activities, endangered species observers (ESOs) would be on board and would record all large whale sightings and note any potential behavioral impacts.

Long Term Effects

The proposed project would have no effect on the food supply, habitat, or life period of the sperm, sei, blue, fin or humpback whale. Since the forecasts and analysis indicate that the proposed project would result in fewer vessel transits than the No Action Alternative, the risks related to vessel strikes would not be expected to increase.

5.4.10.4 Antillean Manatee

The proposed project may affect, but is not likely to adversely affect the manatee. The contractor would adhere to the standard manatee conditions during construction in order to avoid vessel strikes. The Contractor may be held responsible for any manatee harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the ESA. The standard manatee conditions apply year-round in Puerto Rico. The Contractor will be instructed to take the necessary precautions to avoid contact with manatees. If manatees are sighted within 100 yards of the dredging activity, all appropriate precautions would be implemented to insure protection of the manatee. The Contractor would stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50 feet to a manatee shall necessitate immediate shutdown of that equipment.

In addition, the following conservation recommendations were provided by the USFWS in the Final CAR (USFWS 2018):

• Develop and implement navigational aids (manatee speed buoys) for San Juan Bay focused on avoiding and minimizing watercraft threats to the manatees.

• Support ongoing efforts to study manatee use within the San Juan Bay. The Service has a project with the Puerto Rico Manatee Conservation Center and the DNER to assess the health of manatees within the San Juan Bay and track manatees to study movement patterns and habitat use within the San Juan Bay.

• Develop a manatee specific education campaign using existing and new alternatives and media sources.

The USACE agrees to maintain open and cooperative communication with the USFWS regarding actions necessary protect the manatee while constructing and operating the project within our authority.

5.4.10.5 Corals

Construction Related Effects

As stated in Section 2.4.10.6, none of the seven Caribbean listed threatened coral species have been documented within the construction footprint or within the 150m indirect impact zone and Acroporid DCH is also 762m from the closest dredge area (Entrance Channel Cut-6).

There are numerous published papers specific to sedimentation impacts to Caribbean coral reefs (Rogers 1983; Rogers 1990; Dodge and Vaisnys 1977, Bak 1978). However, peer-reviewed literature

specific to monitoring of dredging projects in Puerto Rico is very limited. USACE reviewed four monitoring reports and two peer reviewed studies from recent projects in documented Acropora habitat between 1980 – 2007 where sedimentation and turbidity data were collected not only at sites adjacent to the channels or sediment sources, but also from background sites so that potential indirect impacts associated with dredging could be detected in addition to background impacts from natural events. The four projects that were reviewed were: (1) Port Everglades entrance channel widening and deepening project conducted in 1980-1981; (2) Broward County Shore Protection Project conducted in 2005; (3) Key West Harbor O&M dredging 2004-2006 and (4) Key West Harbor O&M dredging 2007 (Jordan et al. 2010; Gilliam et al. 2006; Fisher et al. 2008; CSA 2007; and CSA 1981). These projects utilized cutterhead, hopper, and clamshell dredges (or a combination thereof) for their operations. To further inform potential impact-reduction methods, BMPs, monitoring protocols, and mitigation feasibility, the results from the recent Miami Harbor project will be considered during the PED phase of the San Juan Harbor project.

From a turbidity and/or sedimentation standpoint, a hopper dredge has the highest likelihood of adverse effect due to the overflow of water being returned from the hopper to the surrounding environment. With this overflow, "fines" (usually clays or silts which are light enough not to have settled out in the hopper) are returned to the water during dredging operations. The clamshell or bucket dredge ranks second since the material may or may not be enclosed in a bucket, and if it is not enclosed, material may escape that bucket into the surrounding environment. The dredging method with the lowest level of associated sedimentation or turbidity is the cutterhead dredge. This dredge has suction that removes the sediment, transports it to the surface where it is either pumped into the receiving site, or placed in a scow for transport to a placement site. The receiving scow may or may not involve overflow of fine-laden water (similar to the previous description of the hopper dredge). The Key West O&M projects in 2004-2006 and 2007 utilized both a clamshell dredge and a hopper dredge. The Broward County Shore Protection Project utilized a hopper dredge and the Port Everglades expansion project in 1980 utilized a cutterhead dredge. Understanding which types of equipment were utilized allows for a comparison across projects of results regarding turbidity and/or sedimentation monitoring.

A review of these four projects found that using BMPs for turbidity and sedimentation control (e.g. ceasing dredging when turbidity levels exceed permitted standards) are protective of the coral and hardground environments surrounding south Florida sand sources and navigation channels. Impacts associated with storms can have sedimentation rates in excess of 400 times those seen with a dredging project. The following information is provided from the Key West Harbor O&M project. (CSA 2007):

"Average daily sedimentation rates at the monitoring sites fluctuated based on weather conditions and ambient suspended sediment load in the surrounding waters. This was especially evident during periods of winter cold-front activity during November 2005 and January 2006, with associated rough seas and high turbidity. During these periods, average daily sedimentation rates were more than twice as high as during the previous November and January, and up to 25 times above levels observed during June 2004 at several sites. The passage of hurricanes during August and September of 2004 and July, September, and October of 2005 provided the most dramatic increase in levels of sediment re-suspension... Average daily sedimentation rates at several of the Hawk Channel seagrass sites and the bank reef sites were up to 400 times higher than levels noted during June 2004. Following Hurricane Dennis in July 2005, nearly every sediment trap site had at least a ten-fold increase in the average daily sedimentation rate compared to the previous month."

"Site BP-41, a bank reef monitoring site adjacent to the Main Ship Channel, had an average daily sediment deposition rate of 18 mg/cm^2/day for August 2005, while in the following month when Hurricanes Katrina and Rita impacted the area, the average daily sediment deposition rate recorded in the traps increased to 1,219 mg/cm^2/day, 67 times the previous month's level. For Site SP-37, a seagrass site located adjacent to the Main Ship Channel, there was an increase in average daily sediment deposition rate during this same period from 14.4 mg/cm^2/day up to 3,529.7 mg/cm^2/day, 245 times the August levels."

Additionally, Gilliam et al. 2010 and Fisher et al. 2011, found there to be no detectable impacts to corals living on the hardgrounds adjacent to the sand sources utilized for the Broward County Shore Protection Project. While the Key West and Broward County projects were required by regulatory permit to maintain a lower turbidity threshold (15 NTUs), a review of the monitoring from the Port Everglades channel widening and deepening from 1980-1981 continues this trend in showing little to no effect of dredging operations on corals adjacent to dredging areas (CSA 1981). The Port Everglades deepening project in 1980-1981 was not bound by any state or Federal agency issued turbidity level that required the dredge to cease operations. USACE did monitor turbidity and sedimentation levels throughout the dredging operations, which is most similar in nature to the dredging currently proposed, and the final report for the Port Everglades deepening conducted states, "(d)ue to the powerful suction ability of the dredge, only a small fraction of the dredged material entered the water column. No significant increase in turbidity levels was detected during daily monitoring of the dredging operations by the USACE environmental contractor" (CSA 1981).

To protect hardgrounds in project areas which could support the seven Caribbean listed threatened coral species, the USACE requires turbidity monitoring with all of its projects. It is a standard practice for the USACE to monitor sedimentation associated with dredging projects where corals and coral habitats are adjacent to the project area. This has been standard practice for more than 30 years.

In a Biological Opinion (BO) for dredging associated with sand mining (Consultation # F/SER/2009/00879), a review of effects of sedimentation associated with *A. cervicornis* was provided. NMFS (2009a) stated the following:

"Additionally, Rogers (1983) tested sedimentation rates on *A. cervicornis*, among other coral species, and determined that daily doses of sediment at a rate of 200 mg/cm^2/day had no effect (Rogers 1990)."

Therefore, since the rates of sedimentation observed during the Key West and Port Everglades deepening monitoring were within the bounds of sedimentation documented to be occurring naturally, and those were far less than this 200 mg/cm^2/day threshold set by Rogers (1983) cited by NMFS (2009a), the USACE concluded that adverse effects to *A. cervicornis* and DCH from increased sedimentation will be insignificant. This determination is consistent with NMFS' previous findings in NMFS Biological Opinions (2008c, 2011) for *Acropora sp.* near dredging projects. The USACE also extrapolates this determination for the remaining six listed threatened coral species.

Dredged Material Management Impacts

Potential environmental impacts could occur as the barge is loaded if material is allowed overflow and during transport if the barge leaks material. 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. 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. It should be noted that historical documentation from dredging projects for the last 50-years show that all scows leak to some extent. This leakage can increase if the ratio of dredged material to water decreases, as the scow seals are designed to contain dredged material, not water. Proper use of the ODMDS minimizes the environmental impacts during placement. The barges will be required to use positioning equipment to place dredged material within the designated ODMDS and inspectors may be required to monitor placement activity. The USACE's required monitoring of vessels in ullage and location ensure that the dredged material is being disposed of in the approved location. The placement of dredged material is not anticipated to have an impact on Acropora sp. corals or DCH. The ODMDS is not within the boundaries of DCH as the site is located offshore of San Juan Harbor in water depths between 213-400 meters.

In order to reduce the chances of turbidity and sedimentation impacts to ESA-listed corals and DCH from dredging and potential leaks from disposal vessels, the USACE will work in conjunction with the NMFS to develop a turbidity monitoring plan. The plan will include turbidity monitoring stations adjacent to ESA-listed corals (if any are found during the pre-construction resource surveys) and at the edges of the DCH for elkhorn and staghorn corals near the disposal vessel transit route. The exact number and locations of the monitoring stations will be determined and detailed in the collaborative monitoring plan. Turbidity in these locations must not exceed 7 Nephelometric Turbidity Units (NTUs) above background as measured at the control locations positioned 200 meters (m) upstream of the dredge. The monitoring plan will include adaptive management measures to be implemented to mitigate turbidity in the event that turbidity exceeds 7 NTUs above background at these locations. Adaptive management may include measures to correct disposal vessel leakage, reducing overflow, etc.

5.4.11 Marine Mammals

A study conducted on the effects of dredging noise on bottlenose dolphins determined that frequencies generated from dredging activities were not unlike those generated from shipping, tourist, and recreational boat traffic (NAVFAC 2008). Bottlenose dolphins are most sensitive to frequencies from 4 to 20 kHz and although source frequencies generated from a dredging vessel can fall in this range, noise effects are unlikely to acoustically mask bottlenose dolphin sound, particularly when generated within 100 meters of a dredging vessel (Applied Ecology Solutions 2006). In addition, dolphins are highly mobile and are likely to only be in the vicinity of dredging operations for a short period of time. Although bottlenose dolphins are common in the study area, the USACE has never documented a direct effect on bottlenose dolphins from dredging activities during its numerous dredging projects throughout the United States; therefore, an Incidental Harassment Authorization in accordance with the MMPA is not anticipated for this project. In the 2005, notice in the Federal Register (70 FR 21174) for the issuance of an Incidental Harassment Authorization for blasting at the Port of Miami, NMFS concluded, "(a)ccording to the Corps, bottlenose dolphins and other marine mammals have not been documented as being directly affected by dredging activities and, therefore, the USACE does not anticipate any incidental harassment of bottlenose dolphins. NMFS concurs."

On the basis of (1) the predicted noise effect thresholds noted by Richardson et al. (1995) presented in Section 2.4.16, (2) the background noise that already exists in the marine environment (approximately 120 dB), and (3) the ability of marine mammals to move away from the immediate noise source, noise generated by bucket, cutterhead, and hopper dredge activities would not be expected to affect the migration, nursing/breeding, feeding/sheltering or communication of marine mammals. Although behavioral effects are possible (i.e. a whale changing course to move away from a vessel), the number and frequency of vessels present in a given project area would be small, and any

behavioral impacts would be expected to be minor. The dredging operations for the proposed project would not take place in every area of the channel at one time. While multiple dredges may be used at any given time, they would operate at distances that allow enough space for the movement of marine mammals and other species around the vessels. Furthermore, for hopper dredging activities, endangered species observers would be on board and would record all large whale sightings and note any potential behavioral impacts. In light of the factors listed, the proposed project is not expected to result in more than minimal and temporary adverse impacts to marine life as a result of dredging and dredge equipment noise. Based on Sections 2.4.16 and 5.4.16, it is reasonable to assume that underwater sounds produced during the San Juan Harbor dredging project would not exceed NMFS Level A Criterion (190 dB re 1µPa rms) for injury/mortality to pinnipeds (e.g., harbor seals) or 180 dB re 1µPa rms for injury/mortality to marine mammals during any aspect of the dredging operations. Noise levels in excess of 120 dB, or the Level B Criterion for harassment, could be exceeded depending on the type of dredging equipment used. However to date, NMFS has not made a determination that sound generation associated with dredging operations, or any other vessel operations, will be considered type B harassment and will require an IHA for operations. Therefore, no additional coordination under the MMPA is anticipated for this project.

5.4.12 Birds

The USACE does not anticipate that avian species, including shorebirds, seabirds, and migratory birds, would be adversely (directly or indirectly) affected by the proposed project. The proposed project would cause only temporary impacts to the bird community as individuals avoid active construction areas due to noise and general activity. Since dredging would occur in open and deep water, impacts to the bird community are expected to be temporary and minor. In addition, placement of dredged material within the ODMDS may displace seabirds using the site for foraging.

Shorelines used by birds within the Harbor are not expected to erode any more in the future with-project condition (proposed project) than in the without-project-condition. However, if the USACE conducts additional dredging of the La Esperanza Peninsula Section 1135 project footprint to correct longshore drift problems, the removal of excess sandy material should be kept to the minimum required to stabilize the Peninsula in order to limit bird habitat loss. Moreover, this sandy dredged material should be beneficially used to cap construction dredged material from the Recommended Plan placed in the artificial depressions within the Condado Lagoon (Material Placement Option 1 Beneficial Use). Capping may be necessary to prevent re-suspension of the placed construction material which is anticipated to have a grain size less than the optimal 0.21-0.46mm (Tetra Tech 2011). Beneficial effects to bird foraging habitat should result from the Condado Lagoon bathymetry/SAV restoration. Finally, both harbor and coastal beaches are important nesting, foraging, and loafing/roosting habitats for migratory birds. USACE is committed to monitoring the assumptions of the project to ensure that additional impacts to natural resources in the harbor are not incurred.

5.4.13 Invasive Species

As mentioned in Section 2.4.13, the primary pathway for non-native species introduction is shipping. The principal way that aquatic invasive species can enter territorial waters through shipping is by the discharge of ballast water while vessels are in port. Ballast water is pumped into the hull of a vessel to help stabilize the vessel and keep it upright while carrying cargo. This water can be discharged at the receiving port as the cargo is loaded or unloaded. Each vessel may take on and discharge millions of gallons of water. Ballast water taken on in foreign ports may include an abundance of aquatic plants,

animals, and pathogens not native to Puerto Rico. If discharged into territorial waters, these foreign species may become problematic.

In addition to ballast water discharge, another important source for the introduction of nonindigenous organisms is the fouling community that grows on the hull, rudder, propellers, anchor, anchor chain, or any other submerged structure of vessels that are not properly cleaned or maintained. Historically, such fouling communities were composed of massive layers of a variety of organisms, both attached and merely entrained in or living on that growth. Although such extensive growth is not as common on seagoing vessels in recent times, it still provides an opportunity for worldwide transport of fouling organisms, particularly on towed barges and other structures. Recent invasions by a number of coastal invasive species offer evidence that hull fouling remains a viable pathway for non-indigenous introductions.

Similar to the future without-project condition, Federal regulation requires the shipping industry to employ one of the listed ballast water management practices to better control the invasive species introduction pathway through the ballasts of vessels (33 CFR §151.1510). This regulation should decrease the rate at which invasive species are introduced to the study area. Project economics show that the No Action Alternative would actually result in a greater increase in the number of vessels anticipated to call on the San Juan Harbor, thus increasing the potential for introduction of invasive species to the project area. The proposed project would result in fewer vessels than what is anticipated in the No Action Alternative, which should reduce the potential for the introduction of invasive species.

5.4.14 Air Quality

Dredging operations are typically powered by diesel engines. Depending on the size, type, age, and condition of the equipment, various emissions can be expected for the duration of the operation. The project area is compliant with Puerto Rico air quality standards. It is important to note that the improvements for the Recommended Plan will occur in a bay that experiences nearly constant trade winds and sea breezes.

The Recommended Plan will improve navigation of commercial vessels through the harbor without adversely affecting air quality. There will be fewer vessel calls overall, albeit larger vessels with greater horsepower and emission potential. A quantitative emissions analysis using EPA's Compilation of Air Pollutant Emission Factors: AP-42 indicates that the difference between future without-project and future with-project in vessel emissions differs anywhere between 0% to 10%. For example, with the assumption that all other harbor operations remain the same, the annual change in CO_2 vessel emissions in Army Terminal Channel may increase from approximately 35,500,000 pounds up to 39,400,000 pounds.

The project will also facilitate newer, larger, cleaner, and more efficient vessels to reach the port, including larger specialized vessels containing LNG to the Army Terminal Area. The future conversion of the Power Plants from bunker or diesel fuel oil to LNG will improve the air quality of the harbor and also offset any additional emissions from the future commerce therein.

Air quality benefits from updating electrical power generation plant from fuel oil to LNG. The fuel oil is the heavy phase from the petroleum distillation process, which typically contains undesirable impurities of sulfur, metals, and some water. Fuel oil when burned releases high levels of heat ideally for heating furnaces, boilers, and power generation. But also produces undesirable combustion products such has ash, particle matter, sulfur compounds (SO_X) and other gases from incomplete

combustion. Some of these combustion by-products can escape from the power plant and contribute to local air pollution problem.

The average chemical composition of the LNG is 97% methane, 1.5% ethane, 0.25% propane, and the reminder 1.25% are inert gases. The burning of LNG is a clean combustion process, due that the gas burns completely forming CO_2 and water as emission. The drawback with gases is that they tend to have lower energy values than liquids per unit of volume.

$CH_4 + O_2 \rightarrow CO_2 + H_2O + Energy$

Versus

$C_XH_YO_Z + O_2 \rightarrow CO_2 + H_2O + SO_2 + PM_X + Ash + Energy$

In comparing the use of Bunker C fuel oil versus LNG for power generation at peak value of 125,000 million BTU per day for the conversion of the two power plants, the Bunker C fuel oil requirements will be approximately 822,368 gallons per day. The LNG requirements will be approximately 1,512,511 gallons per day, approximately double the volume LNG will be needed to reach the power generation needs per day. The advantage is LNG is abundant, has a lower cost, and does not have the undesirable by-product emissions.

The proposed project has been analyzed for conformity applicability pursuant to regulations implementing Section 176(c) of the CAA. It has been determined that the activities proposed under this proposed project would not exceed *de minimis* (a level of risk too small to be concerned with) levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR § 93.153. For these reasons a conformity determination is not required for this project.

5.4.15 Hazardous, Toxic, and Radioactive Waste (HTRW)

Based upon the dredging history of the San Juan Harbor Federal Navigation Channel, the project is not expected to encounter HTRW. No HTRW would be released in the project area during or after construction. The dredging of virgin material should not impact existing sediment conditions. There is a potential risk reduction for fuel oil spills, due to the expected reduction in the demand of fuel oil via the port, after the Power Plants convert from fuel oil to natural gas. Neither the channel(s) nor the dredged material management site(s) would be affected by HTRW during dredging/placement operations. The project would not change or affect the ability for Federal regulations, U.S. Customs, and Port Security to continue to address the transportation of any HTRW.

5.4.16 Noise

Impacts of Dredging Noise on Marine Life

Reine et al. (2012a) found that the majority of underwater sounds produced by hydraulic cutterhead dredging operations were of relatively low frequency (< 1000 Hz). Their study was conducted during rock fragmentation and therefore represented a worst case scenario. The source level was estimated to be between 170 and 175 dB re 1uPa @1m. These sound levels decreased with increasing distance from the source. The authors determined that the area of influence was limited to less than 100 m from the source. At 100 m received levels were less than 150 dB re 1 uPa rms. In addition, according to Reince et al. (2012b) the most intense sounds produced by a backhoe dredge excavating rock and gravel were associated with bottom grabs and the use of dredge spuds. Source levels for bottom grabs were 179.4 dB re 1 µ PA@1m, or 62.3 dB and 48.2 dB above average and maximum background SPLs, respectively. The second most intense underwater sound was associated with the raising or lowering

of the anchoring spuds, followed by the use of the "walking spud." Source levels were 175.5 dB re 1 µ PA@1m for raising and lowering of spuds and 172.4 dB for spud walking. Finally, Reine and Clarke (2014) found source levels ranged from 161.3 dB to 176.8 dB re 1µPa-1m rms during a study of three trailing suction hopper dredges mining 3.1 million yd3 of sand from an offshore borrow area and during offloading of the excavated sediment at the pump-out stations in support of the Wallops Island, Virginia Beach Stabilization Project. While NMFS is currently developing guidelines for determining sound pressure level thresholds for fish and marine mammals, based on existing studies, the NMFS current thresholds for determining impacts to marine mammals is between 180 and 190 dB re 1 uPa for potential injury to cetaceans and pinnipeds respectively, and 160 dB re 1 uPa for behavioral disturbance/harassment from an impulsive noise source, and 120 dB re 1 uPa from a continuous source. Reine et al. (2012) found that the 120 dB re 1uPa proposed threshold was exceeded by ambient noises in their study area. Based on reviews by Popper et al. (2006) and Southall et al. (2007) it is unlikely that underwater sound from conventional dredging operations can cause physical injury to fish species. Some temporary loss of hearing could occur if fishes remain in the immediate vicinity of the dredge for lengthy durations, although the risk of this outcome is low (CEDA 2011). Fish would likely respond to dredging by using avoidance techniques. Avoidance is defined as an effect that causes fish to not occupy an area that is periodically or infrequently occupied. Dredging is likely to cause avoidance due to noise (and increased suspended sediments and other temporary water quality changes).

NMFS interim criterion for physical injury to fish is 206 dB peak, regardless of fish size. However, dredging operations would likely cause the temporary displacement of fish species as a behavioral response to the noise. This would not likely have an effect on populations of fish as they would be able to use areas outside of the navigation channel to traverse to and from spawning and feeding grounds.

The sediment within San Juan Harbor is predominantly sand/silt/mud mixture, with the exception of soft rock in portions of the entrance channel. Therefore, based on the above studies, it is reasonable to assume that underwater sounds produced during the San Juan Harbor dredging project would not exceed NMFS Level A Criterion (190 dB re 1µPa rms) for injury/mortality to pinnipeds (e.g., harbor seals) or 180 dB re 1µPa rms for injury/mortality to marine mammals during any aspect of the dredging operations. Noise levels in excess of 120 dB, or the Level B Criterion for behavioral harassment, could be exceeded depending on the type of dredging equipment used. However to date, NMFS has not made a determination that sound generation associated with dredging operations, or any other vessel operations, will be considered type B harassment and will require an IHA for operations. It is not clear how noise associated with one class of vessels (dredges) can be separated from all others in an active harbor. Other classes of vessels (large cargo vessels, oil tankers, bulk vessels, and cruise ships) generate similar noise profiles and have not been singled out for potential impacts to marine mammals under the MMPA.

Impact of Dredging Noise on the Human Environment

Maintenance dredging and periodic new work dredging has occurred in San Juan Harbor for over 100 years. For continued O&M dredging, the dredging equipment is usually present in the Harbor on a five year frequency and that frequency is not expected to change with the proposed project. There would be a temporary increase in the ambient noise level during the dredging phase of the project. The dredging would be within 150m of sensitive receptors along the Army Terminal Channel and San Antonio Channel. However, since dredging does not occur in one position for any extended period of time, there will be no disproportionate adverse impact on any communities. Noise generated by this project would not be substantially different from other ambient noise levels of a typical harbor.

Impact of Underwater Noise from Vessel Traffic

Most vessels produce low frequency sound (below 1 kHz) from onboard machinery, hydrodynamic flow around the hull, and from propeller cavitations. This frequency relates to vessel size, speed, load, condition, age, and engine type. Low frequency sound can travel hundreds of miles and can increase ambient noise in large areas of the ocean. Additionally, Okeanos (2008) showed that shipping noise does not exceed 100 dB. The economic assessment from this project has determined that the number of vessels transiting in and out of San Juan Harbor would decrease as a result of the proposed project and that fewer larger vessels would call on the Harbor in the future with-project condition. With a deeper channel, the larger vessels can fully load their cargo. Without the project, a greater number of vessels would be required to deliver the same amount of petroleum products, which would have a greater impact on marine noise. As a result of this, no adverse impact is anticipated from underwater noise resulting from vessel activity as a result of deepening the Harbor.

Indirect Impact of Noise from Port Operations as a Result of Deepening the Harbor

Noise from ports can come from port services and facilities, cranes, cargo handling equipment, warehousing, vessel repair or maintenance, engine noise from vessels at berth. The proposed project would not cause an increase in the quantity of petroleum products or containers anticipated to arrive in the San Juan Harbor. Therefore, there would be no increase in the amount of truck traffic from the various port terminals. The only change would be in the timing of vessel unloading and petroleum product or container movements. In light of these factors, the proposed Harbor deepening is not expected to result in adverse noise impacts as a result of port operations.

5.4.17 Coastal Barrier Resources

The proposed project would not affect the three CBRS Units located near San Juan Harbor, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (Figure 2-7).

5.4.18 Cultural and Historic Resources

Analysis of potential impacts to historic and cultural resources considered both direct and indirect effects (*see* Section 2.4.18). Direct effects may result from physically altering, damaging, or destroying all or part of a historic or cultural property, or changing the character of physical features within the property's setting that contribute to its historic significance. An effects analysis focuses on the characteristics of a historic property that qualify it for inclusion in the National Register, and assesses the potential to alter historically significant characteristics and diminish the integrity of a historic property. There may also be cultural resources of value which are not eligible for inclusion in the National Register. The APE for direct affects was defined as being within and adjacent to the Federal navigation channel where widening and deepening measures are proposed. Indirect effects are reasonably foreseeable effects caused by an undertaking that may occur later in time, be farther removed in distance or be cumulative. In the case of harbor deepening, indirect effects would include those that may occur as a result of a change in the wave action or currents in the vicinity of the resource due to dredging and construction, as well as a result of wakes from the number and size of vessels entering the Harbor. The APE for indirect affects is defined as shorelines of San Juan Harbor and adjacent properties within the viewshed of San Juan Harbor.

A background investigation and cultural resources remote sensing survey of the San Juan Harbor channel APE was conducted for the proposed project in consultation with the Puerto Rico SHPO and the *Instituto de Cultura Puertorriqueña*. While background research revealed numerous shipwrecks within the project vicinity, no previously identified cultural resources were located within the APE.

SEARCH, Inc. (SEARCH) conducted a remote sensing survey of the San Juan Harbor between June 1-6, 2017. The survey included a magnetometer, side-scan sonar, and sub-bottom profiler investigation to locate previously unidentified cultural resources. Results of the remote-sensing survey did not identify any potentially significant anomalies in 10 of the 11 areas surveyed. The 10 areas cleared for potentially significant submerged cultural resources include Anegado Channel, San Antonio Channel, Anchorage Area E, Graving Dock Channel and Turning Basin, Puerto Nuevo Channel and Turning Basin, Army Terminal Channel and Turning Basin, and Anchorage Area F. While a number of magnetic anomalies were documented within these areas, previous navigational/channel improvements (primarily dredging) have likely impacted or removed potentially significant submerged cultural resources from within these areas. No further cultural resources investigations are recommended within these eight areas.

The only potentially significant cultural resources identified within the APE were located within the Anchorage Area F USCG Expansion. Four clustered anomalies (comprised of 18 individual magnetic anomalies) and one individual anomaly (CA-21M) were identified that may represent potentially significant submerged cultural resources. These anomalies are recommended for avoidance or additional investigations in the form of diver identification to determine significance and eligibility for listing in the NRHP. However, proposed deepening and widening measures within the Anchorage Area F Expansion Area are not included in the Recommended Plan and the Anchorage Area F Expansion Area will not be dredged or otherwise maintained as a part of the San Juan Harbor Improvement Study. Anchorage Area F expansion by the USCG is considered a FWOP condition for this study and is no way incorporated into the benefits of the Recommended Plan

Historic resources along the shoreline of the San Juan Harbor are currently protected from wave energy in the harbor by revetments. However, during the NEPA scoping process, various entities wanted to understand how the project may influence the wave climate in the Harbor and potential erosion to surrounding shorelines. Therefore, these historic resources are included in the APE. Erosion of San Juan Harbor shorelines is controlled predominantly by wind waves and tidal currents. The relative infrequency of cargo vessel wakes compared with wind waves makes them a minor factor contributing to shoreline changes and erosion. Deepening the Federal navigation channel would reduce the shoreline impact of vessel wakes by reducing the number of vessels and increasing the range of tides during which vessels can transit the harbor. Therefore, the deeper alternatives have a progressively smaller vessel wake impact on surrounding shorelines. Because of this, it has been determined that all of the deepening alternatives would generally result in lower impacts to shorelines and existing protective revetments. Therefore, no adverse impacts to historic properties, including *Castillo de San Felipe del Morro*, are anticipated.

Economic analysis also indicates that fewer total vessels would call on San Juan Harbor under the with-project conditions compared to the future without-project condition/No Action Alternative. Since fewer vessels would be calling on the port with the proposed project, there would be no effect on the viewshed of historic properties, including Old San Juan Historic District. None of the project alternatives would result in a change in the existing use of San Juan Harbor, which is an historic seaport and would continue to remain so. Commercial and recreational vessel traffic patterns, shoreline land uses, and natural resources that define the aesthetic (including noise and visual) characteristics of the harbor would remain subject to the traffic and use trends that would govern the with and without-project future conditions. Accordingly, the historic resources in or nearby the APE would not be adversely affected by any of the project alternatives.

Based on the results of the submerged cultural resources survey of San Juan Harbor and historic property viewshed and wake analysis, the USACE has determined that the Recommended Plan for the San Juan Harbor Improvement Study poses no effect to historic properties listed or eligible for listing in the NRHP. Consultation with the Puerto Rico SHPO and the National Park Service (NPS) was initiated in letters dated November 7, 2016. Consultation with the *Instituto de Cultura Puertorriqueña* was initiated via phone and email on May 3, 2017. The Puerto Rico SHPO concurred with the determination of no historic properties affected by letter dated December 5, 2017.

5.4.19 Aesthetics and Recreation

The proposed project would not change the aesthetic resources of San Juan Harbor, nor the numerous recreational opportunities. Although the definition of aesthetics is fluid (see Section 2.4.22), for the purposes of the present evaluation, the principal aesthetic "targets" include the visual perception of San Juan Harbor's land- and seascapes, historic features, and certain architecture. The degree to which any adverse feature affects aesthetics is frequently based on scale, position, and proximity relative to the viewer. Commercial and recreational vessel traffic patterns, shoreline land uses, and natural resources that define the aesthetic characteristics of the area would not be adversely affected. The economic analysis for this project determined that fewer vessels would call on the port with the proposed project. This would reduce the number of vessels visible within the harbor, as well as the many parks, cultural resource sites, and natural resource areas in and around the Harbor. Additionally, if the beneficial use project of placing dredged material in Condado Lagoon becomes a viable option, the resource(s) would experience a temporary impact to recreational activities due to placement of material to fill artificial depressions (to encourage sea grass restoration) and a temporary reduction in the aesthetic appeal of Condado Lagoon during construction.

As a public safety measure, boating would be prohibited near the operating construction equipment (and sediment placement locations). Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short-term impacts could occur, no long-term adverse effects are anticipated. Commercial shipping would continue in the Federal navigation channel. Information would be provided to the USCG so they could issue a "Notice to Mariners" prior to initiation of construction and for each major change in the construction activities. This would alert public boaters of areas to avoid and the possibility of limited and restricted access. No significant adverse impacts to public safety are expected from the proposed project.

5.4.20 Socioeconomics

The USACE collected and analyzed information to consider the potential impacts of the proposed action on minority and low-income populations, the elderly, and children. The information and analyses presented below demonstrates that the proposed action complies with Executive Orders 12898 and 13045 and would not cause disproportionately high and adverse impacts to minority populations, low-income populations, and sensitive populations such as the elderly, or children.

Many of the port terminals accessible from the Federal navigation channel are along the San Juan Peninsula. Possible factors that could impact EJ communities include those resulting directly from the construction of the project and the secondary effects that could occur as a result of the navigation channel improvements. These factors include, but are not limited to the following:

- Construction-related impacts
    - Construction equipment through neighborhoods
    - Noise from construction
    - Air emissions from construction
    - Affects to subsistence fishermen
    - Increasing exposure to contaminants
    - Decreasing water quality
    - Effects from sediment transport and placement
- Possible impacts resulting from navigation improvements
    - Changing terminal infrastructure
    - Increased truck traffic resulting from an increase in cargo
    - Increased emissions resulting from an increase in cargo and subsequent effects
    - Increasing exposure to contaminants
    - Decreasing water quality
    - Effects from sediment transport and placement
    - Effects to subsistence fishing

See the Economics Appendix for additional details on the EJ analysis.

Construction-Related Impacts

The Recommended Plan consists almost entirely of the deepening and widening of existing navigation channels and berthing and maneuvering areas used by petroleum product vessels. As such, the construction and operational activities are almost entirely limited to the existing water-based navigation system. The construction and operational work areas are located far from residential communities, schools, and hospitals; therefore, impacts from noise, air, and other inconveniences would not significantly impact identified communities. Compared to most large land-based projects, there is little potential for direct adverse impacts to minority populations, low-income populations, the elderly, or children. As indicated in previous sections of this document, during construction there would be temporary and minor impacts resulting from increase turbidity (decreased water quality) from dredges in and around the construction zone. These impacts would be most strongly noticed at the site of the construction and would dissipate away from the dredge depending on the tidal direction. Since the dredge will not be operating in one area for more than a few days, these impacts will be temporary and minor and will not disproportionately impact low-income, minority, juvenile, or elderly populations. Additionally, the potential exists for subsistence fishing within the harbor; however these practices will not be significantly impacted by the proposed project due to the impacts being temporary and minor in nature. No significant impacts to fish populations are expected to result from the construction of the project. Lastly, since the placement of sediments will occur at the ODMDS, there will be no affects to any EJ communities from the placement of dredged material from this project. In summary, there will be no disproportionately high and adverse impact on low-income, minority, juvenile, or elderly populations resulting from the construction of the project.

Impacts Resulting from Navigation Improvements

As reported in the Economics Appendix, the proposed harbor deepening would not increase the amount of commodities moving through the port in a given year. Since the population is not anticipated to grow, based on recent trends, the amount of commodities moving through the port is not expected to increase in the without-project condition independent of a harbor deepening project. Federal participation in the proposed action is justified by efficiencies that would result from the use of a smaller number of vessels loading deeper and more efficiently to bring to the same quantity of goods to San Juan. Those efficiencies are expected to provide up $4.3M per year in transportation cost savings. No change in the amount of cargo moved through the port would result from the harbor widening or deepening, with the exception of LNG (which increases) and diesel fuel (which decreases) to the PREPA in an industrial area outside the EJ communities. Instead the project would simply increase the efficiency related to the transportation of the existing and projected cargo volumes. As a result, the project would not affect the number of containers that move through the areas and EJ communities that surround the port. With the proposed harbor widening and deepening project, the total number of vessels needed to transport the forecasted cargo volumes would decrease, compared to the without-project conditions, as individual vessels would be able to load more cargo with a deeper navigation channel. Regardless, vessel related noise and vessel traffic within the navigation channels have little noticeable landside impacts away from industrial facilities.

Effects from changing landside cargo handling practices, and specifically effects to regional and local air quality was a concern generated during the public review of the Draft IFR/EA. Since large vessel access to the port terminals will not be restricted, some of the non-monetary benefits of the proposed action include reduced and less concentrated air emissions, noise, and vessel traffic. Additionally, since the amount of commodities per year is not predicted to increase as a result of deepening, no landside increases in emissions would occur as a result of the deepening. Under the with-project condition, the USACE predicts a reduction in the number of vessels used to transport petroleum products each year. As a result, total air emissions within the harbor and at each terminal would decrease in a given year as a result of harbor widening and deepening. Additionally, since there would be an overall decrease in emissions (including air toxics), no NAAQS violations would result from the proposed project. Therefore, a risk-based assessment of the health effects associated with the proposed action is not warranted. Any adverse effects resulting from the presently permitted air emissions would be reduced if the harbor is deepened because of the reduction in the number of vessels as well as a shift to more modern and more efficient vessels. Additionally, when compared to the without-project conditions, the proposed project would have positive impacts resulting from reduced and less concentrated air emissions. Construction of the proposed project would not induce additional growth, including additional traffic, noise, or lighting. Considering all effects to air quality together, the proposed action would benefit the general area and minority populations, low-income populations, the elderly, and children by lowering emissions, increasing flexibility and operational efficiency and allowing newer, larger, and more modern vessels to replace older, smaller and less efficient vessels.

Schools/childcare facilities and hospitals are dispersed throughout the area. The data indicates that while some communities within this area meet environmental justice criteria, there is a diversity of communities situated within the area immediately surrounding or adjacent to the channels to be deepened. In summary, there would be no disproportionately high and adverse impact on low-income, minority, juvenile, or elderly populations resulting from any secondary changes from the navigation improvements of the proposed project.

Summary of Project Effects on Environmental Justice Populations and Children

As discussed above, construction of the proposed project and changes resulting from the navigation improvements would not have a disproportionately high and adverse impact on low-income, minority, juvenile, or elderly populations. The proposed project 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." *See* the Economics Appendix for additional details on the EJ analysis.

Public Engagement during Construction

An important component of any project is informing the public at all stages of the project (i.e., planning, design, construction, and maintenance). USACE engaged in public outreach efforts through the media and public information meetings during the feasibility phase (planning phase). USACE will provide a contact information link on the public website for anyone with concerns about, or related to, the project. Depending on the level of local interest, these plans may be modified in the future.

Irreversible and Irretrievable Commitment of Resources

Section 102(2)(C)(ii) of NEPA (42 U.S.C. §4332(2)(C)(ii)) requires that an environmental assessment include information on any adverse environmental effects that cannot be avoided, should the proposed action be implemented. An irreversible commitment of resources is one in which the ability to use a resource is lost forever. An irretrievable commitment of resources means that opportunities for other uses are foregone for the period of the proposed action. Typically, it refers to the use of renewable resources, including human effort, and to other utilization opportunities foregone in favor of the proposed action. In the case of San Juan Harbor, examples of such resources include the fossil fuels that would be required to run the equipment to construct the project and the loss of biological resources (entrained fish, invertebrates, other aquatic life, including but not limited to threatened and endangered species) that could be incurred during construction. The loss of biological resources during construction would be mainly confined to the immediate construction area (i.e., the navigation channel and adjacent wideners). This impact is not generally irreversible or irretrievable because recovery of the benthic community will occur after construction. The removal of sediment from the channel and placement in the ODMDS will irreversibly commit those sediment resources. An irretrievable commitment of resources stems from the use of fossil fuels, equipment, man-power, etc. that will be incurred during construction.

5.4.21 Summary of Cumulative Impacts

NEPA, as implemented by Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500 -1508), requires Federal agencies, including the USACE, to consider cumulative impacts in rendering a decision on a Federal action under its jurisdiction. According to 40 CFR § 1508.7, a *cumulative impact* is the impact on the environment that results 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; cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. An inherent part of the cumulative impacts analysis is the uncertainty surrounding actions that have not yet been fully developed. The regulations provide for the inclusion of uncertainties in the Final IFR/EA analysis, and state, “When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an Environmental Impact Statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking” (40 CFR Part 1502.22). However, the CEQ has also recognized that "the complexities of cumulative effects problems ensures that even rigorous analyses will contain substantial uncertainties about predicted

environmental consequences" (*Considering Cumulative Effects Under the National Environmental Policy Act*, CEQ 1997).

Potential cumulative impacts on many resources were considered as part of this study and the majority of these resources were determined to have little risk of being cumulatively impacted. These included land use, terrestrial natural resources, threatened or endangered species, other fish and wildlife, managed fishes, the estuarine water column, certain water quality parameters (turbidity and hazardous and toxic constituents), sediments (hazardous and toxic constituents), coastal barrier resources, harbor shorelines (of properties adjacent to the project), dredged material, air quality, noise, aesthetics, cultural and historic resources, native American resources, environmental justice, and recreation.

U.S. Coast Guard Related Actions

Relocation of Aids to Navigation (ATONs). The USCG San Juan Sector plans to move buoys G5, G7, and G9 (Figure 3-3) to areas of existing deep water east of the Federal channel limits, which allows widening of the Entrance Channel reaches from Cuts 4 – 6 without deepening as a non-structural measure. Another non-structural measure involves the USCG relocation of buoy R2 and G3 to allow use of existing wideners (Figure 3-4). No negative cumulative impacts are anticipated from this related action since benthic surveys and precautions are required per permit conditions prior to ATON relocation.

Anchorage F expansion: Although not part of the Recommended Plan, in order to obtain permits to construct their proposed anchorage area expansion the USCG will conduct an additional environmental analysis. Regarding the proposed expansion's potential impacts to hardbottom and SAV habitats. The USACE expects that the proportion of benthic habitat that would be affected by the USCG anchorage expansion dredging is very small relative to the hardbottoms and SAV available in the region, including natural fringing coral reefs along the north coast and SAV beds throughout San Juan Bay. Therefore, the potential contribution of the expansion of Anchorage F to cumulative effects on hardbottoms and SAV is anticipated to be minimal.

The USACE has determined that the net contribution to cumulative adverse impacts due to the proposed project and the overall cumulative adverse impact will be appropriately minimized based on (1) efforts to avoid and minimize the environmental impact of the proposed action, and (2) Federal and State permitting requirements that will be required for any ongoing present and/or potential future actions.

6.0 ENVIRONMENTAL COMPLIANCE AND COMMITMENTS*

Compliance with the following environmental laws (and implementing regulations) and Executive Orders is required for all alternative channel deepening plans under consideration (Note: this is not necessarily an exhaustive list of all applicable environmental requirements).

6.1 Table of Compliance

Relationship of the Proposed Action to Applicable Federal Laws and Policies		
Public Laws		
Title of Public Law	**U.S. Code**	**Compliance Status**
Abandoned Shipwreck Act of 1987	43 U.S.C. §§2101-2106	Full Compliance
Anadromous Fish Conservation Act of 1965, as amended	16 U.S.C. §757a *et. seq.*	Full Compliance
Bald Eagle Act of 1972	16 U.S.C. §§668-668d	Full Compliance
Clean Air Act of 1972, as amended	42 U.S.C. Chapter 85	Full Compliance
Clean Water Act of 1971, as amended	33 U.S.C. §1251 *et. seq.*	Full Compliance
Coastal Barrier Resources Act of 1982	16 U.S.C. §3501-3510	Full Compliance
Coastal Zone Management Act of 1972, as amended	16 U.S.C. §1451 *et seq.*	Full Compliance
Deepwater Port Act of 1974, as amended	33 U.S.C. §1501 *et. seq.*	Full Compliance
Endangered Species Act of 1973	16 U.S.C. §1531 *et. seq.*	Full Compliance
Estuary Program Act of 1968	16 U.S.C. §1221 *et. seq.*	Full Compliance
Federal Insecticide, Fungicide, and Rodenticide Act	7 U.S.C. §136 *et. seq.*	Full Compliance
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. §§661-665; 665a; 666; 666a-666c	Full Compliance
Flood Control Act of 1944, as amended, Section 4	P.L. 78–534	Full Compliance
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. §1801 *et. seq.*	Full Compliance
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. §1361 *et. seq.*	Full Compliance
Marine Protection, Research and Sanctuaries Act of 1972	33 U.S.C. §1401 *et. seq.*	Full Compliance
Migratory Bird Conservation Act of 1928, as Amended	16 U.S.C. §715	Full Compliance
Migratory Bird Treaty Act of 1918, as amended	16 U.S.C. §§703-712	Full Compliance
National Environmental Policy Act of 1969, as amended	42 U.S.C. §4321 *et. seq.*	Full Compliance
National Historic Preservation Act of 1966, as amended	54 U.S.C. §300101 *et. seq.*	Full Compliance
Noise Control Act of 1972, as amended	42 U.S.C. §4901 *et. seq.*	Full Compliance
River and Harbor Act of 1888, Sect 11 (as codified)	33 U.S.C. §608	Full Compliance
River and Harbor Act of 1899, Sections 9, 10, 13	33 U.S.C. §§401, 403, and 407	Full Compliance
River and Harbor and Flood Control Act of 1962, Section 207	PL 87-874	Full Compliance

River and Harbor and Flood Control Act of 1970, Sections 122, 209, and 216	PL 91-611; *see generally* 33 U.S.C. §701 *et. seq.*	Full Compliance
Safe Drinking Water Act	42 U.S.C. §§300f-300j	Full Compliance
Merchant Marine Act	46 U.S.C. §861 *et. seq.*	Full Compliance
Submerged Lands Act of 1953	43 U.S.C. §1301 *et. seq.*	Full Compliance
Executive Orders		
Title of Executive Order	**Executive Order Number**	**Compliance Status**
Protection and Enhancement of Environmental Quality	11514/11991	Full Compliance
Protection and Enhancement of the Cultural Environment	11593	Full Compliance
Floodplain Management	11988	Full Compliance
Protection of Wetlands	11990	Full Compliance
Federal Compliance with Pollution Control Standards	12088	Full Compliance
Offshore Oil Spill Pollution	12123	Full Compliance
Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	12843	Full Compliance
Federal Compliance with Right-To-Know Laws and Pollution Prevention	12856	Full Compliance
Federal Actions to Address Environmental Justice and Minority and Low-Income Populations	12898	Full Compliance
Federal Acquisition and Community Right-To-Know	12969	Full Compliance
Protection of Children from Environmental Health Risks and Safety Risks	13045	Full Compliance
Invasive Species	13112	Full Compliance
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full Compliance
Executive Order Facilitation of Cooperative Conservation	13352	Full Compliance

6.2 National Environmental Policy Act of 1969 (NEPA), as amended, 42 U.S.C. §4321 *et. seq*.

NEPA requires that all Federal agencies use a systematic, interdisciplinary approach to protect the human environment. This approach promotes the integrated use of natural and social sciences in planning and decision-making that could have an impact on the environment. NEPA requires the preparation of an environmental assessment (EA) for any major Federal action that does not significantly affect the quality of the human environment. NEPA regulations issued by CEQ provide for a scoping process to identify and the scope and significance of environmental issues associated with a project. The process identifies and eliminates from further detailed study issues that are not significant. As previously stated, the USACE used this process to comply with NEPA and focused this IFR/EA on the issues most significant to the environment and the decision making process.

The Draft IFR/EA was released for a 45 day public review period from August 2017 to September 2017. All comments/edits have been addressed in the development of this Final IFR/EA, and responses to the comments are included in Correspondence Appendix. This Final IFR/EA, including all appendices

and supporting studies, fulfills all requirements of NEPA for the San Juan Harbor Navigation Improvements Feasibility Study and is in full compliance with the NEPA.

6.3 Clean Water Act

The January 14, 2015 (Appendix K) WQC covers the discharge of dredged material into the Condado Lagoon artificial depressions. A new WQC will be sought from the EQB for the new dredging areas after completion of this IFR/EA. Per the process of obtaining a WQC in Puerto Rico, the FONSI with accompanying NEPA documents will be submitted to the OGPe after signature/approval for another round of public and agency coordination. Once the OGPe approves the project by letter, that letter and the CZMA consistency concurrence is submitted to the EQB who will then issue the WQC. All Commonwealth water quality standards would then be met.

6.3.1 Wetlands

CWA Section 404 and implementing USACE regulations at 33 C.F.R. §320.4(b) requires the USACE to avoid, minimize, and mitigate impacts to wetlands. No effects to adjacent mangrove wetlands are anticipated as a result of the Recommended Plan.

6.3.2 Section 404 (b)(1) Guidelines

All of the harbor deepening alternatives considered involved discharges of dredged and fill material into waters of the U.S. All sites designated to receive dredged or fill material, excluding those sites governed solely by separate authorization criteria (the ODMDS site covered under Section 103 of the MPRSA), have been evaluated using the CWA Section 404 (b)(1) Guidelines and found to be in compliance with the requirements of these guidelines. The Section 404 (b)(1) Evaluation can be found in Appendix I.

6.4 Federal Coastal Zone Management Act (CZMA), 16 U.S.C. §1451 *et. seq*.

This Act requires each Federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable, i.e. fully consistent, with the enforceable policies of approved state management programs unless full consistency is prohibited by existing law applicable to the Federal agency.

To implement the CZMA and to establish procedures for compliance with its Federal consistency provisions, NOAA promulgated regulations which are contained in 15 C.F.R. Part 930. As per 15 CFR §930.37, a Federal agency may use its NEPA documents as a vehicle for its consistency determination. The Puerto Rico Planning Board concurred with USACE's Federal consistency determination via letter dated January 4, 2018 (*See* Appendix H).

6.5 Clean Air Act (CAA), 42U.S.C. §7401 *et. seq.*

All harbor deepening alternatives would be in compliance with the CAA. An Air Emission analysis is provided as part of this IFR/EA. The analysis determined that air emissions from port operations would be less if the harbor is deepened when compared to the No Action Alternative. The study area is in an attainment area for all air quality criteria and the proposed project will not cause the study area to go out of attainment.

6.6 U.S. Fish and Wildlife Coordination Act, 16 U.S.C. §§661-666(c)

Coordination with the USFWS began in late 2015 and a scope of work for the Coordination Act Report (CAR) was signed by USACE and USFWS on December 7, 2015. The USFWS provided a Draft CAR in May 2017 which was included in Appendix G of the Draft IFR/EA. The Final CAR was received June 21, 2018. The USFWS continues to support Condado lagoon restoration using construction dredged material. The project is in full compliance with this Act. The recommendations from the Final CAR are included and discussed below.

1. Engineering details regarding construction techniques, disposed material quality and quantities, and possible impacts from induced wake-erosion and potential of channel slumping should be provided to the Service and other natural resource agencies in a timely manner to ensure conservation measures can be fully developed and incorporated into the project design.

District Response: Comment noted the Corps will continue to coordinate project details including plans and specifications and adaptive management in PED.

2. The Service recommends that completion of the previously authorized mitigation associated with past dredging activities should be pursued immediately in conjunction with any future construction/maintenance activities. The mitigation debt regarding previous COE dredging action in San Juan Bay needs to be calculated into the current Project cost/benefit analysis.

District Response: The Corps will incorporate the Condado mitigation into future contracts for this project as practicable. However, since the mitigation was previously authorized and permitted, it is not appropriate to add these costs into the IFR/EA for new harbor improvement measures.

3. The Service recommends that mitigation be implemented at the Condado Lagoon Depressions and that the mitigation is implemented concurrent with project construction.

District Response: The Corps is exploring options to implement the mitigation through beneficial use of construction dredged material to completely restore Condado lagoon which is discussed in detail in IFR/EA Sections 4.3.3, 5.3.4.1, 6.22, and 9.0,p. Should a local sponsor for the beneficial use be identified and funding secured, it will be incorporated into the construction contract.

4. The Corps should coordinate with the Service and other natural resource agencies to develop mitigation monitoring and success criteria, reporting requirements, and an adaptive management plan for such mitigation.

District Response: As discussed in Section 5.4.6 of the IFR/EA, using dredged material to create 1.2 acres of SAV was included in the 14 January 2015 WQC. In addition, a mitigation plan for this action was coordinated with the Service and other agencies and is included as Appendix D in the February 2015 SAV Mitigation EA and 2 March 2015 FONSI. Should mitigation be included as a component of any future construction contract, the Corps will follow the mitigation plan approved in 2015. In addition, should the full restoration of Condado lagoon be approved, the Corps will coordinate an expanded mitigation plan with the Service and other natural resource agencies.

5. We encourage the Corps to consider the opportunity to implement an ESA Section 7(a)(1) project to determine manatee usage in the project area to ensure future and ongoing construction and maintenance do not unintentionally result in unforeseen impacts to manatees.

District Response: Comment noted the Corps will continue to coordinate manatee conservation measures with the Service including all potential 7(a)(1) options throughout the project lifespan.

6.7 Endangered Species Act, 16 U.S.C. §1531 *et. seq.*

Biological Assessments evaluating the potential impacts of the proposed action on endangered and threatened species and their critical habitat were submitted to NMFS on July 14, 2017 and USFWS on August 1, 2017. The USFWS has jurisdiction over the Antillean manatee and nesting sea turtles and NMFS jurisdiction over Nassau grouper, scalloped hammerhead sharks, swimming sea turtles, corals, whales, and other protected marine and aquatic species which may occur in the project vicinity, pursuant to Section 7 of the ESA. The USFWS concurred with the not likely to adversely affect determinations via informal consultation letter dated June 21, 2018. A final Biological Opinion was received from NMFS on May 29, 2018 for formal consultation for hopper dredging impacts to sea turtles and informal consultation for listed corals and whales. USACE will abide by the conditions of these documents and ESA consultation is complete.

6.8 Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. §1801 *et. seq*.

This Act requires Federal action agencies to consult with the NMFS HCD if a proposed action may adversely affect EFH. The USACE evaluated potential project impacts on NMFS-managed fish species and their EFH. Impacts would occur to the water column and unconsolidated substrate. Implementation of the monitoring plan for this project should bring all channel deepening alternatives under consideration into compliance with the provisions of the MSA. An EFH Assessment is incorporated into this integrated document in Sections 2 and 5 and was coordinated with NMFS HCD concurrent with the public review of the Draft IFR/EA. NMFS HCD responded via letter dated January 5, 2018 with no formal EFH conservation recommendations which concluded the consultation.

6.9 Anadromous Fish Conservation Act, 16 U.S.C. §757, *et. seq.*

No anadromous fish species would be affected by the proposed action. Therefore, this Act is not applicable.

6.10 Marine Mammal Protection Act (MMPA), 16 U.S.C. §1631 *et. seq*.

The MMPA prohibits the take of marine mammals including the Antillean manatee, bottlenose dolphin, and humpback, sperm, sei, finback, and blue whales. Protective measures for marine mammals will be implemented. The project is being coordinated with USFWS and NMFS. The project, as conditioned, is in compliance with this Act and no take or incidental harassment would occur.

6.11 Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. §306108

The Proposed Action is in compliance with Section 106 of the NHPA. As part of the requirements and consultation process contained within the NHPA implementing regulations of 36 CFR Part 800, this project is also in compliance with the Archaeological and Historic Preservation Act (16 U.S.C. §§469-469c,) Archeological Resources Protection Act (16 U.S.C. §§470aa-470mm), and Executive Order 11593. Consultation with the Puerto Rico SHPO and the National Park Service was initiated in letters dated November 7, 2016. Consultation with the *Instituto de Cultura Puertorriqueña* was initiated via phone and email on May 3, 2017. The USACE determined that the Proposed Action will have no effect on historic properties listed or eligible for listing on the NRHP. The Puerto Rico SHPO concurred with the determination of no historic properties affected by letter dated December 5, 2017.

6.12 Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6901 *et. seq*.

RCRA controls the management and disposal of hazardous waste. Dredged material from the USACE Civil Works projects is excluded from the definition of hazardous waste under 40 CFR 261.4(g), 33 CFR 336.1 and 33 CFR 336.2.

6.13 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund), 42 U.S.C. §9601 *et. seq*.

CERCLA governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites. As discussed in Section 5.4.16, none of the sediments that would be excavated or dredged during the project would be considered a hazardous substance under CERCLA or addressed under that law.

6.14 Marine Protection, Research and Sanctuaries Act, 33 U.S.C. §1401 *et. seq.*

In order to determine sediment characteristics and contaminant concerns from dredging San Juan Harbor sediments to obtain a Section 103 of the Marine Protection, Research, and Sanctuaries Act concurrence, samples will be collected for chemical and biological evaluations approximately two years prior to construction. It is anticipated that the dredged material will be suitable for ocean placement and the USACE will receive EPA's Section 103 concurrence prior to construction.

6.15 Executive Order 11988, Floodplain Management

This EO states that Federal agencies shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibilities. The project would have no adverse impacts to flood plain management.

6.16 Executive Order 11990, Protection of Wetlands

This EO directs all Federal agencies to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands in the conduct of the agency's responsibilities. Indirect wetland impacts resulting from the proposed deepening have been evaluated and would be monitored (turbidity) during construction.

6.17 Executive Order 13112, Invasive Species

Under this EO, the introduction of invasive species has been evaluated in Sections 2.4.16 and 5.4.16. The project is not anticipated to increase the introduction of invasive species to the project area, and if implemented, may decrease the potential for introduction of invasive species into the project area.

6.18 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

In accordance with this EO, the USACE has determined that no group of people would bear a disproportionately higher share of adverse environmental consequences resulting from the proposed work. See the Economics Appendix for additional details on the EJ Analysis.

6.19 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

This EO ensures that all Federal actions address the unique vulnerabilities of children. In accordance with this EO, the USACE has determined that no children would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work.

6.20 Migratory Bird Treaty Act, 16 U.S.C. 703 *et seq.*; Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

This Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The USACE does not anticipate that migratory birds would be adversely (directly or indirectly) affected by the proposed action. For a detailed description of this assessment please see the USFWS Draft CAR (USFWS, 2017; Appendix G).

6.21 Executive Order 13783, Promoting Energy Independence and Economic Growth

This EO promotes clean and safe development of our Nation’s vast energy resources, while at the same time avoiding regulatory burdens that unnecessarily encumber energy production, constrain economic growth, and prevent job creation. Therefore, this EO is not applicable to this Civil Works project.

6.22 Environmental Commitments

The USACE commits to completing or implementing the following analyses prior to construction and ensuring the following environmental protection measures are implemented during construction:

Timing of Commitment	Title of Commitment	Description of Commitment
Pre-Construction Engineering and Design	Beneficial Use of Dredged Material	Continues evaluation of the feasibility for various beneficial use projects during PED and coordinated with the resource agencies. Options include all those identified in this Final IFR/EA, as well as new concepts that may arise
	Coral and SAV Surveys	Quantitative and qualitative surveys for listed hard coral species at the entrance to San Juan Harbor and for SAV along the army terminal channel flares will be conducted in PED to confirm the separation distances estimated in this IFR/EA are accurate.
Construction	Endangered Species	USACE will abide by the Terms and Conditions of the Biological Opinion(s) issued for the new work construction and the most up-to-date Regional Biological Opinion. USFWS Antillean Manatee conditions include: 1. The contractor shall instruct all personnel associated with construction of the presence of manatees and the need to avoid collisions with manatees. 2. All construction personnel will be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972. The contractor shall be held responsible for any manatee harmed, harassed, or killed as a result of construction of the project. 3. The project work area shall be surveyed for the presence of manatees at least one hour before any dredging starts and prior to the installation of any silt fence. If manatees are found before any in-water project activity starts, the contractor shall wait for the manatee to leave the area by itself and be at least 100 feet from the project in-water area. Manatees must not be herded or harassed into leaving the area. 4. Siltation barriers will be made of material in which manatee cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Barriers must not block manatee entry to or exit from essential habitat. 5. All vessels associated with the project construction will operate at “no-wake/idle” speed at all times while in water within manatee areas and vessels will follow routes of deep water whenever possible. 6. If manatees are seen within 100 yards (300 feet) of the in-water work area, all appropriate precautions shall be implemented to ensure protection of the manatees. These precautions shall include

		operating all equipment in such a manner that moving equipment does not come any closer than 50 to 100 feet of any manatee. If a manatee is within 50 feet of in-water work, all in-water activities must shut down, until manatee moves on its own at least 100 feet away from the in-water work area. Manatees must not be herded or harassed into leaving the area. 7. Any collision with and/or injury to a manatee shall be reported immediately to the Department of Natural and Environmental Resources Law Enforcement (787-724-5700) and the USFWS Caribbean Ecological Services Field Office (787-851-7297). 8. The contractor shall keep a log detailing sightings, collisions, or injury to manatees, which have occurred during the contract period. Following project completion, a report summarizing the above incidents and sightings will be submitted to the U.S. Fish and Wildlife Service, Caribbean Ecological Services Field Office, P.O. Box 491, Boquerón, Puerto Rico 00622. 9. The contractor shall install and maintain temporary manatee signs placed in a prominent location for maximum visibility. NMFS BO Conditions include: 1. Notification of take shall be provided to NMFS at the following email address within 24 hours, referencing the present Opinion by NMFS identifier number (SER-2017-18763), title, and date: takereport.nmfsser@noaa.gov and will cc Kelly.Logan@noaa.gov. 2. To prevent impingement of sea turtles in the water column, every effort shall be made to keep the dredge pumps disengaged when the dragheads are not firmly on the bottom. 3. USACE will require the use of rigid sea turtle deflectors on all hopper dragheads. The hopper dredge's sea turtle deflector draghead is to be inspected prior to startup of hopper dredging operations to ensure they are functioning properly. In addition, USACE shall ensure that all contracted personnel involved in operating hopper dredges receive thorough training on measures of dredge operation that will minimize sea turtle takes. 4. USACE shall arrange for NMFS-approved protected species observers to be aboard the hopper dredge to monitor the hopper bin, screening, and dragheads for sea turtles and their remains. For the proposed action, 100% shipboard observer monitoring of inflow screens is required year-round. If conditions disallow 100% inflow screening, inflow screening can be reduced gradually, but effective, 100% overflow screening is then required, and an explanation must be included in the project report, and NMFS notified beforehand. The hopper's inflow screens should initially have 4-in by 4-in screening, for effective screening and capture of entrained protected species body parts. However, if USACE, in consultation

		with observers and the draghead operator, determines that the draghead is clogging and reducing production substantially, the mesh size may be increased after prior consultation with and approval by NMFS, to 8-in by 8-in; if this still clogs, then 16-in by 16-in openings. NMFS believes that this flexible, graduated-screen option is prudent since the need to constantly clear the inflow screens will increase the time it takes to complete the project; therefore, it will increase the exposure of sea turtles to the risk of impingement or entrainment. Inflow screen clogging should be greatly reduced with these flexible options; however, further clogging (e.g., as when encountering heavy clay or debris) may compel removal of the inflow screening altogether, in which case effective 100% overflow screening is mandatory. USACE shall notify NMFS beforehand if inflow screening is going to be reduced or eliminated, and provide details of how effective overflow screening will be achieved. NMFS, in consultation with the dredging company and USACE, shall determine what constitutes effective overflow screening. The USACE will work in conjunction with the NMFS to develop a turbidity monitoring plan which will include turbidity monitoring stations adjacent to ESA-listed corals (if any are found during the pre-construction resource surveys) and at the edges of the DCH for elkhorn and staghorn corals. Turbidity in these locations must not exceed 7 NTUs above background as measured at the control locations positioned 200 meters upstream of the dredge. The monitoring plan will include adaptive management measures to be implemented to mitigate turbidity in the event that turbidity exceeds 7 NTUs above background at these locations. Adaptive management may include measures to correct disposal vessel leakage, reducing overflow, etc.
	Water Quality	USACE will abide by the conditions within the Section 401 WQC to be issued by EQB in PED.
	Fish and Wildlife Habitat	USACE will abide by the conservation recommendations outlined in the USFWS CAR, as practicable.
Pre-, during, and Post-construction	Monitoring	USACE will perform pre-, during, and post-construction monitoring as detailed in the Main Report.
	Adaptive Management	USACE will commit to coordinating adaptive management and corrective actions related to project impacts and monitoring results with resource agencies.

7.0 PUBLIC / AGENCY PARTICIPATION AND COMMENTING*

Study coordination efforts involve keeping the public, state, and Federal agencies informed of study progress and obtaining feedback. This study involved close coordination between the USACE, the PRPA, and the PREPA. The USACE is conducting the study, consolidating information from other agencies, formulating plans, and coordinating study findings. The USACE has encouraged participation of environmental resource agencies during the formulation of data gathering plans for sediment analysis and environmental resource evaluations. The harbor and docking pilots, the USCG, maritime interests, the sponsor, and the public have provided recommendations and will review potential measures to resolve navigation concerns in small groups and a public meeting. In addition to reviews by the public and other local, state, and Federal agencies, USACE requires quality control and agency technical reviews during the study process.

7.1 Authority

Public involvement during this study has been conducted in compliance with the following Federal laws and regulations:

- National Environmental Policy Act (NEPA) of 1969;
- U.S. Clean Water Act, Section 404(a);
- Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA, 40 CFR §1501.7 (Scoping) and 40 CFR §1506.6 (Public Involvement);
- 30 CFR Part 230 and ER 200-2-2;
- ER 1105-2-100

Federal agencies are required under NEPA to undertake an assessment of the environmental effects of their proposed actions prior to making decisions. Two major purposes of the environmental review process are better informed decisions and citizen involvement in weighing the effects of those decisions. There are three Federal agencies that have particular responsibilities for NEPA. Primary responsibility is vested in the CEQ, established by Congress as outlined in NEPA. The USEPA-Office of Federal Activities reviews environmental impact statements (EISs) and some EAs issued by Federal agencies. Another government entity that may become involved in NEPA is the U.S. Institute for Environmental Conflict Resolution, which was established by the Environmental Policy and Conflict Resolution Act of 1998 to assist in resolving conflict over environmental issues that involve Federal agencies.

In 1978, CEQ issued binding regulations directing agencies on the fundamental requirements necessary to fulfill their NEPA obligations. The CEQ regulations set forth minimum requirements for agencies. The CEQ regulations also called for agencies to create their own implementing procedures that supplement the minimum requirements based on each agency's specific mandates, obligations, and missions. In accordance with these regulations, the USACE put in place ER 2002-2 (30 CFR Part 230) specific to NEPA compliance, as well as ER 1105-2-100 to provide, among other things, specific internal guidance on a number of environmental compliance issues including NEPA.

7.2 Scoping and Public Meetings

As stated by CEQ regulations and guidance, there shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process is called scoping. The CEQ identifies the public that should be involved in the scoping process as affected Federal, state, and local agencies, the proponent of the action, and other interested persons (including those who might not be in accord with the action on environmental grounds).

In compliance with ER-200-2-2 and 40 CFR §1501.7, a Notice of Intent was published in the Federal Register (Vol. 80, No. 194, October 7, 2015) to advertise the intent of the USACE to prepare an EIS. NEPA scoping was an important part in the development of study objectives, identification of constraints and in determining the significant concerns of the public and agencies. In accordance with the NEPA, an information letter and planning charrette invitation was sent to resource agencies and special interest groups on October 1, 2015. Additionally, NEPA scoping meeting information was mailed to interested parties on October 1, 2015. A planning charrette with the resource agencies was held on November 4, 2015. The NEPA Scoping meeting was held on November 5, 2015, at Puerto Rico Convention Center, 100 Convention Blvd, San Juan, Puerto Rico. The purpose of the meeting was to solicit for views and comments regarding environmental and cultural resources, study objectives, and

other important features/concerns in the study area. The following list identifies the main issues generated and comments and concerns from stakeholders, which are discussed thoroughly within this IFR/EA:

Economics: The general public and agencies want to understand how the project would use updated economic data, including growth trends to evaluate alternatives.

Sea Level Change: Many citizens, stakeholder, and agencies were concerned about the impact of sea level rise cumulatively evaluated with the impacts of the project.

Sediment Quality and Placement: Must thoroughly review impacts related to sediment toxics and dredged material placement.

Fish and Wildlife Habitat: Many comments were related to ensuring that the project won't significantly impact threatened and endangered species as well as other fish and wildlife resources, including coral reef habitat.

Shoreline Erosion: The general public and agencies are concerned with existing erosion problems facing many areas in San Juan Harbor and how the proposed deepening may affect this issue. Some of these stakeholders have also requested that USACE place dredged material along certain shorelines to reduce the effects of erosion. This area includes Cataño shoreline.

Air Quality: The general public and agencies want to understand how the project would influence air quality in the region, including priority pollutants, toxics and greenhouse gases. Also of concern was the potential concentration of pollutants in certain areas and impacts to environmental justice communities.

Cultural Resources: The general public and agencies were concerned about impacts to cultural and historic resources, both in-water and land-side.

Written comments from Federal, state, and local governmental agencies, various private and non-profit organizations, and individuals are included in the Correspondence Appendix. Both of the meetings followed a similar format consisting of a brief presentation/remarks, followed by an informal poster session which provided stakeholders with opportunity to further discuss the study with the experts. The meetings were organized around three basic themes: Environmental, Engineering, and Economics. In addition, there were informative displays related to project schedule, process, and plan formulation processes. The meetings were advertised through the Federal Register, mailings, e-mailing, and on the study website. The administrative record generated from the NEPA scoping efforts discussed above indicates that the San Juan Harbor improvements is not likely to have a significant impact on the quality of the human environment; therefore, the project was evaluated in an EA as opposed to an EIS that was originally planned.

The Draft IFR/EA was released for public review in August 2017 for a 45-day public review period. A public meeting accompanying the release of the Draft IFR/EA was held in San Juan on August 22, 2017. The meeting was held in order to present the findings of the study and the Tentatively Selected Plan to interested members of the public. Appendix J contains a mailing list of participants.

Study presentations, reports, minutes to meetings, and other documents can be found at the following study website: http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-Branch/Environmental-Documents/.

7.3 Agency Coordination

Federal, state, and local agencies invited to attend meetings and to provide comments throughout the scoping and public involvement process included the USACE, USCG, USEPA, USFWS, NPS, and NMFS. State agencies included the Puerto Rico DNER, EQB, SHPO and Instituto de Cultura Puertorriqueña.

7.4 Environmental Operating Principles

The USACE Environmental Operating Principles (EOPs) have been taken into consideration throughout the study process, and will continue to be part of construction and operation of the proposed San Juan Harbor Improvements Project. Below are the USACE EOPs:

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all USACE 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 USACE, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

In coordination with the agencies and other stakeholders, the USACE proactively considered the environmental consequences of the proposed deepening project. Avoidance and minimization measures were evaluated, and monitoring and adaptive management will be provided to insure protection of natural resources (i.e., hardbottoms and submerged aquatic vegetation). In accordance with the mandate of this designation and the EOPs, the USACE has proposed a project that supports economic and environmentally sustainable solutions.

7.5 USACE Campaign Plan

USACE Vision: Engineering solutions for the Nation's toughest challenges.

USACE Mission: Deliver vital engineering solutions, in collaboration with partners, to secure our Nation, energize our economy, and reduce risk from disaster.

Commander's Intent: The USACE Campaign Plan (UCP) is our Agency's strategic change decision document. It is fully nested with the Army Campaign Plan and National Goals and Objectives. As such, it drives and aligns strategic change; anticipates and shapes our future operating and fiscal environments; unites all of USACE with a common vision, purpose, and direction; and responsively adapts to mission and "battle space" changes by:

1) Anticipating and responding to a resource-constrained, volatile, uncertain, complex, and ambiguous external environment;

2) Driving improvements in our processes for both DELIVERING THE PROGRAM (products, projects, and services for our stakeholders and partners) and STRENGTHENING THE FOUNDATION (those routine tasks needing to be done to an exceptionally high-standard, routinely); and

3) Driving us to ACHIEVE OUR VISION. Fundamentally, we DO what we measure and we ARE what we do. Over time, our behaviors become habits, and these habits become our culture. Since we cannot change everything at once, and to develop the best habits, we prioritize those highest pay-off behaviors for our success. As such, FY18 Priority Actions reflect our "best bet" to drive focused strategic change across the command, now and in the future.

Our four (4) Campaign Plan Goals define the strategic change we will achieve, stated in fourteen (14) words: "Support National Security", "Deliver Integrated Water Resource Solutions", "Reduce Disaster Risks", and "Prepare for Tomorrow".

The IFR/EA for this project is consistent with these themes. The vertical USACE project team jointly applied the latest policy and planning guidance and worked closely with Federal, state and local stakeholders and professionals familiar with the problems, opportunities and resources of San Juan Harbor to fully and fairly evaluate the feasibility of improving the port in an expeditious fashion to achieve the common goals of providing safe, effective, and efficient navigation while protecting the nation's environment. Extensive reviews requiring the timely cooperation of internal and external team members were performed to ensure quality and consistency.

8.0 LIST OF PREPARERS AND REVIEWERS*

The USACE for the study included not only USACE members but environmental resource agencies, USCG, San Juan Bay Pilots, maritime interests, PREPA, and PRPA. The team members listed below provided substantial text to the IFR/EA. Primary authors are marked with an asterisk.

Name (First Last)	Affiliation
Steve Conger*	Civil Engineer, Jacksonville District, USACE
Phil Sylvester	Hydraulic Engineer, Jacksonville District, USACE
Tony Ledford	Civil Engineer, Jacksonville District, USACE
Courtney Jackson*	Economist, Jacksonville District, USACE
Christopher Bukolt	Real Estate, Jacksonville District, USACE
Paul DeMarco*	Biologist, Jacksonville District, USACE
Carla Roig-Silva	Geologist, Jacksonville District, USACE
Jessamyn Fluitt	Civil Engineer – Geotechnical, Jacksonville District
Meredith Moreno	Archeologist, Jacksonville District, USACE
Patrice Morey	Planning Division, Jacksonville District, USACE
Javier Cortes	Environmental Engineer, Jacksonville District, USACE
Dick Powell*	Civil Engineer, Jacksonville District, USACE
Ashleigh Fountain*	Biologist, Jacksonville District, USACE
Terri Jordan-Sellers	Biologist, Jacksonville District, USACE

9.0 RECOMMENDATIONS

I concur with the findings presented in this report. The Recommended Plan developed is technically sound, economically justified, and socially and environmentally acceptable.

There are portions of the work proposed that are not within the existing authority. I recommend that the Recommended Plan selected herein, with such further modifications thereto at the discretion of the Chief of Engineers, as advisable, be authorized by Congress for implementation. Evaluation of existing surveys and benthic surveys conducted by NMFS HCD and the USACE, the deepening and widening measures along the Army Terminal Channel would not result in direct impacts to SAV. The closest previously mapped hardbottom habitat (colonized pavement) is 1,500 feet from the closest dredge area (Cut-6) and Acroporid coral DCH is approximately 2,500 feet North of Cut-6. Therefore, impacts to listed corals from dredging and dredged material transport related turbidity are not anticipated and no compensatory mitigation is required. Aids to navigation would be provided at a 100% Federal cost. Absent sufficient USCG funding, or adequate justification for the navigation aids, non-Federal interests may be required to provide them.[7]

For the purpose of calculating the Section 902 limit, the estimated project first cost is $54,042,000, October 1, 2017 price level, with an estimated Federal share of approximately $40,500,000 and an estimated non-Federal share of approximately $13,500,000, which does not include the local service facilities investment of approximately $350,000,000 for the LNG conversion. The AAEQ costs for the Recommended Plan are $15,172,000 with the LNG conversion and $2,281,000 without the LNG conversion. The AAEQ benefits of the Recommended Plan range from $4,322,000 without the LNG conversion to $75,269,000 with the LNG conversion and has a BCR that ranges from 1.9 (without the LNG conversion) to 5.0 (with the LNG conversion).

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 USCG.

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 25% of the cost of design and construction of the general navigation features (GNFs) attributable to dredging to a depth in excess of -20 feet MLLW but not in excess of -50 feet MLLW, plus;

b. Provide all lands, easements, and rights-of-way including those necessary for the borrowing of material and the placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal Government to be necessary for the construction or operation and maintenance of the GNFs;

[7] Planning Guidance Notebook, ER 1105-2-100, E-8 a.(2)

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% of the total cost of construction of the National Economic Development (NED) Plan GNFs less the amount of credit afforded by the Federal Government for the value of all lands, easements, rights-of-way, and relocations (LERRs), including utility relocations, provided by the non-Federal sponsor for the GNFs. If the amount of credit afforded by the Federal Government for the value of LERRs, including utility relocations, provided by the non-Federal sponsor equals or exceeds 10% 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 LERRs, including utility relocations, in excess of 10% of the total cost 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 Federal Government;

e. Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

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

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

h. 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;

i. 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 are 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 §33.20;

j. 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 U.S.C. §§9601–9675, that may exist in, on, or under LERR and placement areas 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 investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

k. 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 LERR and placement areas that the Federal Government determines to be necessary for the construction or operation and maintenance of the project;

l. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

m. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. §1962d-5b) and Section 101(e) of the WRDA 1986, Public Law 99-662, as amended, (33 U.S.C. §2211(e)) which provide 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;

n. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. §§4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the beneficial use 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;

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

p. 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% of the total amount authorized to be appropriated for the project;

q. 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 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.

Additionally, the Regional Sediment Management (RSM) option discussed in this report for the beneficial use of dredged material in Condado Lagoon may be addressed in the future if there is adequate Federal funding and authority to do so, and if a non-Federal sponsor is identified to implement this option and timely execute a cost-sharing agreement during the period of design and construction to cost-share in the beneficial use of dredged material.

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

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District Commander

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