Integrated Feasibility Report and
Environmental Impact Statement

DRAFT

New Haven Harbor
Navigation Improvement Project
Connecticut

US Army Corps
of Engineers®
New England District

September 2018

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NEW HAVEN HARBOR
CONNECTICUT

NAVIGATION IMPROVEMENT PROJECT

DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SEPTEMBER 2018

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Executive Summary

The purpose of this Feasibility Study is to determine if improvements to the existing Federal navigation project at New Haven Harbor, Connecticut are warranted and in the Federal interest and if necessary, recommend Federal participation in implementing improvements. Figure ES-1 shows the harbor and the features of the Federal Navigation project. The New Haven Port Authority and Connecticut Port Authority requested the study. Legislative authority for the study of New Haven Harbor, Connecticut, is contained in a resolution by the United States Senate Committee on the Environment and Public Works dated 31 July 2007.

> "*Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army is requested to review the report of the Chief of Engineers on New Haven Harbor, Connecticut, published as House Document 517, 79th Congress, 2nd Session, and other pertinent reports, to determine whether modifications to the recommendations contained therein are advisable in the interest of navigation, sediment control, environmental restoration and preservation, and other related purposes at New Haven Harbor, Connecticut.*"

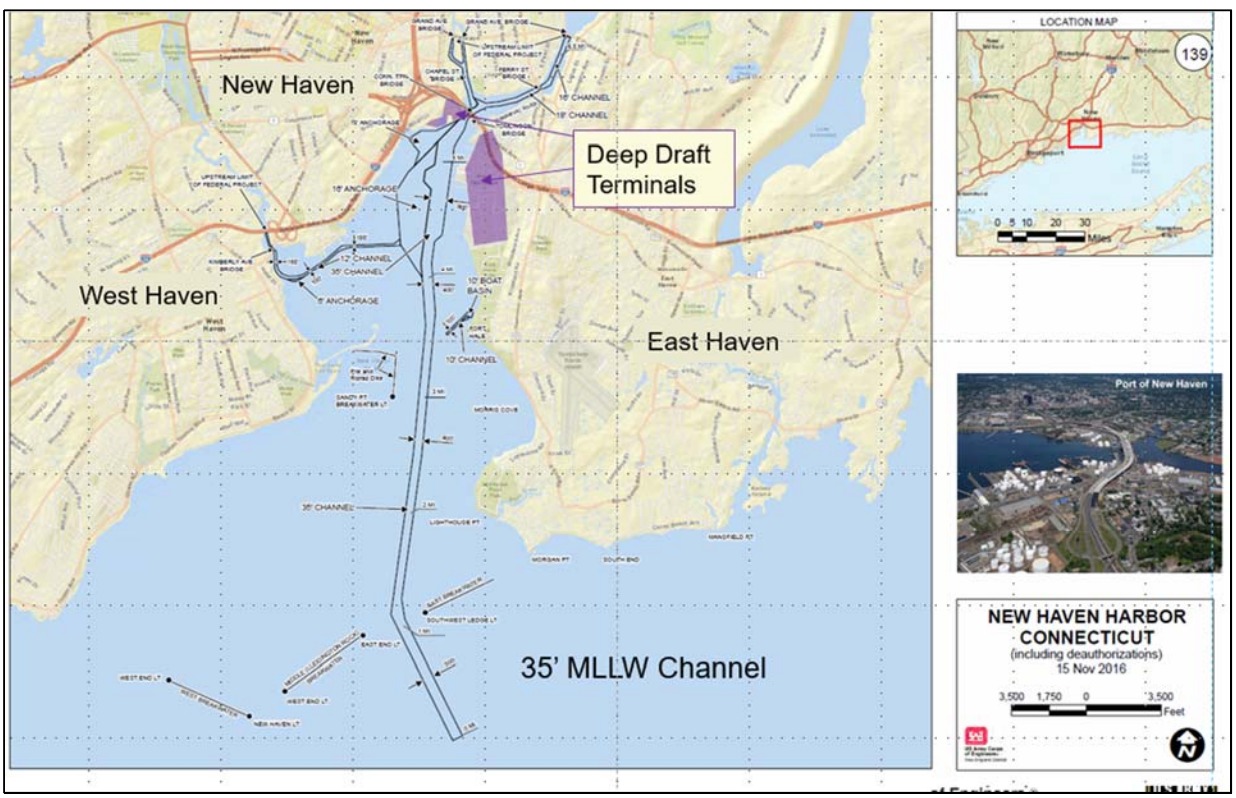

Figure ES-1: New Haven Harbor Federal Navigation Project

DESCRIPTION OF REPORT

This document is an integrated Feasibility Report and Environmental Impact Statement (FR/EIS). The purpose of the Feasibility Report is to develop alternatives to address navigation problems and opportunities, evaluate those alternatives, and identify the improvement project that reasonably maximizes the national economic development benefits, is technically feasible, and environmentally sustainable. The integrated FR/EIS complies with NEPA requirements to identify and analyze the environmental effects of the alternatives, incorporate environmental concerns into the decision-making process, and to evaluate any environmental impacts of the tentatively selected plan (TSP).

This report provides documentation of the plan formulation process to identify, formulate, evaluate, and screen potential alternatives for channel deepening and other related improvements, along with the environmental, engineering, and cost details of the TSP.

The existing authorized Federal Navigation Project for New Haven Harbor includes the deep draft ship channel, turning basin, and maneuvering area authorized at a depth of -35 feet at mean lower low water (MLLW), three shallow draft channels, several anchorages, three breakwaters, and a training dike. While the project area includes multiple navigation features, this assessment focuses on the deep draft ship channel, turning basin, and maneuvering area, as these are the features identified by the Non-Federal Sponsors and harbor users as in need of improvements.

PURPOSE AND NEED

The purpose of the proposed Federal action (i.e. the navigation improvement project) is to improve navigation safety and efficiency for existing and prospective commerce. The deep draft ships using the port now and in the future are expected to achieve transportation cost savings (increased economic efficiencies) for the improvements.

Pilots, shippers, and terminal owners have identified navigational challenges in New Haven Harbor, as authorized depths do not meet the draft requirements of today's fleet of dry bulk, break-bulk, and tank ships. Tide restrictions, light loading, and lightering operations necessitated by inadequate channel depth result in economic inefficiencies that translate into costs for the national economy.

In terms of total tonnage shipped and received, the Port of New Haven was the largest port in Connecticut and the second largest port in New England in 2016, ranking only behind the port of

Boston. In 2016, its total freight traffic of 8.8 million tons represented about 24 percent of all waterborne commerce in New England and about 81 percent of all waterborne commerce in Connecticut.

Commodities received at the port include petroleum and petroleum products and various dry bulk and break-bulk commodities. Petroleum products imports have historically constituted approximately 80 percent of the channel tonnage. Salt, sand, and cement imports are the dominant bulk cargoes and virtually all volumes are for immediate local use. Scrap metal is Connecticut's largest single export commodity by weight.

The Port of New Haven serves a hinterland including the greater New Haven region, the state of Connecticut, and much of the American Northeast. The port is a crucial import location for refined petroleum products, which supplies demand within Connecticut and the broader Northeast region. The Northeast maintains a large refinery production/demand deficit and must rely heavily on imported volumes of petroleum products in order to meet demand. The majority of the landside acreage at the Port of New Haven is devoted to energy-related uses. This represents a long-term land use and economic asset for the economy of the State of Connecticut.

TENTATIVELY SELECTED PLAN

Navigation improvement alternatives evaluated included project depths from 37 to 42 feet. Additional channel width and turning area width were also included in the design to accommodate today's larger ships. The average annual equivalent cost and benefits for each plan were evaluated and the National Economic Development (NED) plan; i.e. the plan that reasonably maximizes net annual benefits was identified. Net annual benefits of an improvement plan are equal to its annual benefits minus its annual costs. The result of this evaluation identified the 40-foot depth plan as the NED plan and this plan is the Tentatively Selected Plan (TSP). The other navigation improvement alternatives considered also contribute to the national economy but to a lesser extent. The TSP will deepen the existing Federal main ship channel, turning basin, and maneuvering area from a depth of -35 to -40 feet MLLW. The study also considered various placement options for the dredged material and identified the Federal Base Plan (least cost disposal option) and a Beneficial Use (BU) plan. The BU plan would employ some of the dredged material to create a salt marsh at Sandy Point in West Haven.

Following selection of the 40-foot depth plan, a ship simulation study was conducted by the USACE Engineer Research and Development Center, Coastal and Hydraulics Laboratory. This confirmed the selected channel widths and advised additional bend widening to improve maneuverability through the breakwaters at the entrance to the harbor. The TSP includes widening the existing channel by 100 feet (to 600 feet in the entrance outside the breakwaters and to 500 feet inside the harbor), widening the turning basin 200 feet to the north, and widening the channel bend near the East Breakwater from 560 feet to 800 feet.

The TSP refined design involves dredging about 4.28 million cubic yards (cy) of ordinary improvement material and removing 43,500 cy of rock.

Table ES-1: Dredged Material Quantity Estimates, TSP, Refined Design

General Navigation Features (GNF) for the TSP, 40-FT Plan, Refined Design	**Dredging Quantities (CY)**		
	Cut to Design Depth	2-Foot Overdepth	Total CY
Entrance Channel	278,300	240,000	518,300
Bend (Ordinary Material)	475,300	161,300	636,600
Interior Channel	1,537,400	776,000	2,313,400
Maneuvering Area	377,700	274,600	652,300
Turning Basin	117,900	40,200	158,100
Total Improvement Dredging - Ordinary Material	2,786,600	1,492,100	4,278,700
Bend (Rock) (Required Cut to El -42 Feet)	24,900	18,600	43,500
All Improvement Material	2,811,500	1,510,700	4,322,200

Dredged material removed from the project would transported by dump scow and placed at several open water sites. Sites included in the Federal Base Plan are:

- Morris Cove Borrow Pit
- Oyster Habitat Creation site at the East Breakwater
- West River Borrow Pit
- Rock placement site at West Breakwater (rock reef habitat creation)
- Open Water Placement at Central Long Island Sound Disposal Site[1] (CLDS) with targeted placement to cover historic disposal mounds
- Potential CAD cell (if needed)

The BU plan, in addition to the above placement sites, utilizes the dredged material to create a salt marsh at Sandy Point Dike. This involves added costs of mobilizing a hydraulic dredge plant, creating a containment perimeter at the placement site, and managing placement and

[1] CLDS an open water dredged material disposal site designated by the Environmental Protection Agency under Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA)

development of salt marsh. For the salt marsh creation site the Non-Federal sponsor must acquire a temporary work area easement for 2 years (access, staging, mobilization) (0.24+/- acre) and permanent road easement (3.77+/-acres). This land is owned by the City of West Haven. The Non-Federal sponsor will be required to furnish the easements.

The material proposed to be dredged from the harbor is composed of mainly silt and clays with some fine sand in the entrance channel. Most of the material has been determined to be suitable for unconfined open water placement (see Suitability Determination Appendix J). However, there is about 13 percent of the material near the turning basin that requires further testing to determine suitability of the material for open water placement. Supplemental sampling and testing will be conducted in Fall 2018 and results will be coordinated with EPA and CTDEEP to determine suitability for open water placement. Material unsuitable for open water placement would be disposed of in a confined aquatic disposal (CAD) cell constructed in New Haven Harbor near the ship channel. Construction costs for the Federal Base Plan and the BU plan are provided in the table below.

Table ES-2: Project First Cost Summary

Project First Cost Summary TSP (40-FT Plan, Refined Design) (Oct. 2018 price level)		
Cost Account and Feature	Federal Base Plan ($)	Beneficial Use Plan - Salt Marsh Creation ($)
12 Navigation Ports and Harbors		
Mobilization/Demobilization	3,236,000	5,920,000
Entrance Channel	6,513,000	6,568,000
Bend (Ordinary)	4,781,000	4,822,000
Bend (Rock)	19,668,000	19,832,000
Interior	18,585,000	19,601,000
Maneuvering area	5,904,000	5,954,000
Turning Basin	1,130,000	1,140,000
Total	59,817,000	63,837,000
01 Lands and Damages	0	160,000
30 Planning, Engineering and Design	3,044,000	3,372,000
31 Construction Management	3,044,000	3,248,000
Project First Cost	**65,905,000**	**70,617,000**

For the economic analysis, project first costs plus investments related to the project are annualized over a 50-year period of analysis for comparison to the project economic benefits. Benefits are calculated based on transportation cost savings through increased use of larger vessels, delay reductions, and decreased lightering. The net benefits for the TSP Federal Base Plan are $2,634,000. The project is economically justified with a BCR of 1.6.

Table ES-3: Annual Cost and Benefits

NEW HAVEN HARBOR, CONNECTICUT **Average Annual Equivalent (AAEQ) Benefits and Costs**** **TSP (40-FT Plan, Refined Design)** **FEDERAL BASE PLAN** **(October 2018 price level, 50-year Period of Analysis, 2.75 %)**	
Project Improvement Investment Cost	
GNF, Project Construction First Cost	$65,905,000
Lands, Easements, Rights of Way, and Relocations (LERR)	none
New Aids to Navigation	none
Cable Enforcement Action Cost	$32,648,000
Total	$98,553,000
Interest During Construction	$2,744,000
Local Service Facilities (LSF), Berth Deepening Cost	$2,000,000
Total Investment Cost	$103,297,000
AAEQ Investment Cost	3,826,000
Annual Increased Maintenance Dredging	$510,000
Total AAEQ Cost	$4,336,000
Total AAEQ Cost	$4,336,000
AAEQ Benefits	$6,970,000
Net AAEQ Benefits	**$2,634,000**
Benefit-Cost Ratio (BCR)	**1.6**
** Note: Numbers may be adjusted as a result of public, agency, and USACE reviews and further analysis of costs and benefits.	

Table ES-4 provides a summary of the allocation of Federal and Non-Federal Costs for the TSP.

Table ES-4: Federal and Non-Federal Costs

New Haven Harbor Navigation Improvement Project TSP (40-FT Plan, Refined Design) Federal and Non-Federal Cost (October 2018 Price Level)			
Item	**Federal Cost**	**Non-Federal Cost**	**Total Cost**
General Navigation Feature (GNF) 75% Federal/ 25% Non-Federal			
Construction	$44,863,000	$14,954,000	$59,817,000
Planning, Engineering and Design (PED)	$2,283,000	$761,000	$3,044,000
Construction Management	$2,283,000	$761,000	$3,044,000
GNF, Construction Cost	$49,429,000	$16,476,000	$65,905,000
LERR	$-	$-	$-
Total GNF - Project First Costs	$49,429,000	$16,476,000	$65,905,000
Beneficial Use (BU) Incremental Cost (Salt Marsh) 65% Federal / 35% Non-Federal			
Construction	$2,613,000	$1,407,000	$4,020,000
PED	$213,000	$115,000	$328,000
Construction Management	$133,000	$71,000	$204,000
LERR	$-	$160,000	$160,000
Total BU - Incremental Cost	$2,959,000	$1,753,000	$4,712,000
Total Project First Costs - GNF and BU	**$52,388,000**	**$18,229,000**	**$70,617,000**
Other Items			
Non-Federal Sponsor, Additional 10% Payment	$-	$6,590,500	$-
Aids to Navigation - 100% Federal – US Coast Guard	$-	$-	$-
Local Service Facilities - Port Berthing Areas 100% Non-Federal	$-	$2,000,000	$2,000,000
Cable Enforcement Action (Permit Compliance) 100% Non-Federal (CSC LLC)	$-	$32,648,000	$32,648,000

The Non-Federal cost share would be 25 percent of the cost of design and construction of the general navigation features including any necessary disposal facilities, payable at the beginning of the design and construction phases. Once construction is completed, the Non-Federal sponsor would be required to pay an additional 10 percent of the cost of design and construction of the general navigation features and disposal facilities over a period not to exceed 30 years. The Federal government will be responsible for 100 percent of future navigation project maintenance. For the beneficial use increment that exceeds the Federal Base Plan, the Non-Federal cost share is 35 percent. The terminal owners would be responsible for the cost of berth deepening. Cross Sound Cable LLC (CSC) would be responsible for the cost of bringing the cable into compliance with the USACE permit.

The TSP is supported by the Non-Federal sponsors for the project, the New Haven Port Authority and the Connecticut Port Authority. The sponsors are willing to pay above the Base Plan for the salt marsh creation beneficial use.

The possible environmental consequences of the TSP are considered in terms of probable environmental, social, and economic factors. Coordination with Federal and State Resource Protection Agencies including USFWS, NMFS, EPA, USCG, CTDEEP, CT SHPO, and NYDOS is on-going and coordination will be completed with these agencies in compliance with all applicable regulations. Avoidance and minimization measures were incorporated in development of the project. There would be no significant impacts anticipated to benthic or fish and wildlife resources, or water quality. All impacts are anticipated to be temporary and minor in nature. No cultural resources impacts are anticipated during project implementation.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the State of Connecticut, the Non-Federal sponsor (the Connecticut Port Authority and New Haven Port Authority), 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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LIST OF ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
AEP	Annual exceedance probability
AVS	acid-volatile sulfide
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAD	confined aquatic disposal
CBG	Census Block Group
CBRA	Coastal Barrier Resources Act
CDF	contained disposal facility
CEQ	Council on Environmental Quality
CGS	Connecticut General Statutes
CLDS	Central Long Island Sound Disposal Site
cm	centimeter
CO	carbon monoxide
CSO	combined sewer overflow
CT DOT	Connecticut Department of Transportation
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDPH	Connecticut Department of Public Health
CWA	Clean Water Act
cy	cubic yard
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
dB	decibel
dBA	A-weighted decibel
dCO2	dissolved carbon dioxide
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenylchloroethylene
DDT	dichlorodiphenyltrichloroethane
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DMMP	Dredged Material Management Plan
DO	dissolved oxygen
dw	dry weight
EFH	essential fish habitat
EJ	environmental justice
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Engineer Regulation

ERDC	Engineer Research and Development Center
ERL	Effects Range-Low
ERM	Effects Range-Median
ESA	Endangered Species Act
FDA	U.S. Food and Drug Administration
FHWA	Federal Highway Administration
FNP	Federal Navigation Project
FVP	Field Verification Program
FY	fiscal year
g	gram
g/m2/yr	grams per square meter per year
GC	General Conformity
H2S	hydrogen sulfide
HAB	harmful algal bloom
HAP	hazardous air pollutant
HARS	Historic Area Remediation Site
HEPA	high-efficiency particulate air
Hz	Hertz
IFREIS	Integrated Feasibility Report and Environmental Impact Statement
KHz	Kilohertz
L10	noise level exceeded for 10% of a period of time
Leq	equivalent continuous sound level
Ldn	day-night average sound level
lb	pound
LC	lethal concentration
LSF	local service facility
m	meter
MCDA	Multi-Criteria Decision Analysis
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mi	mile
MLLW	mean lower low water
MLW	mean low water
MMPA	Marine Mammal Protection Act
MPA	marine protected area
MPRSA	Marine Protection, Research, and Sanctuaries Act
NAAQS	National Ambient Air Quality Standards
NAD	North Atlantic Division (USACE)
NAE	New England District (USACE)

NBSP	National Benthic Surveillance Program
NCA	National Coastal Assessment
NDC	Navigation Data Center
NEPA	National Environmental Policy Act
NERDT	New England Regional Dredging Team
ng/g	nanograms/gm
NLDS	New London Disposal Site
NMFS	National Marine Fisheries Service
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOx	oxides of nitrogen
NR/SR	National Register/State Register
NWR	national wildlife refuge
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSOA	New York State Ornithological Association
OBS	optical backscatter
ODMDS	offshore dredged material disposal sites
OLISP	Office of Long Island Sound Programs
Pa	pascal
PAHs	polycyclic aromatic hydrocarbons
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PEG	polyethylene glycol
PM	particulate matter
PM2.5	particulate matter less than 2.5 microns in diameter
PM10	particulate matter less than 10 microns in diameter
PMP	Project Management Plan
PON	particulate organic nitrogen
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
psi	pounds per square inch
QC	Quality Control
RAT	Regional Air Team
RCRA	Resource Conservation and Recovery Act
REMOTS	Remote Ecological Monitoring of the Seafloor
RPD	redox potential discontinuity
RSLC	relative sea level change
SAV	submerged aquatic vegetation

SHPO	State Historic Preservation Office
SIP	state implementation plan
SMMP	Site Management and Monitoring Plan
SO2	sulfur dioxide
SPI	sediment profile imagery
SQG	sediment quality guideline
SQT	Sediment Quality Triad
SQUID	Sediment Quality Information Database
SVOC	semi-volatile organic compound
TMDL	Total Maximum Daily Load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TPH	total petroleum hydrocarbon
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
VTR	vessel trip report
WLDS	Western Long Island Sound Disposal Site
WQC	water quality certification
WRDA	Water Resources Development Act
ww	wet weight
WWTP	wastewater treatment plant
yd	yard
yr	year

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1.0 STUDY INFORMATION

1.1 Introduction

This Draft New Haven Harbor, Connecticut, Navigation Improvement Project, Integrated Feasibility Report and Environmental Impact Statement (EIS) documents the USACE study planning and decision process for recommended channel improvements at New Haven Harbor and documents compliance with the National Environmental Policy Act (NEPA) in the planning process.

New Haven is Connecticut's largest seaport and is located on the northern shore of Long Island Sound on the central Connecticut coast. The existing Federal navigation project (FNP) was adopted by the Act of 1852 and modified by the Acts of 1870, 1871, 1873, 1875, 1878, 1879, 1882, 1890, 1899, 1902, 1905, 1907, 1910, 1912, 1913, 1930, 1935, 1945, 1946, 1949, 1955, and 1986. The existing project, as completed in 1950, consists of (1) a 35-foot main channel, 400 to 500 feet wide, widened to 800 feet along the wharves to form a maneuvering basin, (2) a 16-foot by 134-acre anchorage in the upper harbor west of the main channel, (3) a pile and stone dike extending easterly from Sandy Point, (4) 18 and 16-foot channels in the Quinnipiac River, (5) a 12-foot channel in the Mill River, and (6) a 12-foot channel and 6-foot anchorage in the West River. The Mill and Quinnipiac River project segments were last maintained in 1982 and the West River in 1989. The project also includes three offshore stone breakwaters totaling about 12,100 feet long providing a refuge in the outer harbor. The list of project authorization and construction history is included in Appendix B.

The focus of this study is the main ship channel, maneuvering area, and turning basin as these are the places requiring improvements to efficiently accommodate today's larger deep-draft ships. These areas were last dredged in 2014 to remove shoals and restore the project to the authorized depth. This type of routine maintenance occurs about every 10 years at 100 percent Federal government expense. Routine maintenance and implementation of required improvements by the Federal government and its partners ensures the harbor waterway network is available and capable of providing important marine transportation services to the nation.

1.2 Congressional Districts

The New Haven Harbor FNP is in the 3rd Congressional District represented by Senators Blumenthal (CT) and Murphy (CT); and Representative DeLauro (CT).

1.3 Study Authority

Legislative authority for the study of the New Haven Harbor, Connecticut, is provided by the United States Senate Committee on the Environment and Public Works resolution of 31 July 2007.

> "*Resolved by the Committee on Environment and Public Works of the United States Senate, that the Secretary of the Army is requested to review the report of the Chief of Engineers on New Haven Harbor, Connecticut, published as House Document 517, 79th Congress, 2nd Session, and other pertinent reports, to determine whether modifications to the recommendations contained therein are advisable in the interest of navigation, sediment control, environmental restoration and preservation, and other related purposes at New Haven Harbor, Connecticut.*"

1.4 Non-Federal Sponsorship

The New Haven Port Authority (NHPA) is the study's Non-Federal sponsor in partnership with the Connecticut Port Authority (CPA). The NHPA and USACE executed a feasibility cost sharing agreement (FCSA) on December 4, 2015 for the study.

NHPA is a public authority created by the City of New Haven, Board of Alderman in 2003 in accordance with the General Statutes of the State of Connecticut CGS Sec. 7-329a. The purpose of the NHPA is to stimulate the shipment of freight and commerce through New Haven's port, to develop and promote the facilities within the port district and thereby to create jobs and increase the tax base of the city, to work with the city in maximizing the usefulness of available public funding by consolidating and coordinating efforts to assist the waterfront of the city and to cooperate with the state and federal agencies in connection with the maintenance, development, improvement, and use of the facilities within the port district.

The Connecticut Port Authority is a quasi-public authority created by Connecticut Public Act 14-222 and began operation in October 2015. CPA is responsible to coordinate port development with a focus on private and public investments, pursue federal and state funds for dredging and other infrastructure improvements to increase cargo movement through Connecticut ports, operate and manage state port facilities, market the advantages of such ports to the domestic and international shipping industry, coordinate the planning and funding of capital projects promoting the development of the state's ports, and develop strategic entrepreneurial initiatives that may be available to the state.

1.5 Cooperating Agencies

The lead Federal agency is USACE. Cooperating agencies for this project are the National Marine Fisheries Service (NMFS), Environmental Protection Agency Region 1 (EPA), US Coast Guard (USCG), CT Department of Energy & Environmental Protection (CTDEEP), CT State Historic Preservation Office (SHPO), and the Mohegan Tribal Historic Preservation Office.

1.6 Purpose and Need for Improvement Project

The purpose of the proposed Federal action (i.e. the navigation improvement project) is to improve navigation into and out of the port for the deep draft ships using the port now and in the future and to achieve transportation cost savings (increased economic efficiencies).

Navigational challenges have been identified in New Haven Harbor by pilots, shippers and terminal owners, as authorized depths do not meet the draft requirements of today's fleet of bulk and tanker ships. Tide restrictions, light loading, and other operational inefficiencies created by inadequate channel depth result in economic inefficiencies that translate into costs for the national economy.

The main ship channel and turning basin have inadequate channel depths. To reach the terminals, large ships must lighter outside the breakwaters, or be light-loaded at their port of origin, and/or experience delays while waiting for favorable tide conditions, or some combination of all three. Deeper and wider navigation features (main channel, maneuvering area, and turning basin) are needed to increase the navigation efficiency and safety of New Haven Harbor. The economic analysis is anticipated to demonstrate NED benefits; e.g. reduced navigation cost with an improvement project.

Improvements to the Quinnipiac River Channel, Mill River Channel and West River Channel are not included in the improvement study. For the Quinnipiac and Mill River Channels current authorized depths are reported by users to be adequate for existing and future barge and recreation marine traffic that utilize the waterways.

1.7 Feasibility Study and EIS Purpose

This integrated document serves as the USACE decision document supporting the recommended navigation improvement project and as the EIS to meet NEPA requirements for the proposed action. The analysis conducted during the Feasibility Study determines if improvements to the constructed Federal navigation project at New Haven Harbor, Connecticut are warranted and necessary and if necessary, recommend improvements.

The NEPA Council on Environmental Quality (CEQ) Regulation, Section 1502.13, provides the fundamental legal guidance on Purpose and Need statements for an EIS. The Purpose and Need statement, "shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." This step in the NEPA process mirrors a similar step in the USACE 6-step planning process, development of problems and opportunities statements. Once the problems and opportunities are properly defined, the next step is to define the study planning objectives and the constraints that will guide efforts to solve these problems and achieve these opportunities. In developing a feasibility report with integrated NEPA components, the problem and opportunities can be used synonymously with "need" and objective and constraints can be used synonymously with "purpose".

1.8 Harbor Location and Study Area

New Haven Harbor, Connecticut, is centrally located on the north shore of Long Island Sound, about mid-way between the cities of New York and Providence, Rhode Island. See Figure 1-1.

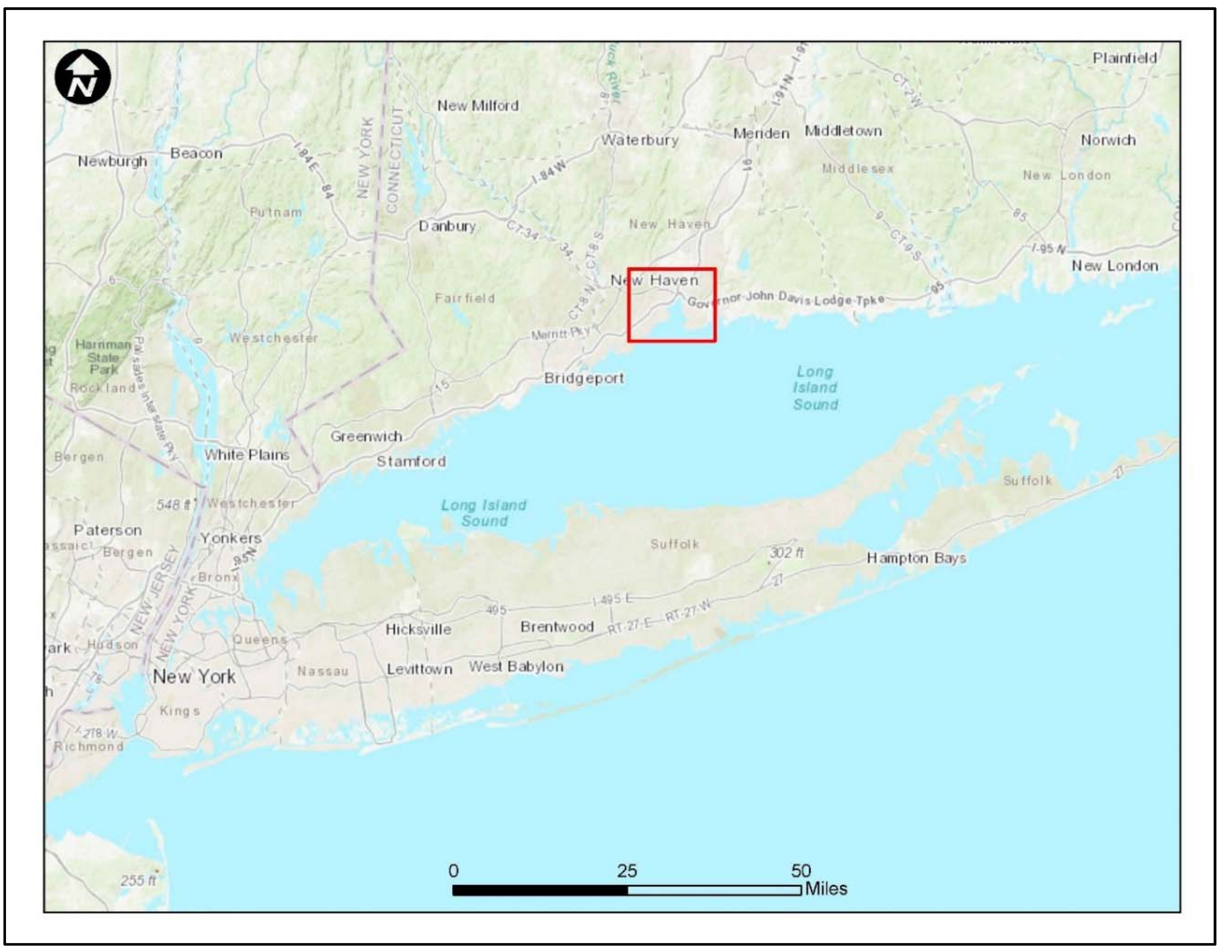


Figure 1-1: Location of New Haven Harbor, CT

The study area includes New Haven Harbor, Long Island Sound, and the Port service area. The Port of New Haven serves a hinterland including the greater New Haven region, the state of Connecticut, and much of the American Northeast. The port is a crucial import location for refined petroleum products, which supplies demand within Connecticut and the broader Northeast region. The Northeast maintains a large refinery production/demand deficit and must rely heavily on imported volumes of petroleum products in order to meet demand. The majority of the landside acreage at the Port of New Haven is devoted to energy-related uses. This represents a long-term land use and economic asset for the economy of the State of Connecticut.

In terms of total tonnage shipped and received, the Port of New Haven was the largest port in Connecticut and was the second largest port in New England in 2016, ranking only behind the port of Boston. In 2016, its total freight traffic of 8.8 million tons represented about 24 percent of all waterborne commerce in New England and about 81 percent of all waterborne commerce in Connecticut.

Commodities received at the port include petroleum and petroleum products and various dry bulk and break-bulk commodities. Petroleum products imports have historically constituted approximately 80 percent of the channel tonnage. Salt, sand, and cement imports are the dominant bulk cargoes and virtually all volumes are for immediate local use. Scrap metal is Connecticut's largest single export commodity by weight.

See Figure 1-2 that provides a view of a potion of the terminals.

Figure 1-2: View of Terminals

1.9 Existing Federal Navigation Project

Figure 1-3 shows the Federal navigation project and the authorized and constructed dimensions of the project are listed below. The main ship channel extends from deepwater in Long Island Sound through the harbor breakwaters to the head of New Haven Harbor. Throughout the history of the project, several improvements were made to the project to keep pace with changes in the commercial shipping industry. See Appendix B. The last improvement to the deep draft commercial shipping channel was completed in 1950. After approximately 70 years, improvements are now needed to meet existing use.

The entrance channel width in Long Island Sound is 500 feet and widens to 560 feet at the bend between the breakwaters. The channel width is 400 feet from the bend north past Fort Hale and Sandy Point, where it widens again to 500 feet. In the vicinity of the Port of New Haven, the channel and maneuvering area are 800 feet wide. The project also includes a 35-foot deep, trapezoidal-shaped turning basin west of the main channel across from New Haven Terminal.

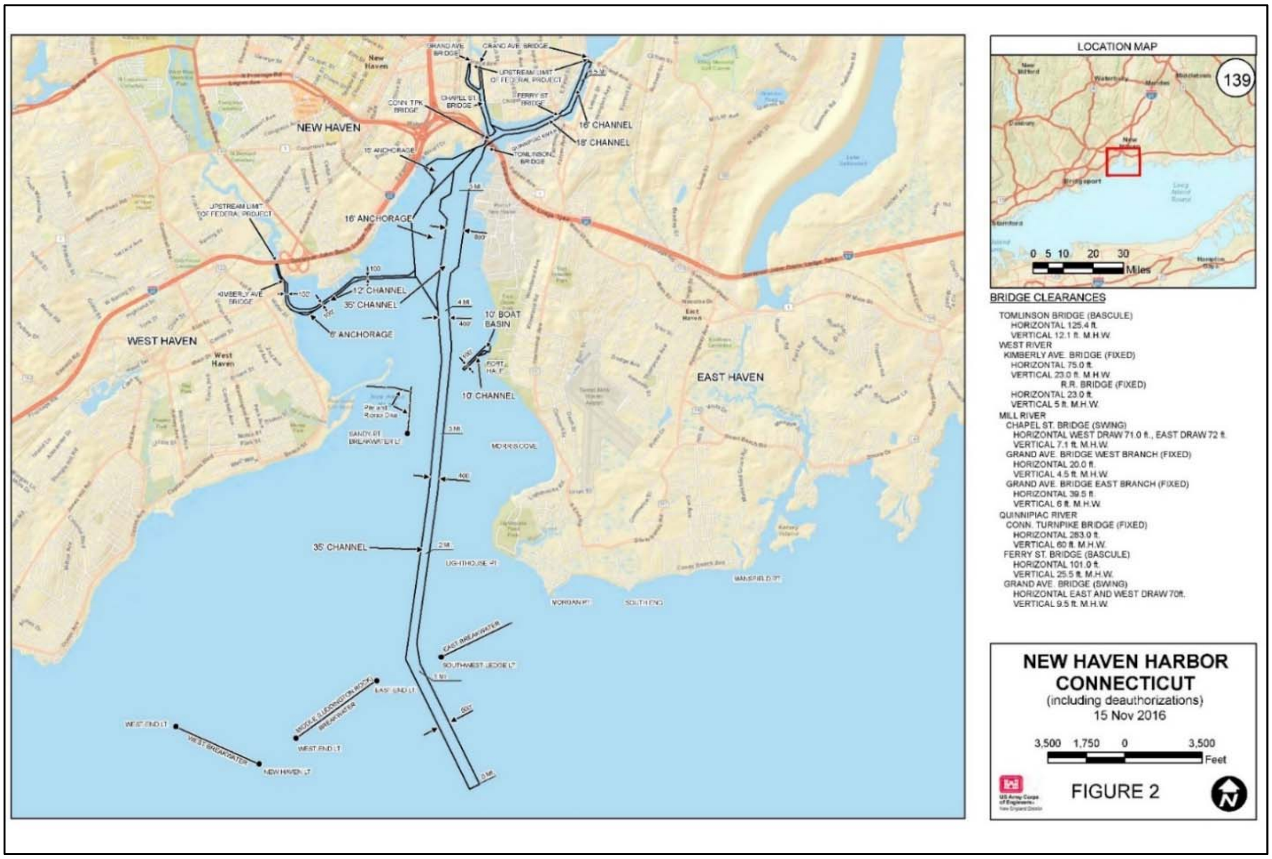


Figure 1-3: Existing Federal Navigation Channel

<u>Navigation Features of the Existing Federal Navigation Project</u>

- A main ship channel, -35 feet MLLW, extending about 5 miles from deep water in Long Island Sound to the head of the harbor at the mouth of the Quinnipiac River, varying in width from 500 feet (outer-harbor) to 400 feet (inner-harbor), and widened to 800 feet along the upper harbor terminals to provide a maneuvering area;
- A turning basin in the upper harbor west of the channel also at -35 feet MLLW;
- Two anchorages west of the main channel, at -15 and -16 feet MLLW;
- The Quinnipiac River Channel, at -18 feet MLLW (lower channel) and -16 feet MLLW (upper channel), and generally 200 feet wide;
- The Mill River Channel, at -12 feet MLLW, 200 feet wide, including two branches (east branch at 100 ft. wide, and west branch at 125 feet wide);
- The West River channel authorized at -12-feet MLLW, 100 to 150 feet wide, with a -6 foot MLLW anchorage;

- A pile and stone T-dike at Stony Point west of the main channel, 4,200 feet long; and
- Three offshore stone breakwaters, totaling 12,100 feet in length providing a refuge in the outer harbor.

1.10 Prior Reports and Studies

The following are relevant prior reports completed for the New Haven Harbor.

- Long Island Sound Dredged Material Management Plan (DMMP) and Final Programmatic Environmental Impact Statement (FPEIS), January 2016
- Navigation Improvement Project New Haven Harbor, Connecticut, Preconstruction Engineering and Design Efforts, U.S. Army Corps of Engineers, New England District, August 1988.
- Technical Report Hl-88-24, New Haven Harbor Numerical Model Study, by David R. Richards, Hydraulics Laboratory, U.S. Army Corps of Engineers, Waterways Experiment Station, Final Report September 1988.
- Navigation Improvement Project, New Haven Harbor, Connecticut, Interim Report, Assessing the Potential Impacts the Navigation Improvement Project on the Oyster Resource in New Haven Harbor, U.S. Army Corps of Engineers, New England District November 1987.
- Supplement Report to April 1981 Feasibility Report Including the Addendum to the Final Environmental Impact Statement, U.S. Army Corps of Engineers, New England District 15 October 1981, with accompanying Chief's report 26 July 1982.
- New Haven Harbor Feasibility Report including Final Environmental Impact Statement, U.S. Army Corps of Engineers, New England District April 1981.

The 1981 Feasibility Report and Environmental Impact Statement recommended a plan that included deepening and widening the main channel and turning basin. The plan estimated removal and disposal of about 4.4 million cubic yards of soft dredged material and about 27,200 cubic yards of rock. WRDA 1986 authorized deepening the main channel and maneuvering basin to -40 feet MLLW. This improvement was never constructed and the 1986 authorization expired 16 April 2002 (Federal Register Vol. 68, 26 June 2003).

1.11 Federal Policy & Procedures

The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. In support of the Federal objective, it is within both the National and USACE interest to participate in studies to improve commercial navigation.

The "Federal Interest" decision in USACE planning is generally limited to instances where benefits of a potential project are expected to exceed the costs to the nation and the project is consistent with protecting the nation's environment. Because this is a single purpose navigation project, National Economic Development (NED) benefits are evaluated in terms of reduced navigation costs.

Identification of project-specific planning criteria used in USACE project planning is guided by the Principles and Guidelines (P&G) of 1983, the Planning Guidance Notebook, ER 1105-2-100 (22 April 2000), and NEPA of 1969, the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508), and Procedures for Implementing NEPA, ER 200-2-2 (4 March 1988).

Corps of Engineers project planning follows the six-step process first described in the P&G and further elaborated in the Planning Guidance Notebook, ER 1105-2-100 (April 2000). Although presented in series, these steps are applied in an iterative process. Steps in the P&G plan formulation process include:

1. Specification of water and related land resources problems and opportunities (relevant to the planning setting) associated with the federal objective and specific state and local concerns;
2. Inventory, forecast, and analysis of water and related land resource conditions within the planning area relevant to the identified problems and opportunities;
3. Formulation of alternative plans;
4. Evaluation of the effects of the alternative plans;
5. Comparison of alternative plans; and
6. Selection of a recommended plan

The planning practice has continued to evolve since the 1983 P&G, an evolution that now includes its confluence with risk analysis. The challenge in a world of limited time and budget is to efficiently reduce uncertainty by gathering only the instrumental evidence needed to make the next planning decision and to manage the risks that result from doing so without more complete information. (USACE, 2017) This study utilizes the model of risk identification, analysis and management throughout the planning decision making process.

1.12 Report Organization

As noted above, this report serves as the USACE decision document supporting the recommended navigation improvements and as the EIS to meet NEPA requirements for the proposed action. It is also formatted to facilitate review and processing by the Assistant Secretary of the Army Civil Works to provide a report with recommendations to Congress. The remainder of the report is organized as follows.

Section 2: Project Setting: General, Existing Economics (Waterborne Commerce), Physical
Section 3: Exiting Conditions: Environmental, Cultural Resources, and Socioeconomic
Section 4: Plan Formulation
Section 5: Alternatives: Navigation Improvement Alternatives, Dredged Material Placement
Section 6: Tentatively Selected Plan
Section 7: Environmental Consequences
Section 8: Environmental Compliance
Section 9: Public Review and Agency Coordination
Section 10: List of Preparers
Section 11: Recommendations
Section 12: References
Appendices

2.0 PROJECT SETTING

2.1 General Setting

New Haven Harbor is located on the northern side of Long Island Sound, about 68 nautical miles northeast of New York City, and 179 nautical miles southeast of Boston, Massachusetts via the Cape Cod Canal. Three detached breakwaters[1] protect the entrance of New Haven Harbor from Long Island Sound. The deep-water entrance of the main ship channel to the harbor lies between the Luddington Rock (Middle) Breakwater and the East Breakwater, and the ship channel extends from deep water in Long Island Sound to the head of the harbor about 6 miles in length. New Haven Harbor's open water area varies from about 4 miles in width near the breakwaters to 0.5 mile at the north end of the Harbor.

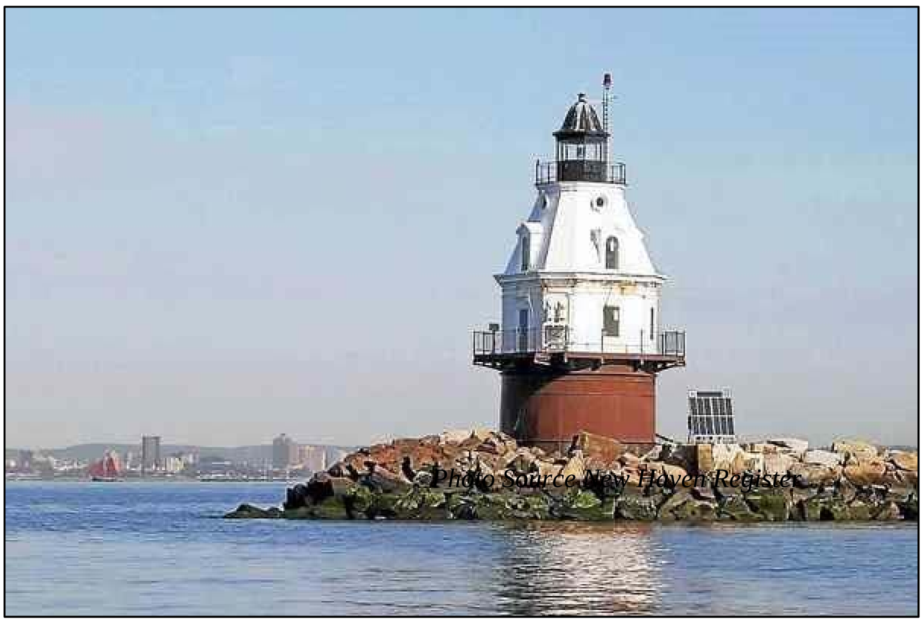


Figure 2-1: View of Lighthouse on East Breakwater

The port area of New Haven includes the inner portion of New Haven Harbor extending from Sandy Point on the west side and Fort Hale on the east to the head of the harbor, and the

[1] The three detached armor stone breakwaters are at the southern entrance to New Haven Harbor. These structures were authorized by the River and Harbor Acts of 3 March 1879 and 19 September 1890. Construction of the East Breakwater was started in 1880 and was completed to a length of 3,450 feet in 1890. The Middle or Luddington Rock Breakwater was started in 1891 and was completed to a length of 4,500 feet in 1896. Construction of the West Breakwater began in 1896 and was completed to a length of 4,200 feet in 1915. These structures provide a harbor of refuge at the mouth of the harbor and afford protection to the harbor from all but southwestern storms. The breakwaters also afford the northern shore of the City of West Haven protection from southern and southeastern storms, thereby reducing storm damage to this area.

navigable portions of the Mill, Quinnipiac and West Rivers. The Mill and Quinnipiac Rivers empty into the head of the harbor through a common mouth, and the West River enters the west side of the harbor about one mile below its head. See Figure 2-2 that provides a view of the harbor from Sandy Point looking to the north.

The primary tributary area served by the harbor is the south central Connecticut region, encompassing 767 square miles and includes 46 cities and towns. The largest city is New Haven. The most significant natural resources in south central Connecticut are the harbor itself, the coastal terrain, the Quinnipiac, West, and Mill Rivers that flow into New Haven Harbor, and Long Island Sound. The irregular coastline provides many fine beaches and sheltered covers for a variety of waterside recreation.

Figure 2-2: View of New Haven Harbor Looking Northerly from Sandy Point

2.2 Economic Conditions (Waterborne Commerce)

The Port of New Haven serves a hinterland including the greater New Haven region, the state of Connecticut, and much of the American Northeast. The port is a crucial import location for refined petroleum products, which supplies demand within Connecticut and the broader Northeast region. The Northeast maintains a large refinery production/demand deficit and must rely heavily on imported volumes of petroleum products in order to meet demand. The majority of the landside acreage at the Port of New Haven is devoted to energy-related uses. This represents a long-term land use and economic asset for the economy of the State of Connecticut.

2.2.1 Port Facilities and Commodities

New Haven Harbor port facilities include seven privately owned terminals (see Figure 2-3a, 2-3b, and Table 2-1). New Haven terminals have connections to interstate highways 95 and 91, rail and pipelines. Rail service is provided by the Genesee & Wyoming (formerly Providence & Worcester), and the Buckeye Pipeline connects to Bradley International Airport in Connecticut and the Westover Air Reserve Base in Massachusetts.

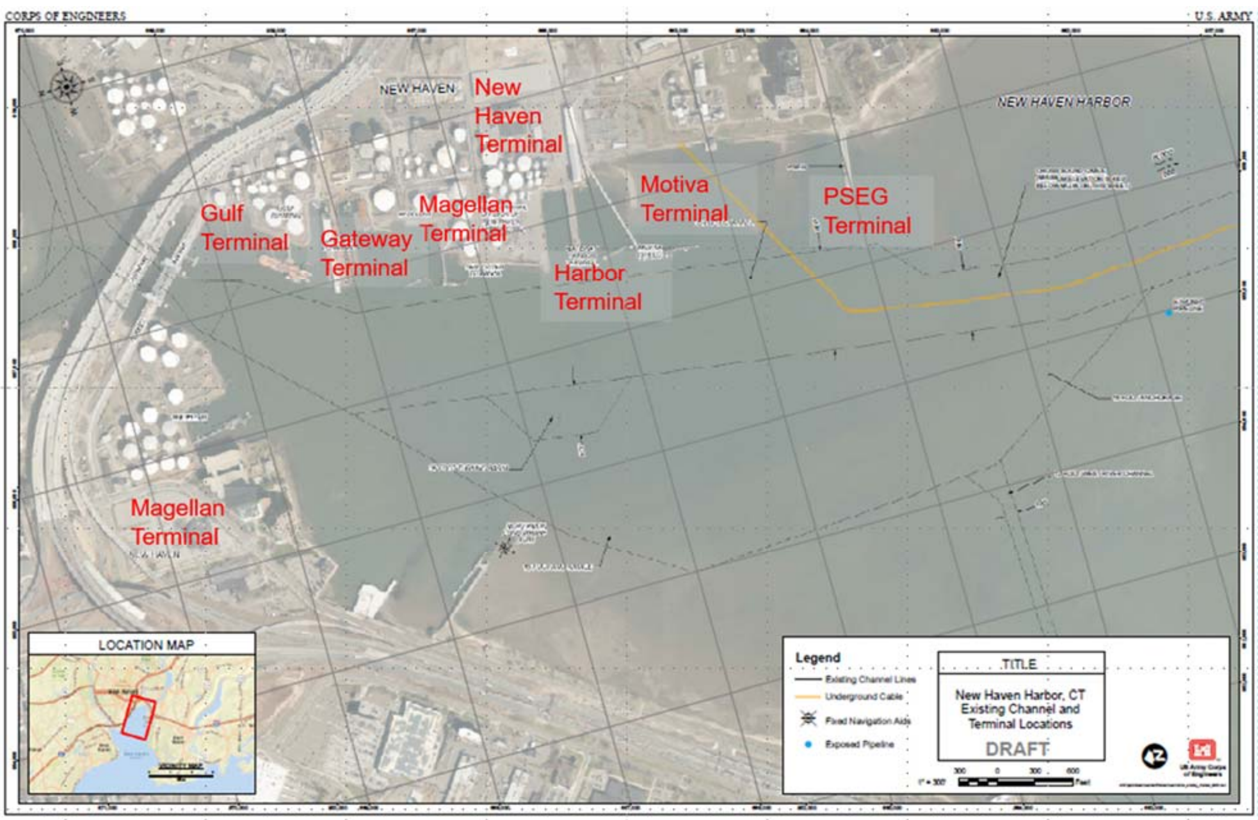


Figure 2-3a: Port Terminals Location

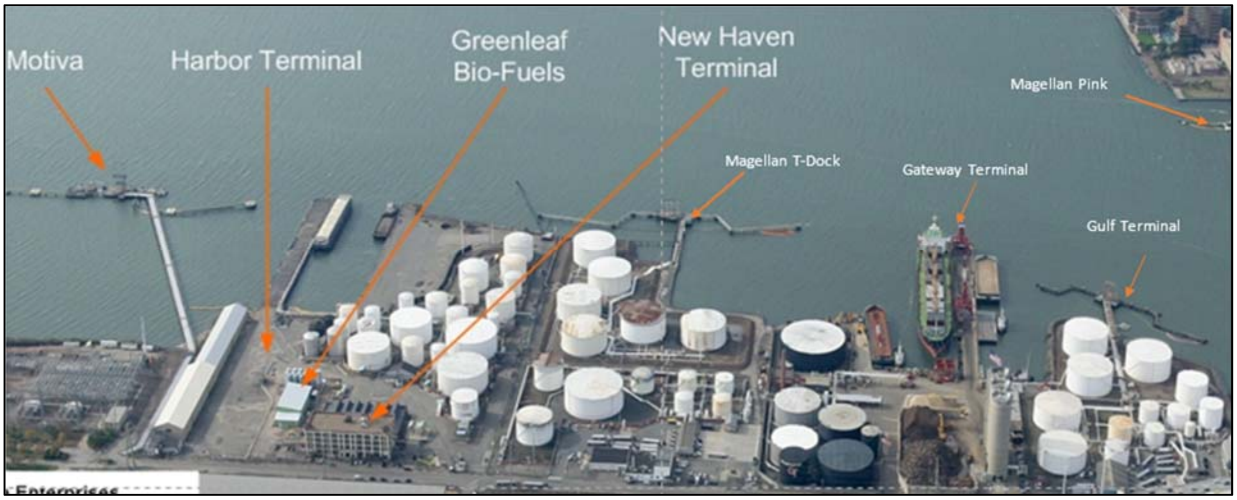


Figure 2-3b: Aerial View of Port Terminals

The Gulf Oil Terminal receives petroleum products by tankers and barges. Gulf Oil supplies gasoline, heating oil, diesel fuel, jet fuel and kerosene through its terminal network. The terminal operates one berth for tankers.

Gateway Terminal, the most active terminal in the port, is located on the western shore of New Haven Harbor. The terminal receives bulk products, such as salt and dry cargo including aggregates, coal, steel billets, steel rail, rebar, scrap metal, and pumice. Gateway Terminal then delivers these commodities to customers in the Northeast, Midwest, and Eastern Canada by truck, rail or barge. Two berths, the north and south berths, are located at Gateway Terminal's main concrete finger pier.

Figure 2-3c: Gateway Terminal Cranes

Gateway Terminal has two high-speed FMC link-belt gantry cranes with a duty cycle capability of 50-ton lifts and a reach of 120 feet to load/discharge a variety of dry cargoes.

The Magellan terminal located on Waterfront Street receives and ships petroleum products by barge and tanker. The T-dock has two berths for tankers.

A second Magellan facility on East Street receives petroleum products by barge and tanker and also ships petroleum products by barge. The tanks are connected to Westover Air Reserve Base, in Massachusetts by pipeline. This terminal has one berth for tankers.

The New Haven Terminal (and Harbor Terminal Wharf leased by Gateway) handles general cargoes and liquid petroleum products. There is also a bio-diesel manufacturing facility on site at this terminal. The Harbor Terminal finger pier extends westward into New Haven Harbor with two berths. The New Haven facility also has a marginal wharf used for dry cargo. This wharf is directly next to a paved lay down/storage area capable of holding all or part of a ship's cargo.

Motiva (Shell) Terminal, located on the west side of New Haven Harbor handles commodities such as gasoline, diesel fuel, jet fuel, and ethanol. Products received via marine vessel are distributed by truck, vessel, and pipeline. The terminal has two berths one for liquid tankers and the other for barges.

PSEG Power Connecticut built an electric generating peaking facility at its New Haven Harbor Station. The new peaking units began commercial operation in 2012. The terminal is operated for barges.

Table 2-1: Terminals and Commodities

Terminal	Commodities	Vessels
Gulf Oil	Petroleum Products, Chemicals and Related Products	Barges, Tankers
Gateway Terminal	Petroleum Products, Cement, Steel Products, Salt, Sand, Stone, Scrap Metal, General Cargo	Barges, Bulk Carriers, General Cargo, Tankers
Magellan Terminal - Waterfront Street (T-Dock)	Petroleum Products, Chemicals and Related Products	Barges, Tankers
New Haven Terminal (and Harbor Terminal)	Petroleum Products, Steel Products, Sand, Scrap Metal, General Cargo, Lumber, Waste Paper	Barges, Bulk Carriers, General Cargo, Tankers

Motiva Enterprises	Petroleum Products, Chemicals and Related Products	Barges, Tankers
PSEG Power	Petroleum Products	Barges
Magellan Terminal - East Street Wharf (Pink Tanks)	Petroleum Products, Chemicals and Related Products	Barges, Tankers

2.2.2 Commodities and Trends

In terms of total tonnage shipped and received, the Port of New Haven was the largest port in Connecticut and was the 2nd largest port in New England in 2016, ranking only behind the port of Boston. In 2016, its total freight traffic of 8.8 million tons represented about 24 percent of all waterborne commerce in New England and about 80 percent of all waterborne commerce in Connecticut. Figure 2-4 shows the distribution of tonnage by commodity for New Haven in 2016. New Haven also provides dry bulk and break-bulk services. Salt, sand, and cement imports are the dominant bulk cargoes and virtually all volumes are for immediate local use. Approximately 1 million tons of scrap metal are produced annually within the State, with approximately half of that amount is exported through the Port of New Haven.

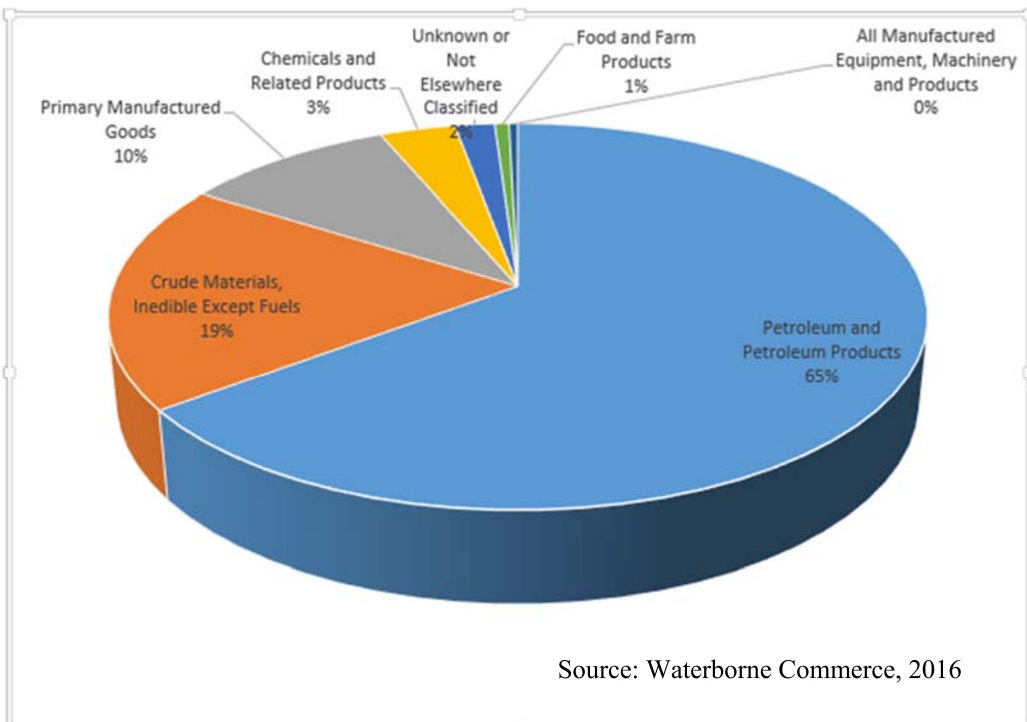


Figure 2-4: Commodity Mix

New Haven Harbor is essentially a receiving port for petroleum products. During the 2012-2016 period, petroleum products accounted for approximately 81 percent of all waterborne commerce (65 percent in 2016). These products were gasoline, jet fuel, kerosene, fuel oils, asphalt, and petroleum coke. The remaining 19 percent of waterborne commerce (2012-2016 period) was comprised of coal, chemicals, crude materials, primary manufactured goods, food and farm products, manufactured equipment and machinery, and goods not elsewhere classified. Petroleum products are shipped to New Haven by shallow-draft coastal tankers and barges from Northeastern U.S. ports and by ocean-going, deep-draft tankers from foreign ports. In 2016, about 21 percent of inbound petroleum products were foreign imports and the remaining 79 percent were domestic receipts. Outbound domestic shipments of petroleum products from New Haven are generally carried in shallow draft coastal tankers and barges to other Long Island Sound ports. Figure 2-5 displays foreign petroleum product tonnage by year.

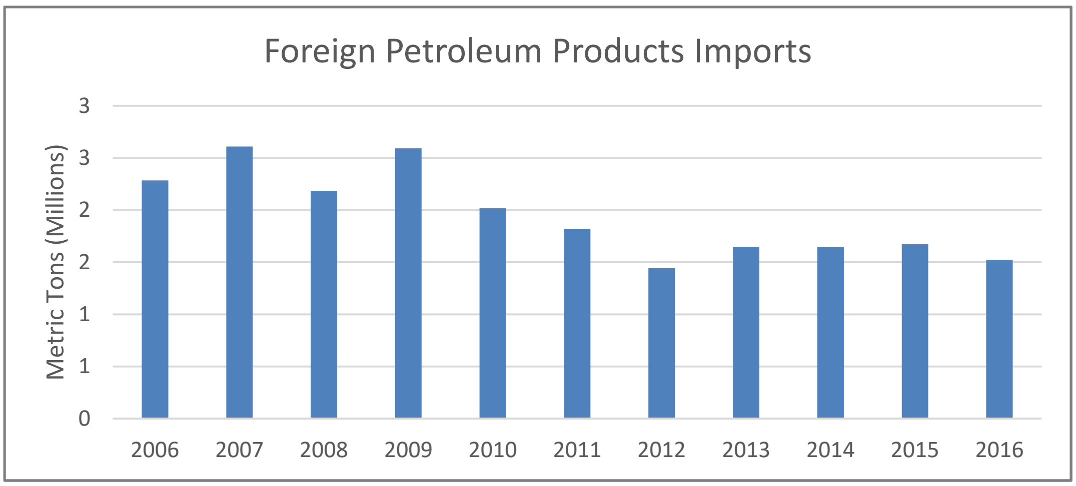


Figure 2-5: New Haven Petroleum Products Tonnage (Foreign Imports)

Source: Waterborne Commerce, 2006-2016

Scrap metal is Connecticut's largest single export commodity by weight. The market for scrap metal is highly competitive with few large producers (shredders) accounting for the majority of production volume/sales. An estimated 1 million tons of scrap metal are produced annually within the State, with approximately half of that amount exported through the Port of New Haven to destinations in Turkey, Peru, Egypt, and Saudi Arabia. The balance is exported, largely by truck, through New Jersey, Rhode Island and Philadelphia. Figure 2-6 displays foreign scrap metal export tonnage by year.

Figure 2-6: New Haven Scrap Metal Foreign Export

Source: Waterborne Commerce, 2006-2016

Salt is a major import at the port of New Haven, much of which is road salt used mostly by municipalities but also by commercial retailers for winter use. Gateway terminal built a storage facility for salt imports from Chile through Morton Salt. Figure 2-7 displays foreign salt imports.

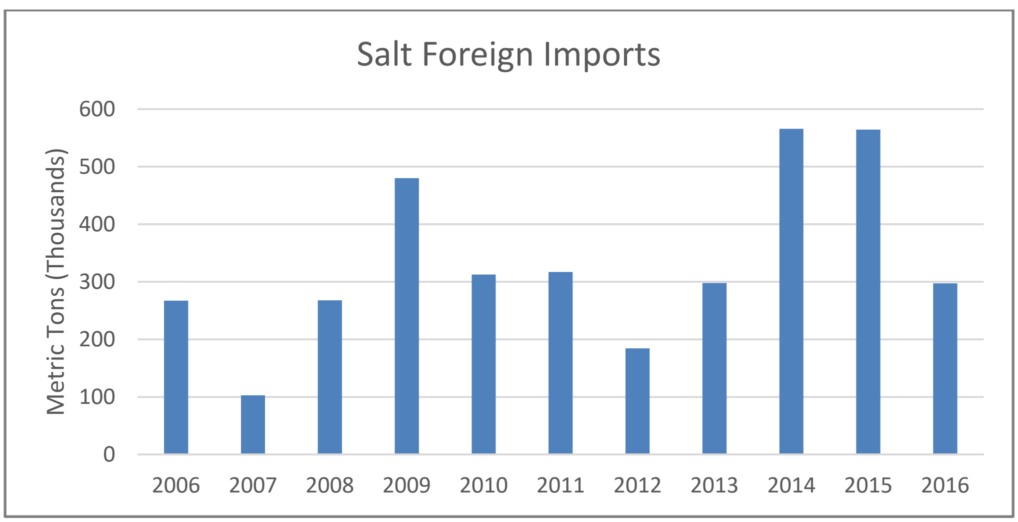


Figure 2-7: New Haven Salt Foreign Imports

Source: Waterborne Commerce, 2006-2016

The Port of New Haven receives foreign imports of primary manufactured goods consisting of iron and steel products (primary forms, sheets, shapes, pipe & tube), aluminum, and fabricated metal products. Figure 2-8 displays foreign primary manufactured goods.

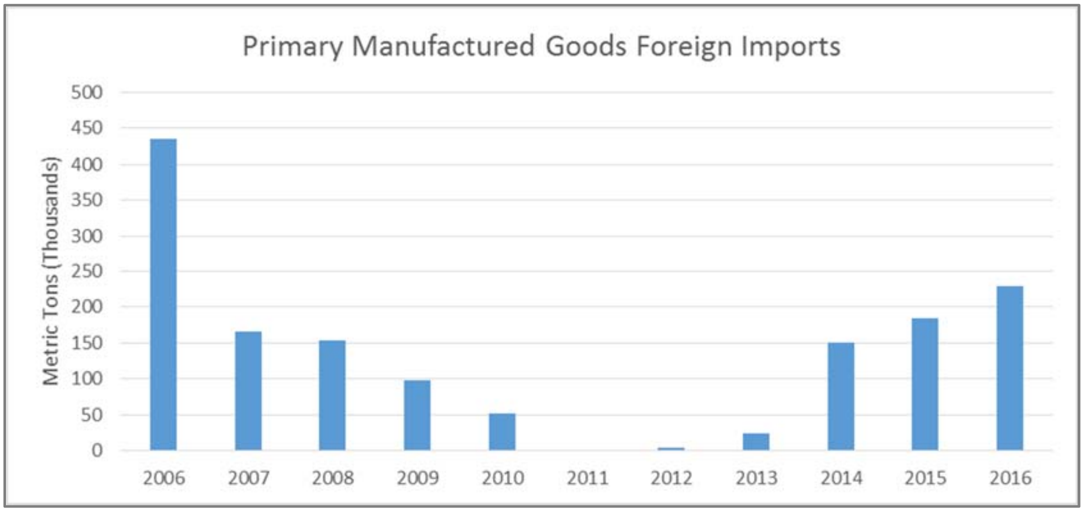


Figure 2-8: Primary Manufactured Goods Foreign Imports

Source: Waterborne Commerce, 2006-2016

The miscellaneous category of commodities includes all remaining tonnage (excluding petroleum products, scrap metal, salt, and primary manufactured goods). Commodities in this category include all manufactured equipment and machinery, forest products, agricultural products, chemicals, and commodities that are unknown or not elsewhere classified. During the 2006-2016 timeframe, miscellaneous foreign imports represented only 2% of foreign import tonnage on average at the Port of New Haven.

2.2.3 Vessel Traffic

The current depth of New Haven Harbor's deep draft project features is -35 feet MLLW, and pilot rules in the channel require that each vessel must have four feet of underkeel clearance. With this configuration, inbound vessels must either light-load, wait for the tide, or perform lightering operations in the Long Island Sound. The tide range at New Haven is six feet (rounded), meaning that inbound vessels can have a maximum draft of 37 feet. If a vessel cannot wait on the tide or has a draft greater than 37 feet, then the vessel must anchor in the Long Island sound and unload cargo onto barges until its draft is shallow enough to transit the channel (a process known as lightering). New Haven Harbor receives three vessel types: Tankers, Bulk Carriers, and General Cargo Ships. Figure 2-9 displays the total trips by draft.

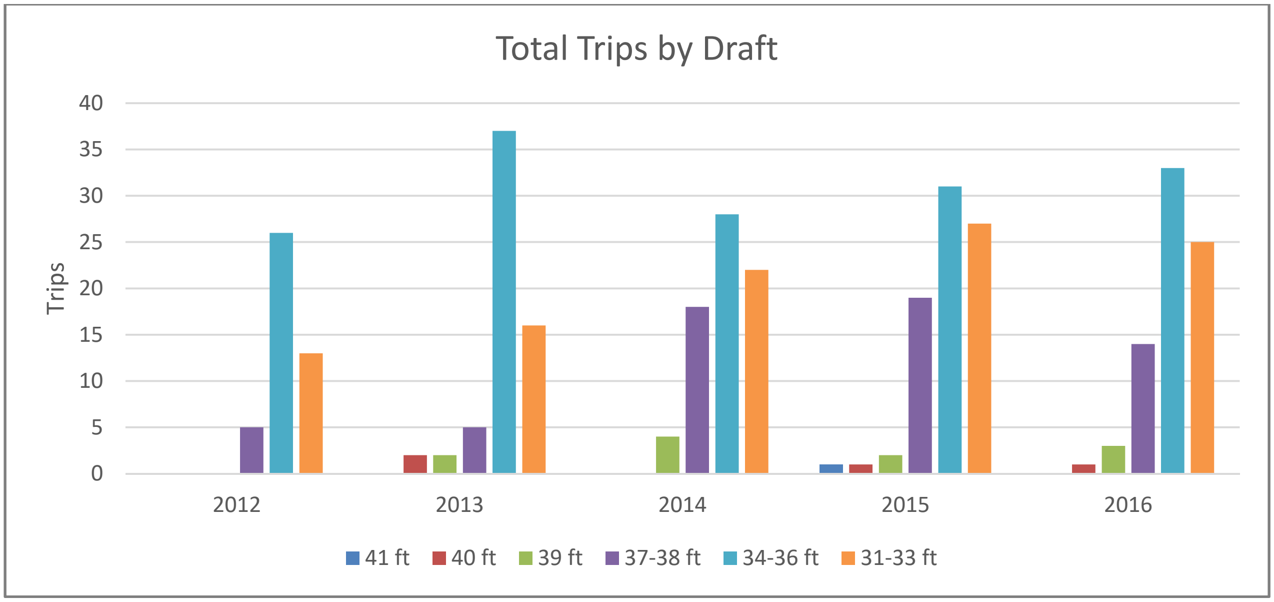


Figure 2-9: Total Vessel Trips by Draft

2.3 Physical Setting

2.3.1 Wind and Wave Climate

Connecticut lies in a transition zone of westerly air currents that encompass the southward movement of dry polar air masses and the northern movement of moist tropical air masses. It is in this transition zone that storm centers form and move. Superimposed on these large-scale effects are those created by New Haven's proximity to Long Island Sound. During warmer months when air temperatures exceeds water temperature, a sea breeze is likely to occur which tends to reinforce normal wind flow from the south or southwest. Such sea breezes occur when the pressure gradient is weak along Long Island Sound. This environment moderates the climate of New Haven by producing cooler summers and warmer winters in comparison to inland areas of Connecticut. In addition, the low-level air mass wind speeds are increased by the sea breeze in the spring and summer.

Long Island shelters the New Haven shoreline from long period waves from the Atlantic Ocean. Therefore, waves in Long Island Sound in the New Haven Harbor vicinity are fetch-limited only, driven by winds blowing over a length of the Sound. The inner harbor is fairly well protected from storm and wave action in the sound by virtue of its location away for the sound. The outer harbor is protected by the breakwaters that separate the harbor from Long Island Sound.

2.3.2 Water Depths, Tides and Currents

Water depths in the outer harbor (with the exception of the FNP) generally range from -15 to -25 feet MLLW, while majority of the inner harbor is characterized by water depths of less than -6 feet MLLW. Water depths in Long Island Sound near the entrance channel deepen to -45 feet MLLW.

The tide in New Haven Harbor is semi-diurnal. At the entrance to New Haven Harbor, the mean tidal range is 6.1 feet and the mean diurnal range is 6.7 feet (NOAA, 2018). Currents in the harbor are generally less than 0.5 knots. The currents in the main channel as it passes through the breakwaters average about 0.8 knots with peak ebb and flood currents averaging 1.3 and 0.9 knots, respectively. See Coastal Engineering Appendix E for additional information on tides and currents.

2.3.3 Relative Sea-Level Change

Relative sea level is projected to rise in New England. The USACE studies consider three sea level rise scenarios when describing study area conditions. These include a low rate based on the historic rate of rise and intermediate and high rates of rise. See 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 2013).

The low (historic) sea level change scenario produces a 0.46-foot (rise during the 50-year period of analysis and the intermediate and high rates of rise produce a 0.94 and 2.43 rate over the same period). See Figure 2-10 below for the Relative Sea Level Change curves out to 2120.

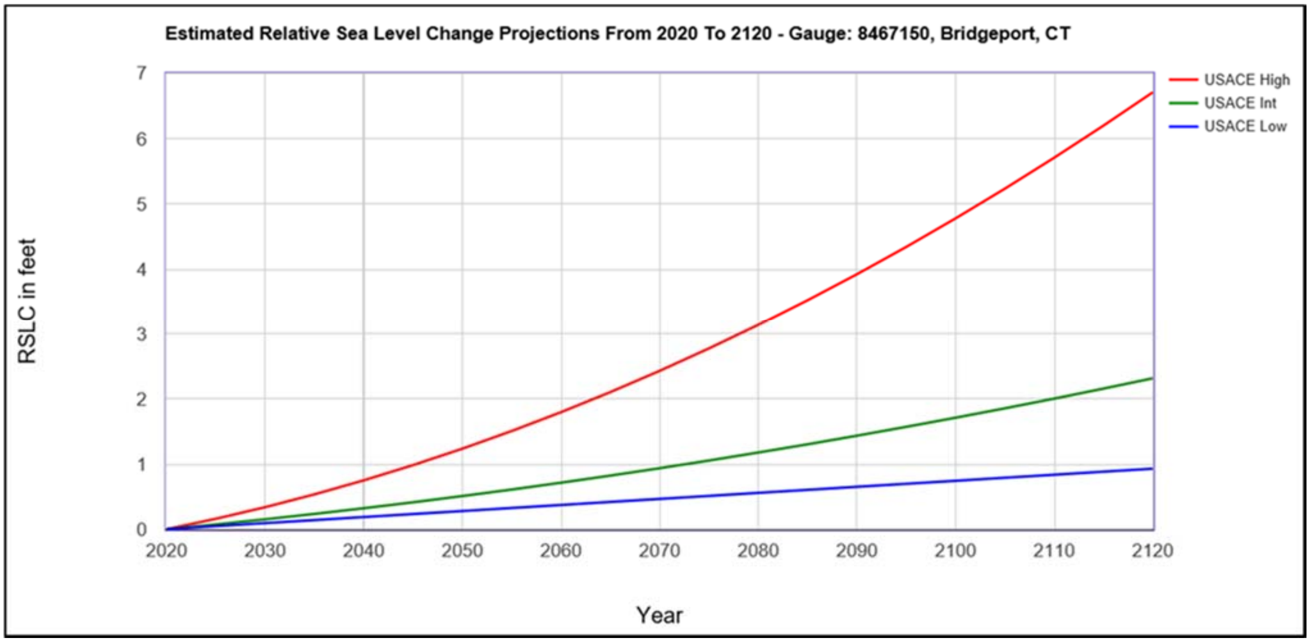


Figure 2-10: Relative Sea Level Change Projections

2.3.4 Geology

Regional Bedrock Geology and Structure

The Eastern Border Fault crosses New Haven Harbor at the approximate latitude of Morris Cove and strikes roughly ENE -WSW. The Eastern Border Fault forms the eastern and southern boundary of the Mesozoic Hartford Basin. Mesozoic sedimentary rock is located to the north and west of the Eastern Border Fault and Precambrian metamorphic rock is located to the south and east of the Eastern Border Fault. As a result, most of New Haven Harbor is surrounded to the north, northwest, and northeast by younger New Haven Arkose consisting of red, poorly sorted sandstone and conglomerate.

South of the fault, New Haven Harbor is underlain by bedrock consisting of undivided schists and gneisses consisting of meta-sedimentary and meta-igneous rocks of Proterozoic to Devonian age. The Buttress Dolerite is located east of New Haven Harbor. It consists of gabbro, traprock, and basalt. The Oronoque Schist is located southwest of New Haven Harbor. It consists of granofels and gray/silver schist. The Light House Gneiss is located south and southeast of New Haven Harbor. It consists of pink granitic gneiss. As a result, most of New Haven Harbor is surrounded to the north, northwest by the younger New Haven Arkose consisting of red, poorly sorted sandstone and conglomerate.

The bedrock topography beneath New Haven Harbor consists of the large West Haven Bedrock Valley formed by the coalescence of three smaller V-shaped bedrock valleys associated with the West River, Quinnipiac River, and Farm River. The head of the large bedrock valley is at the approximate latitude of Morris Cove. The large valley strikes southwesterly, parallel to the western edge of New Haven Harbor, and parallel to the inferred orientation of the Eastern Border Fault, indicating the fault may have exerted structural control on the alignment of the bedrock valley with preferential erosion and down cutting along the fault.

Surficial Geology of New Haven Inner Harbor

Glaciofluvial deposits associated with a sediment-dammed lake are located upland to the north, northwest, and east of New Haven Harbor.

Distal deltaic deposits of sand overly lake bottom sediments in the upland surrounding much of New Haven Harbor. Sand is of variable thickness, commonly in inclined foreset beds and overlying thinly bedded fines of variable thickness.

The uplands north of New Haven, in the area of the Quinnipiac River, also consist of deltaic deposits overlying lake-bottom sediment, consisting of sand and gravel overlying sand, overlying fines. Uncorrelated meltwater terrace deposits of distal meltwater streams are located in the uplands north of New Haven Harbor in the area of the Quinnipiac River.

Surficial Geology of New Haven Outer Harbor

The surficial geology of the outer harbor consists of offshore submerged deposits of Glacial Lake Connecticut, including deltaic deposits consisting of foreset and bottomset beds overlying lake-bottom deposited silt and clay sediments. The deltaic deposits are due to deposition from the Quinnipiac River, the Mill River, and the West River into Glacial Lake Connecticut.

Surficial Geology of Long Island Sound

Offshore submerged deposits of Glacial Lake Connecticut (Late Wisconsinan) include there types of deposits.

1. Deltaic deposits. These deposits are inferred to be delta-foreset and bottomset facies of emergent deltaic deposits of coastal Connecticut. Deposits are up to 131 feet thick and are a dominant component of lake sediment in much of the northern nearshore area. Deposits locally overlie bedrock, undifferentiated drift, end moraine deposits, or lacustrine-fan deposits. Generally, however, they overlie and intertongue distally with varved clay lake-bottom facies.

2. Coarse-grained, proximal facies and fine-grained, distal facies. Ice-marginal lacustrine fan deposits are present in the lower part of the glaciolacustrine section. These deposits overlie bedrock, Cretaceous strata, and/or, undifferentiated drift and are commonly in the same stratigraphic position as moraine deposits. Fans occur locally throughout the basin, but are numerous and more extensive in wide central Long Island Sound. Each lacustrine-fan sequence consists of two facies. Ice-proximal facies always occur in the northern part of the deposit, and fine grained distal facies always occur in the southern part.

3. Lake-bottom deposits. These deposits are inferred to be varved silt and clay commonly 260 feet thick and locally greater than ~500 feet thick in deep valleys. These deposits dominate the glacial section in the southern half of the basin and variously overlie bedrock and/or, Cretaceous beds, undifferentiated drift, end-moraine deposits, and lacustrine-fan deposits.

Early postglacial deposits (Early Holocene/Late Wisconsinan) include submerged marine deltaic deposits – deltaic facies and delta-distal facies and early postglacial deposits (Early Holocene) including submerged fluvial-estuarine, and channel-fill deposits. Fluvial sediments are overlain by estuarine sediments up to 66 feet thick in channel-fill configuration overlying steep-sided, channel-shaped unconformities that truncate glacial-lake deposits. These deposits are interpreted to be terrestrially derived fluvial sediment deposited when streams drained across a subaerially exposed lakebed. Map patterns of these channels show a paleodrainage system related to terrestrial valleys. Tributary channels draining southward from Connecticut and northward from Long Island join an east-draining trunk valley that exits the Long Island Sound basin at The Race. Fluvial facies are commonly overlain in the upper section of channel-fill by fine-grained, estuarine sediment deposited as the rising postglacial sea entered the basin through the notch at The Race and spread to the west via a paleochannel system.

2.3.5 Sediment Characteristics in the Project Area

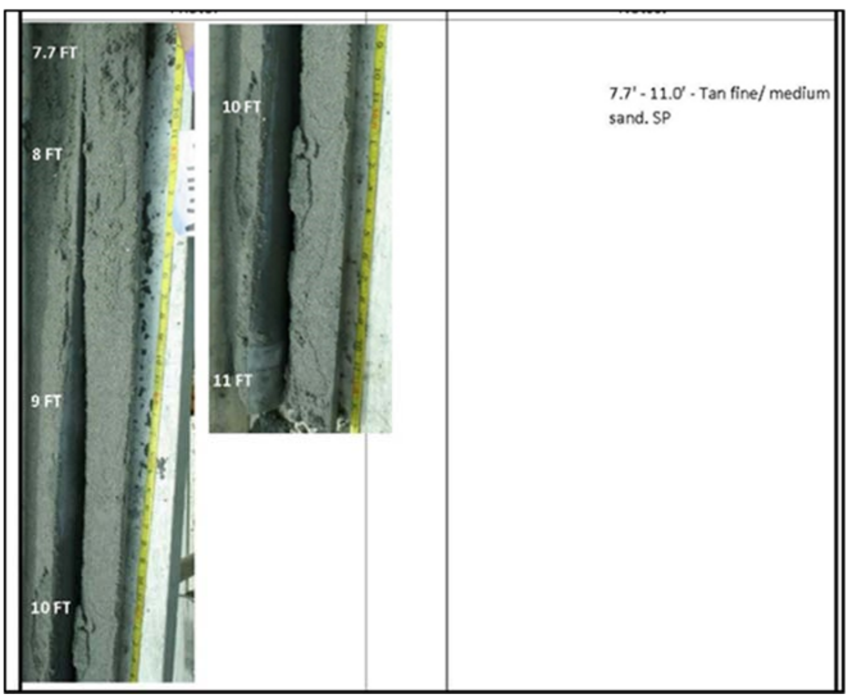
Sediment cores throughout New Haven Harbor were collected in August 2017 in order to characterize the physical and chemical nature of the material proposed to be removed from the FNP for improvement. Using a conceptual site model (see Appendix J – Suitability Determination) and a draft improvement project design (which was based on an expanded turning basin, 100 foot widening of the FNP, and improving to a depth of -42 feet MLLW), NAE prepared a sampling and analysis plan (SAP) for the project on 8 May 2017 which was coordinated with EPA Region 1 and CT DEEP. The SAP called for the collection of 26 individual sediment cores from the project area which were composited based on geographic location and physical properties (i.e., grain size) of the sediments. Sample locations are identified as Stations A through Z on Figures 2-12 and 2-13. During plan formulation, an improvement depth of less than 42 feet was selected as the TSP and the northerly expanded turning basin design was refined.

NAE's environmental services contractor (AECOM) collected sediment vibracores on 8 to 17 August 2017. The cores were collected to the deepest proposed project depth, -42 feet MLLW, plus two feet of allowable overdepth. The cores were described in the field and individual sediment horizons were sub-sampled for grain size and bulk chemistry analysis. The segments subsampled for each individual core are noted in Table 2-2. The remaining material was stored at 4°C until rapid (24-hour turnaround) grain size results could be used to confirm the compositing plan for subsequent biological testing. Due to feasibility study schedule constraints bulk chemistry analysis, whole sediment bioassays, suspended particulate phase toxicity tests, and 28-day bioaccumulation tests were run concurrently on all samples, rather than relying on a more typical sequential sampling and testing program.

Grain size results (Table 2-2) documented coarser grained material throughout the length of all cores collected at the outer harbor stations (A, B, and C) (See Figure 2-11). Surficial sediments at the inner harbor stations were predominantly organic silts and clay. Multiple inner harbor stations (K, N, S, W, and Y) transitioned to a native sand layer at a depth between 5.5 and 8.5 feet below the silty sediment surface. The native sand is likely a deltaic deposit. All other inner harbor stations were predominately fine grained material to project depth with the exception of stations F and T, which exhibited a layer of native clay below the overlying organic silt. The clay is likely a lacustrine deposit. The results of grain size analysis were used to determine the compositing plan for subsequent biological testing. Native sand and clay intervals were excluded from additional testing. Grain size results are presented in Table 2-2. All grain size data, quality control data, core logs, and photographs of cores can be found in Technical Supporting Document #1 (AECOM – Sediment Evaluation).

As no project specific contaminants of concern beyond typical testing requirements (which includes metals, pesticides, PAHs, and PCBs), were identified in the conceptual site model used for the SAP, individual sub-samples from each core were analyzed for the standard suite of contaminants specified in the Regional Implementation Manual (USACE/USEPA, 2004). The sample material was composited into eight samples to undergo whole sediment bioassays, suspended particulate phase toxicity tests, and bioaccumulation tests. The compositing scheme used is shown in Table 2-3.

Figure 2-11: Example Core Log, Station A, Outer Harbor



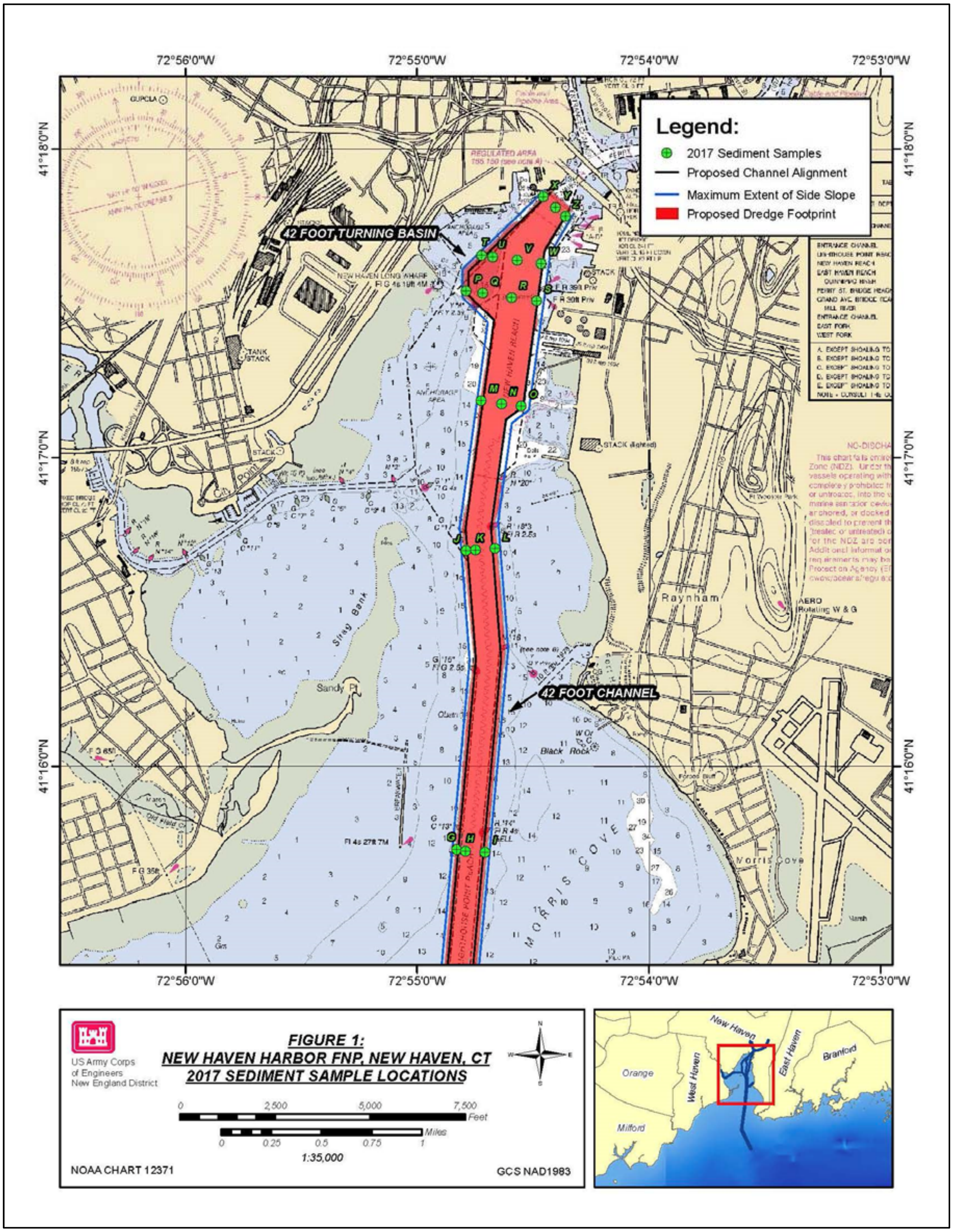


Figure 2-12: Location of Sediment Core Samples (Stations G – Z), New Haven Harbor

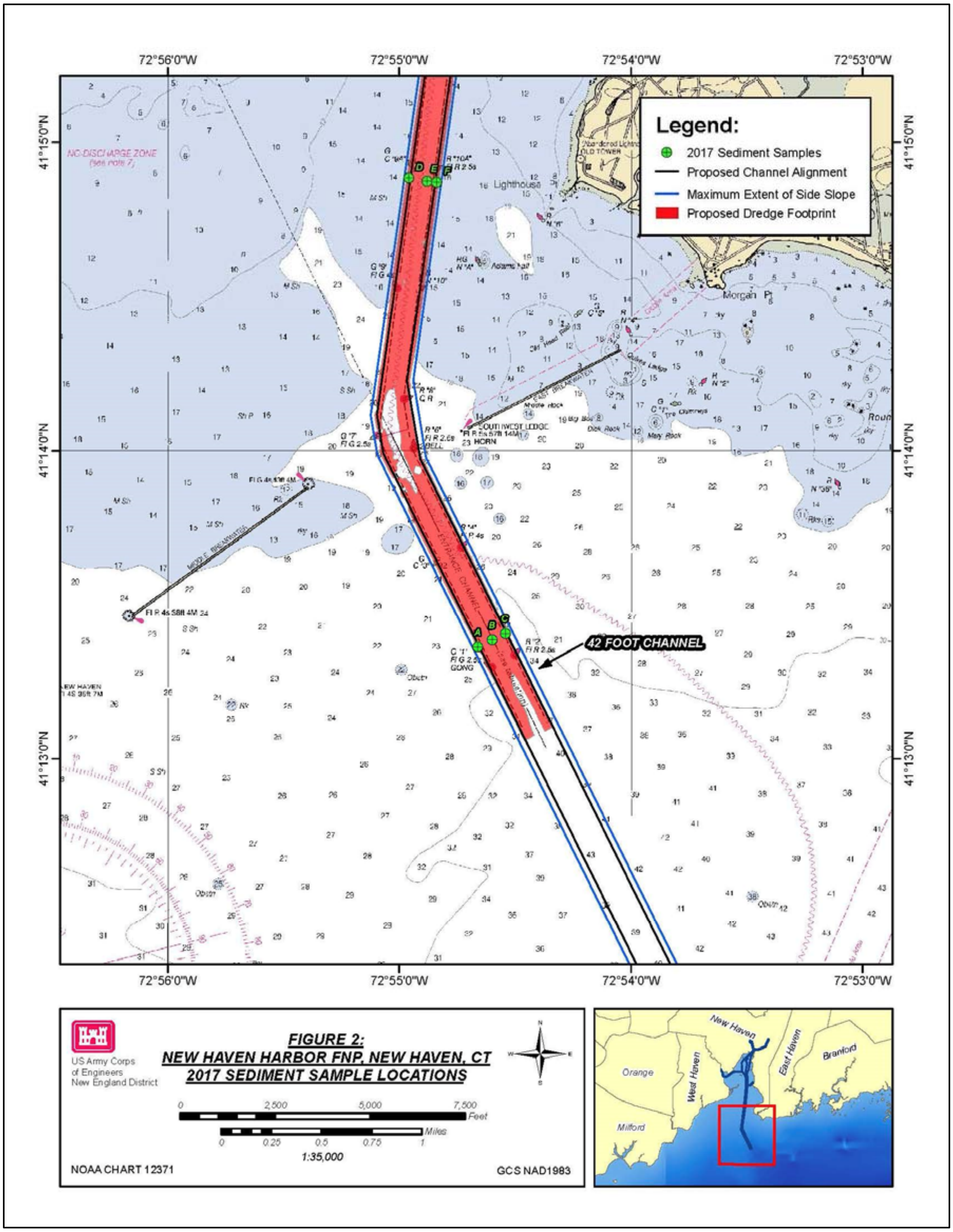


Figure 2-13: Location of Sediment Core Samples (Stations A – F), New Haven Harbor

Table 2-2: Grain Size Percentages and Sediment Descriptions from New Haven Harbor

Sample Name	*Core Length (FT)*	*Sample Top (FT)*	*Sample Bottom (FT)*	*ASTM Group Name*	*% Total Gravel*	*% Total Sand*	*% Total Fines*
NHH-A-TOP	11.0	0.0	2.2	poorly graded sand	1.9	91.1	7
NHH-A-BOTTOM	11.0	2.2	9.9	poorly graded sand	0.1	97.8	2.1
NHH-B	8.8	0.0	4.2	silty sand	2.2	79.7	18.1
NHH-C-TOP	15.0	0.0	2.8	silty sand	3.4	72.5	24.1
NHH-C-BOTTOM	15.0	2.8	8.0	silty sand	0.6	55.3	44.1
NHH-D-TOP	19.5	0.0	4.8	silt with sand	0.2	16.1	83.7
NHH-D-BOTTOM	19.5	4.8	10.3	silt with sand	0.1	16.6	83.4
NHH-E-TOP	9.8	0.0	6.5	silt	0.1	6.9	93.1
NHH-E-BOTTOM	9.8	6.5	8.1	silt with sand	0.2	17.5	82.5
NHH-F-TOP	16.5	0.0	3.2	sandy silt	0.1	32.9	67.1
NHH-F-BOTTOM	16.5	3.2	10.5	silt	0.1	7.1	92.9
NHH-G-TOP	19.6	0.0	4.3	silt with sand	0.3	24.2	75.5
NHH-G-BOTTOM	19.6	4.3	13.7	silt with sand	0.1	18.8	81.2
NHH-H-TOP	9.3	0.0	5.4	silt with sand	0.1	24.8	75.2
NHH-H-BOTTOM	9.3	5.4	7.7	sandy silt	0.1	30.5	69.5
NHH-I-TOP	17.5	0.0	0.7	silt with sand	0.1	25.2	74.8
NHH-I-BOTTOM	17.5	0.7	2.5	silty clay with sand	0.1	15	85
NHH-J	9.7	0.0	5.4	silt with sand	2.5	18.4	79.1
NHH-K-TOP	9.1	0.0	5.5	clayey silt with sand	0.1	18.2	81.8
NHH-K-BOTTOM	8.2	5.5	8.2	poorly graded sand	1.9	96.5	1.6
NHH-L	9.8	0.0	6.7	sandy silt	0.1	32.6	67.4
NHH-M	9.7	0.0	6.8	silt and clay	0.1	2	98
NHH-N-TOP	9.3	0.0	6.0	sand and Silt	3.7	55.7	40.6
NHH-N-BOTTOM	9.3	6.0	7.5	silty sand	0.1	84.7	15.3
NHH-O-TOP	13.4	0.0	8.3	silt	0.1	2.3	97.7
NHH-O-BOTTOM	13.4	8.3	10.9	silty sand	0.1	75.4	24.6
NHH-P-TOP	29.4	0.0	5.8	silt	0.1	1.9	98.1
NHH-P-BOTTOM	29.4	5.8	12.3	silt	0.1	1.5	98.5
NHH-Q-TOP	29.5	0.0	5.3	silt with clay	0.1	1.1	98.9
NHH-Q-BOTTOM	29.5	5.3	29.4	silt with clay	0.1	3.2	96.8
NHH-R-TOP	9.2	0.0	4.2	clayey silt with sand	0.2	18.8	81
NHH-R-BOTTOM	9.2	4.2	7.7	clayey silt with sand	0.1	8.5	91.5
NHH-S-TOP	9.5	0.0	6.0	sandy silt	4.9	33.5	61.6
NHH-S-BOTTOM	9.5	6.0	6.4	silty sand	0.1	71.4	28.6
NHH-T-TOP	19.7	0.0	4.8	silt with clay	0.1	1	99
NHH-T-BOTTOM	19.7	4.8	16.3	clayey silt	0.1	2.1	97.9
NHH-U-TOP	30.0	0.0	5.8	silt with clay	0.1	4.7	95.3
NHH-U-BOTTOM	30.0	5.8	30.0	clayey silt	0.1	1.5	98.5
NHH-V-TOP	9.9	0.0	4.8	silt with clay and sand	4.8	18.6	76.6
NHH-V-BOTTOM	9.9	4.8	8.6	clayey silt with sand	1.1	10.2	88.7

Sample Name	*Core Length (FT)*	*Sample Top (FT)*	*Sample Bottom (FT)*	*ASTM Group Name*	*% Total Gravel*	*% Total Sand*	*% Total Fines*
NHH-W-TOP	9.8	0.0	5.5	silty sand	0.1	53.4	46.6
NHH-W-BOTTOM	9.8	5.5	8.2	silty sand	0.1	69.8	30.2
NHH-X-TOP	9.7	0.0	5.2	silt with sand	0.1	7.7	92.3
NHH-X-BOTTOM	9.7	5.2	8.0	silty sand	0.1	64.5	35.5
NHH-Y-TOP	9.4	0.0	5.9	silt	0.1	4.6	95.4
NHH-Y-BOTTOM	9.4	5.9	8.5	poorly graded sand with silt	9.8	79.7	10.5
NHH-Z-TOP	9.7	0.0	5.0	silt	0.1	4.8	95.2
NHH-Z-BOTTOM	9.7	5.0	8.7	silt with sand	0.1	20	80

Table 2-3: Compositing Scheme for New Haven Harbor Core Samples

Composite	Core Samples Used for Composite
1	A,B,C
2	D,E,F
3	G,H,I
4	J,K,L
5	M,N,O
6	P,Q,R,S
7	T,U,V,W
8	X,Y,Z

The conceptual site model from the sampling and analysis plan identified the uptake of placed dredged material by benthic organisms as a potential exposure pathway for the New Haven Harbor improvement project. As a screening tool to assess the potential for adverse effects to benthic organisms, bulk sediment chemistry results from each core were compared against applicable sediment quality guidelines (SQGs). Applicable SQG screening values for marine and estuarine sediments are the National Oceanic and Atmospheric Administration (NOAA) effects-range low (ERL) and effects-range median (ERM). ERL/ERM values are empirically derived guidelines that identify contaminant levels that indicate when the potential for toxic effects are unlikely (ERL) and when an increased probability of toxic effects is evident (ERM). SQG values are noted in the Suitability Determination (Appendix J).

At all outer harbor stations (A, B, and C) and several inner harbor stations (D, H, I, and X below 5.2’) all analytes were either not detected or were detected at concentrations below the ERL. The majority of the remaining inner harbor stations had detectable concentrations of metals, Total PAHs, Total PCBs, and pesticides that were above the ERL but below the ERM. A subset of inner harbor stations had concentrations of certain metals (copper, mercury, and zinc), Total PAHs, or Total PCBs that were above the ERM. Sub-samples with ERM exceedances were more common in the extreme inner harbor stations near the turning basin and terminals. Bulk chemistry results are presented in the Suitability Determination (Appendix J). All bulk chemistry results, quality control documentation, and laboratory methods are documented in Technical Supporting Document #1 (AECOM - Sediment Evaluation).

Sediment toxicity of the eight composite samples was determined through a 10-day whole sediment acute toxicity test as described in the Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual (Green Book, EPA/USACE 1991). Mortality in the control sample of the 10-day whole sediment acute toxicity test was less than 20% for the amphipod test (*Leptocheirus plumulosus*) and less than 10% for the mysid test (*Americamysis bahia*); therefore the test was valid based on criteria established in the Green Book.

Mean survivability for the amphipod *L. plumulosus* ranged from 87% to 96% for the eight composites and was not statistically different from the survivability of the amphipods exposed to reference sediment with the exception of Composite 8. Survivability in Composite 8 was within 20% of the survivability in the reference sediment that is within the acceptance criteria established in the Green Book. Therefore, the material proposed to be dredged is not considered acutely toxic to the amphipods used in this assessment.

Mean survivability for the Mysid *A. bahia* ranged from 74% to 96% for the eight composites and was not statistically different from the survivability of the mysids exposed to reference sediment with the exception of Composites 5 and 6. The survivability in Composite 5 was within 20% of the survivability in the reference sediment, which is within the acceptance criteria established in the Green Book. Survivability in Composite 6 was 24% lower than the reference sediment, which is outside of the acceptance criteria established in the Green Book. Therefore, the material proposed to be dredged is not considered acutely toxic to the mysids used in this assessment with the exception of the material in the vicinity of Composite 6. Survivability data from the 10-day whole sediment toxicity test for both the amphipod and mysid are summarized in the Suitability Determination (Appendix J). All 10-day whole sediment toxicity test results, quality control documentation, and laboratory methods are documented in Technical Supporting Document #1 (AECOM - Sediment Evaluation).

In order to assess the potential risk to human health through the potential exposure pathways identified in the conceptual site model a 28-day bioaccumulation test was performed with the clam *Macoma nasuta* and marine worm *Nereis virens* on all sediment composites. Results showed statistically significant increases of certain contaminants in tissue samples from clams exposed to project sediments when compared to tissue samples from clams exposed to reference area sediments including cadmium, chromium, copper, lead, several individual PAHs, and the pesticide 4,4'-DDE. Significant increases in worm tissue samples included copper, zinc, several individual PAHs, and two PCB congeners. All bioaccumulation test results, quality control documentation, and laboratory methods are documented in Technical Supporting Document #1 (AECOM - Sediment Evaluation). Based on these bioaccumulation results the tissue burden data were analyzed with the EPA Bioaccumulation Evaluation Screening Tool (BEST) model to determine the toxicological significance of bioaccumulation from exposure to the dredged sediment.

The BEST model includes an evaluation of the non-carcinogenic risk, carcinogenic risk, and any observed exceednces of Food and Drug Administration (FDA) thresholds to determine potential adverse impacts to human health from the consumption of lobster, fish, or shellfish exposed to project sediments. Modeling based on the tissue contaminant loads measured in the New Haven Harbor improvement project found that all contaminants were below the EPA Hazard Quotient for non-carcinogenic risk of 1.0, below the EPA carcinogenic risk threshold (1 x 10-4), and were also less than established FDA action levels. Based on this analysis the sediments are in compliance with the bioaccumulation assessment criteria in the Green Book. BEST model outputs are provided in the Suitability Determination (Appendix J).

The conceptual site model also identified the uptake of contaminants from the water column during the placement of dredged material as a potential exposure pathway for the New Haven Harbor navigation improvement project. 33 U.S.C. §1416(f) requires that all Federal dredging projects of any size and all Non-Federal projects of more than 25,000 CY conducted under permit, and proposing to place dredged material in the waters of Long Island Sound, are subject to the requirements of the Marine Protection Research and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act. Since one of the proposed placement sites for the project, the CLDS, is in Long Island Sound the dredged material has been evaluated based on the requirements of both MPRSA and the CWA. The potential for water column toxicity was determined though a suspended particulate phase toxicity test as described in the Green Book (EPA/USACE 1991).

Suspended particulate phase toxicity results were used to determine the median lethal concentration (LC50) for each species exposed to elutriate from the sediment composites. The mysid *Americamysis bahia*, the minnow *Menidia beryllina*, and the urchin *Arbacia punctulata* showed no effect on survival when exposed to the elutriate from Composite 1 with of LC50 values of >100%. Elutriates from the other seven composites had high levels of ammonia at the start of the suspended particulate phase toxicity tests. Elevated ammonia concentrations occur naturally in sediment and cause toxicity in the static environmental conditions of a laboratory suspended particulate phase test (Kennedy et al 2015). In open water conditions, such as the proposed placement areas, ammonia is a non-persistent compound that dissipates rapidly and is not considered a contaminant of concern for dredged material evaluations (Kennedy et al 2015). In cases where ammonia is the driver for an observed response in a suspended particulate phase test an alternate application factor is applied following MPRSA §227.27(a)(3) to determine the limiting permissible concentration (LPC). Unionized ammonia, the more toxic form, was 2 to 8 times higher than the water quality criteria for acute toxicity in the elutriates from Composites 2-8. Elutriate chemistry results for these composites showed that all COCs were either not detected or were below water quality criteria for acute toxicity with the exception of Total PCBs in Composites 6 and 7. Based on this evaluation NAE identified unionized ammonia as the sole driver for the toxicity observed in the suspended particulate phase tests for Composites 2, 3, 4, 5, and 8 and the alternate application factor (0.05) was applied to calculate the LPC. Due to the presence of Total PCBs above the water quality criteria in Composites 6 and 7 the source of toxicity could not be identified and the standard application factor (0.01) was applied to calculate the LPC for those composites. Suspended particulate phase toxicity results and elutriate chemistry concentrations, including unionized ammonia, are presented in Appendix J.

To determine if the discharge of dredged material would meet the limiting permissible concentration NAE utilized the Short-Term Fate (STFATE) numerical model to analyze the disposal cloud as it is descends through the water column after release from a scow. Results of the STFATE evaluation predicted that the water column would attain the LPC within four hours of disposal and therefore meet the criteria in the testing protocol for Composites 1, 2, 3, 4, 5, and 8. Results of the STFATE model for Composites 6 and 7 did not attain the LPC within four hours and therefore do not meet the criteria for open water placement without additional testing to verify the source of the observed toxicity.

Based on the results of biological testing and subsequent risk assessment modeling no significant adverse impacts were found for the New Haven Harbor navigation improvement project with the exception of the material around Composites 6 and 7, adjacent to the marine terminal facilities. Based on the testing and evaluation requirements set forth in Section 103 of the Marine Protection, Research, and Sanctuaries Act and Section 404 of the Clean Water Act, the sediments to be dredged from the New Haven Harbor navigation improvement project are considered suitable for unconfined open water placement as proposed with the exception of the material around Composites 6 and 7. Further testing may be performed to better refine the extent of contamination and source of toxicity in the areas around Composites 6 and 7. The US EPA and CT DEEP have concurred with this determination.

3.0 EXISTING CONDITIONS/AFFECTED ENVIRONMENT

3.1 Protected and Managed Lands

Numerous surrounding protected and managed lands that provide buffers from development and other benefits to the estuarine environment of New Haven Harbor exist. These areas are all open to the public.

Lighthouse Point Park

Lighthouse Point Park is a park in the city of New Haven, Connecticut that is operated as a New Haven city park. The 82-acre park is located at the eastern point of New Haven Harbor in the East Shore neighborhood. The park features the deactivated Five Mile Point Lighthouse, which is open for tours on special events, and the Lighthouse Point Carousel, which is operated seasonally. Park amenities include a sand beach area with a bathhouse, restrooms and lifeguard, a boat launch, two pavilions, splash play area, playground, summer concession stand, fishing pier, picnic tables, grills and nature trails. Lighthouse Point Park abuts the Morris Creek Nature Preserve, a 20-acre salt marsh that is partly owned by the New Haven Land Trust. The park is located on the Atlantic flyway, a major migration route for butterflies, hawks, and many other migrant bird species, which makes it a popular site for bird watching.

East Shore Park

East Shore Park is an 85-acre parcel of land that operates as a New Haven city park. It is located on the east shore of New Haven Harbor. The park contains tennis courts, athletic facilities, a handicapped accessible playground, and several lighted ball fields. There is also a meandering trail along the shoreline. The park area was elevated and expanded in the 1950s using dredged material from the 35-foot improvement dredging of the FNP.

Fort Hale Park, Black Rock

Fort Hale Park, Black Rock, is a 20-acre park located on the east shore of New Haven Harbor in New Haven, Connecticut. It includes the site of a 1659 colonial era fort, a Revolutionary War-era fort, and a Civil War-era fort. Since 1921, the site has been owned by the state of Connecticut. It is used as a park and maintained as a historical site by the City of New Haven. Educational programs are given throughout the year to students attending local schools. The site was listed on the National Register of Historic Places in 1970. In 1970 the listing included three contributing buildings, one contributing site, and three contributing structures.

Long Wharf Nature Preserve

The Long Wharf Nature Preserve is located in the northwestern portion of New Haven Harbor in New Haven just off Interstate Highway 95 (I-95). The upland, created by filling, evolved into a grassland and a small woodland dominated by tall cottonwood trees, almost all the result of natural seed dispersion. The tidal wetland and dune area accreted over the 50 years since I-95 was constructed. At low tide, the preserve encompasses approximately 15 acres, from mud flat to dune to salt marsh to upland. A loop trail connecting the shore and upland and leads to the historic Oyster Point neighborhood.

Morse Park & Morse Beach

Morse Beach is a sandy beach located in West Haven, Connecticut fronting the southwestern portion of New Haven Harbor. The beach is located adjacent to the City of West Haven's wastewater treatment plant and behind Sandy Point and occupies about 7 acres.

Sandy Point

Sandy Point is a barrier beach (sand spit) system with a tidal creek, an area of tidal marsh, and tidal flats in West Haven, Connecticut. It is situated in the southwest portion of New Haven Harbor. The site is approximately 66 acres. The area is extremely popular for fishing and other beach-related uses in the warmer months, as well as being a popular destination for birders. This area provides some of the most important beach habitat in Connecticut for piping plovers, least tern, and common tern. The 3.5 miles of public beach extending west of Sandy Point are popular for bird-watching year-round, although access to parts of some of these beaches are seasonally-restricted to protect nesting birds. A 1.7-mile paved recreational greenway provides pedestrians, cyclists and roller-bladers with a waterfront view of Long Island Sound.

3.2 Water Quality

3.2.1 Water Quality Classification

New Haven Harbor is largely surrounded by urbanized land. Three waste-water pollution control facilities (WPCF) in the cities of New Haven, West Haven, and North Haven release effluent into the Quinnipiac River and New Haven Harbor. Effects of the WPCFs in North Haven and West Haven are minimal as compared to effects on New Haven east shore WPCF (Bell and Romick, 2002). The intensity of this urbanization and associated industrialization has brought with it all the attendant problems of municipal and industrial pollution, ranging from sewage to oil spills.

The waters of New Haven Harbor are classified by the State of Connecticut as SB throughout the harbor. The term SB is for coastal waters of overall good quality. The Connecticut Class SB waters designated uses are for: marine fish, shellfish and wildlife habitat, commercial shellfish harvesting, recreation, industrial water supply, and navigation (CT DEEP, 2017).

3.2.2 Water Column Turbidity

Turbidity refers to the clarity or clearness of the water. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity. Although turbidity is not an inherent property of water such as temperature or pH (Davies-Colley and Smith, 2001, in Wilde, F.D., 2005), it is an indicator of water body health. Turbidity is caused by suspended and dissolved matter; such as clay, silt, finely divided organic matter, plankton and other microscopic organisms, organic acids, and dyes (ASTM International, 2003, in Wilde, F.D., 2005).

Natural causes of turbidity include runoff, phytoplankton and zooplankton, minute fragments of dead plants, and storm events. Anthropogenic sources of turbidity include runoff from agricultural fields, stormwater runoff from construction sites and urban areas, shoreline erosion from heavy boat traffic, bottom sediment resuspension from vessel traffic, dissolved nutrients released in treated wastewater, organics released by sewage treatment plants, and periodic dredging events.

High levels of turbidity, outside the normal range of turbidity levels, over sustained periods can be a concern for the health and productivity of the estuarine ecosystem for several reasons. Turbid waters can decrease light penetration into the water, thereby lowering photosynthetic activity and reducing the area available for submerged aquatic plants to grow. Algae can greatly limit light penetration and can limit primary production to the uppermost layers of water. This can cause invertebrate population decline (caused by fewer photosynthetic organisms available for food). This in turn can result in fish population decline (caused by fewer invertebrates available for food). Suspended material in large quantities for sustained periods can foul the filter-feeding systems of certain estuarine animals. Particles may accumulate on the gills of fish and inhibit breathing. High levels of turbidity can hinder aquatic predators from spotting and tracking down prey. Additionally, dissolved oxygen can be depleted if turbidity is largely due to organic particles.

Background levels of suspended materials in the waters of New Haven Harbor were documented by USACE (1996) in a study evaluating the effect of dredging on water column suspended sediments. Typical background values averaged 8 mg/l throughout the entire harbor with natural peaks (i.e., peaks not attributed to construction or vessel traffic) on the order of 25 mg/l being observed (USACE 1996).

3.2.3 Dissolved Oxygen

Dissolved oxygen (DO) in marine waters is essential for most healthy aquatic life. If DO levels are too low it can be a sign of human induced impacts such as excessive runoff or nutrients or it can be attributed to natural causes such as seasonal variations. Healthy conditions for aquatic life exist when dissolved oxygen are above 5.0 mg/l. Concentrations between 5.0 mg/l and 3.5 mg/l are generally healthy, except for the some sensitive species. When concentrations fall below 3.5 mg/l, conditions become unhealthy. The most severe effects occur if concentration levels fall below 2.0 mg/l, even for short periods of time (EPA, 1997).

Dissolved oxygen levels exhibit seasonal variations within New Haven Harbor with the highest concentrations occurring during winter months and lowest during the summer months. This temporal pattern of DO concentrations is typical in New England waters and reflects the inverse relationship of temperature and oxygen solubility in water. DO concentrations are usually similar in surface and bottom waters, and between physical locations except during summer, when inner harbor values are usually lower than the outer harbor (DeLeuw Cather, 1991). Recent water quality monitoring in inner New Haven Harbor found DO concentrations ranging from 5.75mg/l to 13.6 mg/l (SCSU 2013).

3.2.4 Nutrients

Nutrients such as nitrogen and phosphorus are necessary in a productive marine ecosystem. However, too much nitrogen, especially in the form of ammonia, can fuel and stimulate the excessive overgrowth of algae and seaweed. The dense algae blooms cloud the water and shade the bottom. Dense algae blooms can prevent enough light from reaching shallow water bottoms to support the growth of submerged aquatic vegetation, an important habitat for shellfish and juvenile fish (EPA, 1997). Also, when the algae die and settle to the bottom, they are decayed by bacteria that use oxygen and this may cause a reduction in DO levels. Oxygen is necessary for aquatic organisms to feed, grow, and live. In extreme low DO conditions, some organisms may suffocate and die, while others flee the hypoxic (low DO level in the water) zones.

Major detrimental water quality impacts have resulted from the large amounts of nutrients discharged into Long Island Sound (and therefore New Haven Harbor) through atmospheric deposition, domestic and industrial waste water flows, fertilizer releases, and urban runoff (Mullaney et al . 2014). Major strides have been made in reducing the inflow of nutrients into Long Island Sound, however cultural eutrophication is still an ongoing problem and nutrient control efforts remains a high priority (Latimer et al. 2014).

3.3 Wetlands

Wetlands, specifically coastal salt marshes, border portions of New Haven Harbor and its tributaries. Figure 3-1 shows the extent of wetland resources in the vicinity of the proposed project. Data for wetland distribution in the area, obtained from the USFWS National Wetlands Inventory (USFWS, 2018), show approximately 450 acres of estuarine and marine wetland areas are currently present in the New Haven Harbor system. Historical data taken from an 1846 Coast Survey map (based upon data collected between 1833-1838) (US Coast Survey, 1846) indicated that there were over 1,200 acres of wetland habitat at the time of the survey. The loss of most wetland habitat in the system appears to be due to the filling of marshes for the development of industrial, commercial, residential, and recreational lands.

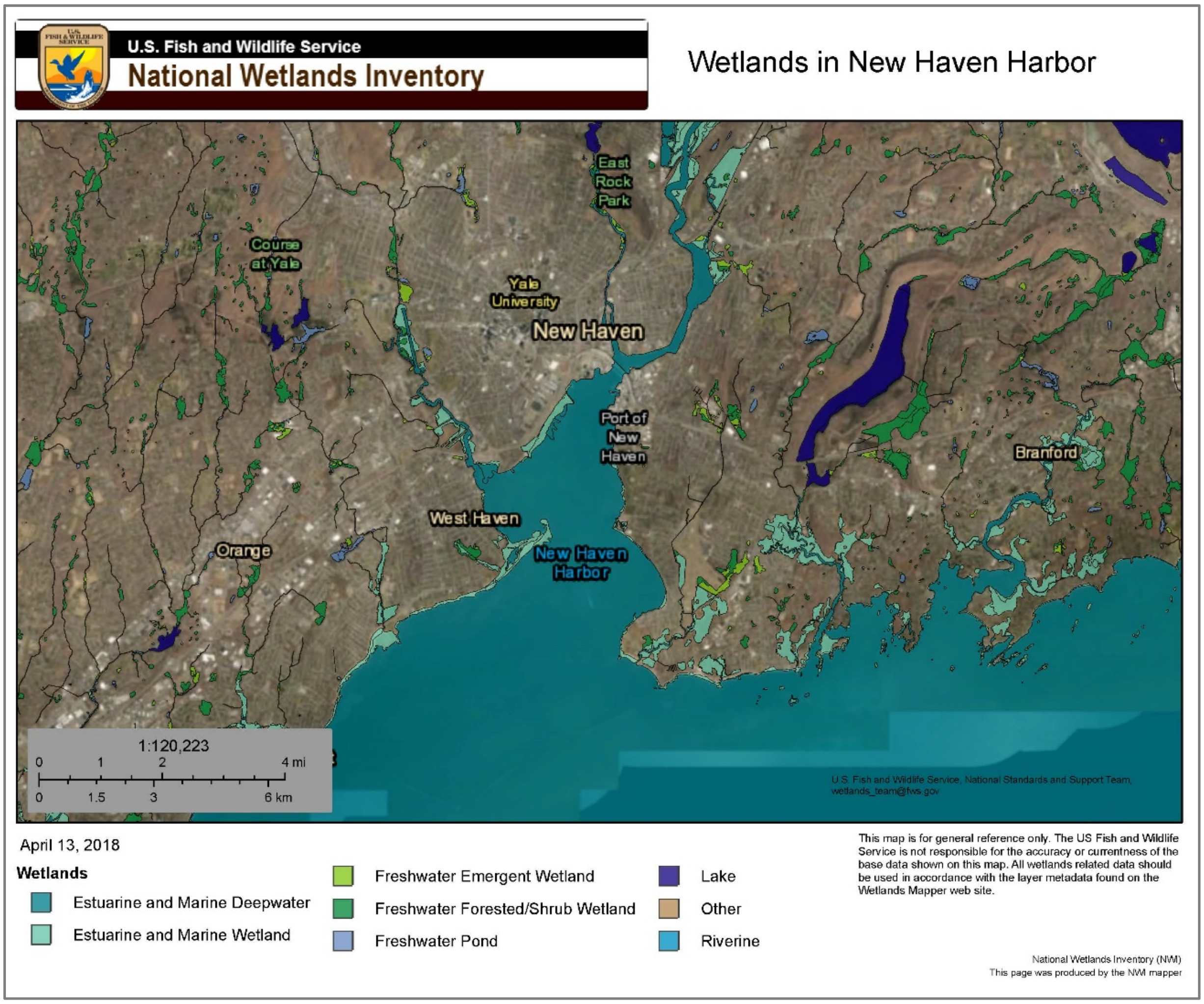


Figure 3-1: Wetlands in New Haven Harbor (USFWS, 2018)

3.4 Benthic Habitat

3.4.1 Navigation Channel

The benthic communities in New Haven Harbor have been documented in numerous studies (NAI 1979, NAI 1985, Pellegrino 1990, DeLeuw Cather 1991, ESS 2001). Data from the sampling stations near and/or in the navigation channel in New Haven Harbor indicate that those areas are generally occupied by a mix of opportunistic early-successional stage benthic communities and mid-successional stage benthic communities (which are a mix of early colonizers and later stage colonizers). Most of the studies noted above described a community of variable species composition, with early successional stage polychaete worms (e.g., *Streblospio benedicti* and *Capitella capitata*) as the dominant species and other species of importance being coot clams (*Mulinia lateralis*), the tube building amphipod (*Ampelisca abdita*), oligochaete worms, mysids (*Neomysis americana*), and the tellinid bivalve (*Tellina agilis*) (NAI, 1985, Pellegrino 1990, ESS 2001).

To validate the findings of the historical studies, the benthic communities in the areas being considered for navigation improvement were sampled in May 2017. Seven grab samples were taken along the length of the navigation channel in proposed dredge areas for the project (See Appendix I for maps of sample locations). The benthic communities of the improvement areas in the New Haven inner harbor area (i.e., areas of the harbor north of sandy point), represented by stations #1 and #2, contained a mix of opportunistic benthic species such as the polychaete *Streblospio benedicti*. The benthic communities in these silty sediment environment were generally low in diversity and dominated by only a few species (Table 3-1). The outer harbor stations (stations #3 - #7), which had silty-clayey sediments, contained a mix of opportunistic species and mid-successional stage organisms such as the tubiculous polychaetes *Clymenella torquata* and *Spiochaetopterus oculatus*. The communities in the outer harbor stations were higher in diversity than the inner harbor stations and individuals tended to be distributed among species more evenly. A complete benthic report is provided as Appendix I.

Table 3-1: Benthic invertebrates collected from the New Haven Harbor Navigation Improvement Areas in May 2017 (Numbers are per 0.04 m^2)

STATION NUMBER	1	2	3	4	5	6	7
ANNELIDA							
POLYCHAETA							
Aricidea sp.	-	-	-	-	-	-	1
Alitta succinea	-	1	2	5	-	-	2
Capitella sp.	-	-	4	-	-	3	4
Clymenella torquata	-	-	-	15	-	-	11
Diopatra cuprea	-	-	-	-	1	-	-
Glycinde solitaria	-	-	1	-	-	1	-
Leitoscoloplos fragilis	-	-	-	2	-	-	7
Nephtys incisa	-	1	-	-	-	-	-
Orbinia sp.	-	-	-	2	-	-	2
Pectinaria gouldii	1	-	-	-	-	-	-
Pherusa sp.	-	-	-	-	-	5	-
Polydora sp.	-	-	-	-	2	-	-
Spiochaetopterus oculatus	-	-	-	3	1	-	
Streblospio benedicti	13	7	9	4	6	-	4
OLIGOCHAETA							
Unidentified Oligochaete sp.	-	10	2	5	-	-	2
ARTHROPODA - CRUSTACEA							
AMPHIPODA							
Unidentified Gammaridae	-	-	-	1	3	2	-
Ampelisca abdita	3	-	-	8	-	6	74
Corophium sp.	-	-	-	1	-	3	-
CUMACEA							
Unidentified Cumacean	-	1	-	-	-	-	-
DECAPODA							
Pagurus longicarpus	-	-	-	-	-	2	-
Neopanope sp.	-	-	-	-	1	-	-
MOLLUSCA							
BIVALVIA							
Anadara ovalis	-	-	-	-	-	1	-
Ensis directus	-	-	-	-	-	-	1
Mulinia lateralis	-	-	-	4	-	-	-
Yoldia limatula	-	1	6	-	4	-	-
GASTROPODA							
Haminoea solitaria	-	6	2	1	-	-	-
Nassarius trivitatus	3	-	5	-	4	-	-
Urosalpinx cinerea	-	-	1	-	-	-	-
INDIVIDUALS / SAMPLE	**20**	**27**	**32**	**51**	**22**	**23**	**108**
SPECIES / SAMPLE	**4**	**7**	**9**	**12**	**8**	**8**	**10**

3.4.2 Shellfish Habitat Creation Area

The benthic communities of the shellfish habitat creation area (described in detail in Section 5.2.5) in New Haven Harbor, represented by stations #8, #9, and #10 contained a mix of opportunistic benthic species such as the polychaete species *Streblospio benedicti* and *Capitella* sp. as well as late-successional stage organisms such as the bivalve *Yoldia limatula*. The benthic communities in this silty sediment environment were generally moderate in diversity and contained an even distribution of individuals among species (Table 3-2).

Table 3-2: Benthic invertebrates collected from the New Haven Harbor Shellfish Creation Area in May 2017 (Numbers are per 0.04 m2)

STATION NUMBER	8	9	10
ANNELIDA			
POLYCHAETA			
Alitta succinea	2	3	2
Capitella sp.	17	6	22
Glycinde solitaria	3	-	-
Leitoscoloplos fragilis	-	-	3
Nephtys incisa	1	4	-
Orbinia sp.	-	-	1
Pectinaria gouldii	1	-	1
Spiochaetopterus oculatus	-	2	6
Streblospio benedicti	21	-	15
OLIGOCHAETA			
Unidentified Oligochaete sp.	-	-	2
ARTHROPODA - CRUSTACEA			
AMPHIPODA			
Ampelisca abdita	-	1	-
CUMACEA			
Oxyurostylus smithii	3	-	-
MOLLUSCA			
BIVALVIA			
Mulinia lateralis	-	-	1
Yoldia limatula	7	6	15
GASTROPODA			
Haminoea solitaria	4	-	-
INDIVIDUALS / SAMPLE	**59**	**22**	**68**
SPECIES / SAMPLE	**9**	**6**	**10**

3.5 Essential Fish Habitat

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act and amended by the Sustainable Fisheries Act of 1996, an Essential Fish Habitat (EFH) consultation is necessary for this project. EFH is broadly defined as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." New Haven Harbor and the Federal Navigation Project fall into this category and thus have the potential to provide habitat for fish species in the area. Per EFH source documents (NEFMC/NMFS, 2017), Table 3-3 denotes the federally managed species and their associated life stages that have EFH within the project area.

Table 3-3: Federally Managed Species and Their Associated Life Stages
that have EFH within the Project Area

Common Name	Scientific Name	Life Stages with EFH in Project Area
pollock	*Pollachius virens*	juveniles, adults
windowpane flounder	*Scopthalmus aquosus*	eggs, larvae, juveniles, adults
winter flounder	*Pseudopleuronectes americanus*	eggs, larvae, juveniles, adults
silver hake	*Merluccius bilinearis*	eggs, larvae, juveniles, adults
red hake	*Urophysis chuss*	eggs, larvae, juveniles, adults
little skate	*Leucoraja erinacea*	juveniles, adults
winter skate	*Leucoraja ocellata*	juveniles, adults
Atlantic sea herring	*Clupea harengus*	juveniles, adults

3.6 Protected Species

3.6.1 Sea Turtles

Four species of federally threatened or endangered sea turtles may be found seasonally in the coastal waters of Connecticut and New York: the federally threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead turtle (*Caretta caretta*); the federally endangered Kemp's Ridley (*Lepidochelys kempi*); the green turtle (*Chelonia mydas*); and the leatherback (*Dermochelys coriacea*) sea turtle. The leatherback is generally found in deep offshore waters and as such, is unlikely to occur in the action area. In general, listed sea turtles are seasonally distributed in coastal U.S. Atlantic waters, migrating to and from habitats extending from Florida to New England, with overwintering concentrations in southern waters. As water temperatures rise in the spring, these turtles begin to migrate northward. As temperatures decline rapidly in the fall, turtles in northern waters begin their southward migration. Sea turtles can be expected in the waters of Long Island in warmer months, typically when water temperatures are at least 15°C. This typically coincides with the months of May through November, with the highest concentration of sea turtles present from June to October

(Morreale 1999; Morreale and Standora 1998; Shoop and Kenney 1992).

3.6.2 Atlantic Sturgeon

There are five DPSs of Atlantic sturgeon listed as threatened or endangered. Atlantic sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are listed as endangered, while the Gulf of Maine DPS are listed as threatened. The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida.

Atlantic sturgeon spawn in their natal rivers, with spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron et al. 2002). Young remain in the river/estuary until approximately age 2 and at lengths of 30-36 inches before emigrating to open ocean as subadults (Holland and Yelverton 1973; Dovel and Berggen 1983; Dadswell 2006; ASSRT 2007). After emigration from the natal river/estuary, subadults and adult Atlantic sturgeon travel within the marine environment (typically in waters between 16 to 164 feet in depth) using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963; Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Collins and Smith 1997; Savoy and Pacileo 2003; Stein et al. 2004; Laney et al. 2007; Dunton et al. 2010; Erickson et al. 2011).

Adult and subadult Atlantic sturgeon are known to occur in Long Island Sound, as well as within the waters off Connecticut and, as noted above, are likely to be migrating and possibly foraging opportunistically should suitable forage be available. As Atlantic sturgeon spawn in freshwater portions of large rivers and early life stages are not tolerant to salinity, no eggs, larvae or juvenile Atlantic sturgeon are likely to occur in New Haven Harbor.

3.6.3 Birds

Several threatened or endangered bird species are present within the New Haven Harbor project area. The Federally threatened piping plover (*Charadrius melodus*) occurs in the harbor areas, generally between April and September, where it utilizes intertidal areas for feeding and resting and beach areas for nesting and fledging. The Federally threatened Red knot (*Calidris canutus rufa*) has the potential to occur and use the beaches and intertidal areas of the harbor for feeding and resting. The Federally Endangered Roseate Tern (*Sterna dougallii dougallii*) also occurs within the harbor areas, using the system for feeding and resting.

3.6.4 Mammals

The Federally threatened northern long-eared bat (*Myotis septentrionalis*) is found across much of the eastern and north central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. The northern long-eared bat is a wide-ranging species found in a variety of forested habitats in summer and hibernates in caves and mines (or habitat with similar conditions to suitable caves or mines) in winter. While this species is not directly within the project area of the proposed project, the possibility of occurrence in adjacent forested areas is possible.

3.7 Marine Mammals

3.7.1 Harbor Seal

Harbor seals (*Phoca vitulina concolor)* are the only marine mammals common to Connecticut. Harbor seals are found on both the east and west coasts of the United States and they inhabit most of Canada's coastline and all of Alaska's. They live in coastal waters off beaches and rocky shores, estuaries and river mouths. Harbor seals are active year round. The seals found in Connecticut migrate from northern waters to the Long Island Sound from mid-November to December. They spend the winter and leave for northern waters again in mid-March to April. During the times they are in Long Island Sound can be found on the Connecticut coast from Stonington to Greenwich.

3.8 Fish

3.8.1 General

Long Island Sound, which includes New Haven Harbor, supports a diverse assemblage of fish. Many of the fish species in Long Island Sound are commercially and recreationally important. Connecticut commercial fisheries, between 2010 - 2014, harvested on average 5 to 6 million pounds of catch from Long Island Sound annually (CT DEEP 2015). Commercial and recreational fisheries in Long Island Sound are valued at over one billion dollars (LIS Task Force 2003).

The most common year-round species of fish found in Long Island Sound include winter flounder, windowpane flounder, Atlantic menhaden, Atlantic silversides, butterfish, and scup. The most common anadromous species of fish (species that migrate from marine waters to freshwater streams and rivers) found in these waters include striped bass, alewife, blueback herring, white perch, and American shad. Table 3-4, based on data from Stone et al. (1994) and CT DEEP (2017), presents a list of highly abundant, abundant, common, and rare species collected in Long Island Sound and, by extension, in New Haven Harbor. Field work conducted in New Haven Harbor from early February to late May 2001 and 2002 to evaluate the ichthyoplankton community in the harbor (Lawler, Matusky, and Skelly Engineers 2003) revealed that life stages of the majority of the species noted in the "highly abundant" and "abundant" sections of Table 3-4 were recovered during the sampling.

3.8.2 Anadromous Fish

Anadromous fish migrate through New Haven Harbor into the rivers that discharge into the harbor. The West River has historically supported runs of sea run brown trout, white perch, alewife, and blueback herring and the Quinnipiac River has historically supported runs of alewife, blueback herring and American shad (USFWS, undated). Data collected during spring 2018 fish runs by the Connecticut DEEP Inland Fisheries Division's diadromous fish program identified only alewife and gizzard shad in only the Quinnipiac River (CT DEEP, 2018).

3.8.3 Winter Flounder

Winter flounder (*Pseudopleuronectes americanus*) have historically been one of the most abundant fish species in New Haven Harbor. The harbor is an important spawning area for winter flounder and tends to have average or above average geometric mean catch of young-of-year (YOY) for winter flounder when compared to other harbors along the Connecticut coast (Howell and Molnar 1994; Schultz, et al. 2007). Winter flounder eggs and larvae have been documented in both inner and outer New Haven Harbor (Schultz et al 2007), with eggs present over sandy sediments as well as fine grained sediments. Schultz et al. (2007) concluded that the prime winter flounder egg habitat occurs in shallow waters in areas of low water velocity (less than 0.8 knots) and is likely a function of current patterns that form as a result of micro-scale variations in seafloor bottom bathymetry.

The inner and outer harbor areas are also important feeding grounds for juvenile and adult winter flounder (Carlson 1991). Carlson et al. (1997) concluded that winter flounder in New Haven Harbor were primarily opportunistic feeders that tended to forage on the predominant benthic prey species available.

Table 3-4: Fish Species Found in Long Island Sound Grouped by Abundance Categories

Common Name	Scientific Name	Characteristics
Highly Abundant		
Alewife	*Alosa pseudoharengus*	anadromous, schooling, shallow water fish
Atlantic menhaden	*Brevoortia tyrannus*	schooling, pelagic, shallow water fish
Atlantic silversides	*Menidia menidia*	estuarine, schooling
Blueback herring	*Alosa aestivalis*	anadromous, schooling, shallow water fish
Butterfish	*Peprilus triacanthus*	coastal/oceanic, pelagic
Skates	*Raja* species	demersal
Scup	*Stenotomus chrysops*	demersal, prefers bays and shallow waters
White perch	*Morone americana*	anadromous
Windowpane flounder	*Scophthalmus aquosus*	demersal
Winter flounder	*Pseudopleuronectes americanus*	demersal
Abundant		
American eel	*Anguilla rostrata*	catadromous

Common Name	Scientific Name	Characteristics
American sand lance	*Ammodytes americanus*	demersal, burrowing fish
American shad	*Alosa sapidissima*	anadromous, schooling, shallow water fish
Atlantic herring	*Clupea harengus,*	schooling shallow water fish
Atlantic tomcod	*Microgadus tomcod*	demersal
Bay anchovy	*Anchoa mitichilli*	schooling, shallow water fish
Bluefish	*Pomatomus saltatrix*	pelagic, schooling oceanic fish
Killifishes	*Fundulus* species	small schooling fish
Red hake	*Urophycis chuss*	demersal
Striped bass	*Morone saxitilis*	anadromous, schooling
Weakfish	*Cynoscion regalis*	pelagic
Yellow perch	*Perca flavescens*	primarily freshwater; semi-anadromous
Common		
Atlantic mackerel	*Scomber scombrus*	pelagic
Black sea bass	*Centropristes striata*	groundfish
Channel catfish	*Ictalurus punctatus*	freshwater species, demersal
Cunner	*Tautogolabrus adspersus*	demersal
Gobies	*Gobiosoma* species	estuarine, often associated with oyster reefs
Hogchoker	*Trinectes maculatus*	demersal
Northern pipefish	*Syngnathus fuscus*	demersal
Northern searobin	*Prionotus carolinus*	demersal
Oyster toadfish	*Opsanus tau*	demersal
Pollock	*Pollachius virens*	groundfish
Rainbow smelt	*Osmerus mordax*	anadromous
Sheepshead minnow	*Cyprinodon variegatus*	estuarine, prefers open vs. vegetated bottom
Shortnose sturgeon	*Acipenser brevirostrum*	anadromous (amphidromous)
Tautog	*Tautoga onitis*	demersal, shore fish
Rare		
Atlantic stingray	*Dasyatis sabina*	anadromous, demersal
Cownose ray	*Rhinoptera bonasus*	benthopelagic, brackish, marine
Atlantic sturgeon	*Acipenser oxyrhynchus*	anadromous, demersal
Atlantic salmon	*Salmo salar*	anadromous, benthopelagic
Atlantic cod	*Gadus morhua*	schooling, benthopelagic, brackish, marine
Haddock	*Melanogrammus aeglefinus*	demersal, marine
Spot	*Leiostomus xanthurus*	demersal, brackish, marine
Northern kingfish	*Menticirrhus saxatilis*	demersal, brackish, marine, shallow coastal waters
Mullets	*Mugil* species	schooling, anadromous, benthopelagic
Summer flounder	*Paralichthys dentatus*	demersal, marine, shallow coastal waters

3.9 Shellfish and Lobster

3.9.1 Shellfish

The harvesting of shellfish is an intensive aquaculture industry in the shallow subtidal areas of New Haven Harbor. Shellfish species commercially managed and harvested in New Haven Harbor include the eastern oyster (Crassostrea virginica) and the hard-shell clam (Mercenaria mercenaria).

The Connecticut Department of Agriculture's Bureau of Aquaculture (BOA) manages the shellfish beds seaward of the mean high water (MHW) line, while shellfish beds located landward of the extension of the MHW line across most harbors, bays, and creeks are typically managed by local municipalities. Under agreements with the New Haven Harbor municipalities (New Haven, West Haven, and East Haven), the BOA monitors and governs all parcels of seafloor within New Haven Harbor, as well as those outside of the breakwaters. Figure 3-2 shows the managed shellfish parcels within New Haven Harbor. Table 3-5 and 3-6 display the parcel name, bed type, and total area of each parcel that falls within the footprint of the proposed navigation improvement project.

The BOA and the CT DEEP also map shellfish concentration areas within the harbor and manage the state's growing areas (CT DEEP 2018). Inner New Haven Harbor is classified as a "prohibited" shellfish area. A "prohibited" classification is used to identify: 1) a growing area where there has been no current sanitary survey or where a sanitary survey has found that the area is adjacent to a sewage treatment plant or other point source outfall with public health significance; 2) an area where pollution sources may unpredictably contaminate the growing area; 3) an area where the growing area is contaminated with fecal waste so that the shellfish may be vectors for disease microorganisms; and 4) an area where the concentration of biotoxin is sufficient to cause a public health risk. Shellfish may not be harvested from "prohibited" areas except for seed oystering or depletion of the areas.

The majority of the outer harbor is designated as a "restricted relay" shellfish area. A "restricted relay" is a classification used to identify a growing area where harvested shellfish stock is relayed to "approved" or "conditionally approved" waters for natural cleansing or depuration. An area may be classified as "restricted relay" when a sanitary survey finds a limited degree of pollution and levels of fecal pollution, human pathogens, or poisonous or deleterious substances so that shellfish stock can be made safe for human consumption by either relaying, depuration or low acid-canned food processing. Shellfish can only be harvested from "restricted" areas by special license, and may not be directly harvested for market or consumption.

Harbor areas just outside of the breakwaters are classified as "conditionally approved" shellfish areas. (CT DEEP 2018). "Conditionally approved" areas are a classification used to identify a growing area that is safe for the direct, marketing or consumption of shellfish when the area is in the open status. The area must meet the criteria for "approved" classification when the area is in the open status, and meets the criteria for the restricted classification in the closed status. An area may be classified as "conditionally approved" when a sanitary survey finds that the area can remain in the open status for a reasonable period of time, the factors impacting the area are known and predictable and do not preclude a reasonable management approach, and the water quality correlates with the environmental conditions or other factors affecting the distribution of pollutants into the growing area. Each "conditionally approved" growing area must have a written management plan that is adhered to by all responsible parties.

Table 3-5: Shellfish Parcels within New Haven Harbor in the Footprint of the Proposed Improvement Project

Parcel Name	Bed Type	Fishing Status	Total Area of Parcel (acres)
05-14	Hard Clam/Oyster	inactive	134.7
Lot 66	Oyster	active	4.5
Lot 49	Oyster	active	30.7
Lot 70	Oyster	inactive	14.3
Lot 72	Oyster	active	204.8
Lot 74	Oyster	active	71.3
Lot 90	Oyster	active	61.8
Lot 97	Oyster	active	20.1
Lot 99	Oyster	active	28.9
Lot 100	Oyster	active	10.8
Lot 103	Oyster	active	33.7
Lot 106	Oyster	active	23.5
Lease 146	Oyster	inactive	31.5
324B	Hard Clam/Oyster	inactive	52.8
324A	Hard Clam/Oyster	active	41.6
Lot 327	Clam	active	55.5
Lot 339	Hard Clam/Oyster	active	198.3
Lot 343	Hard Clam/Oyster	active	107.9
Lease 568	Clam	active	233.6

Parcel Name	Bed Type	Fishing Status	Total Area of Parcel (acres)
L-635	Clam	active	89.1
L-636	Clam	inactive	50.4

Table 3-6: Shellfish Parcels within New Haven Harbor in the Footprint of the Proposed Confined Aquatic Disposal Cell

Parcel Name	Bed Type	Fishing Status	Total Area of Parcel (acres)
Lot 80	Oyster	Unknown	10.0
Lot 86	Oyster	Unknown	1.0
Lot 89B	Oyster	Unknown	3.5
Lot 90A	Oyster	active	61.8

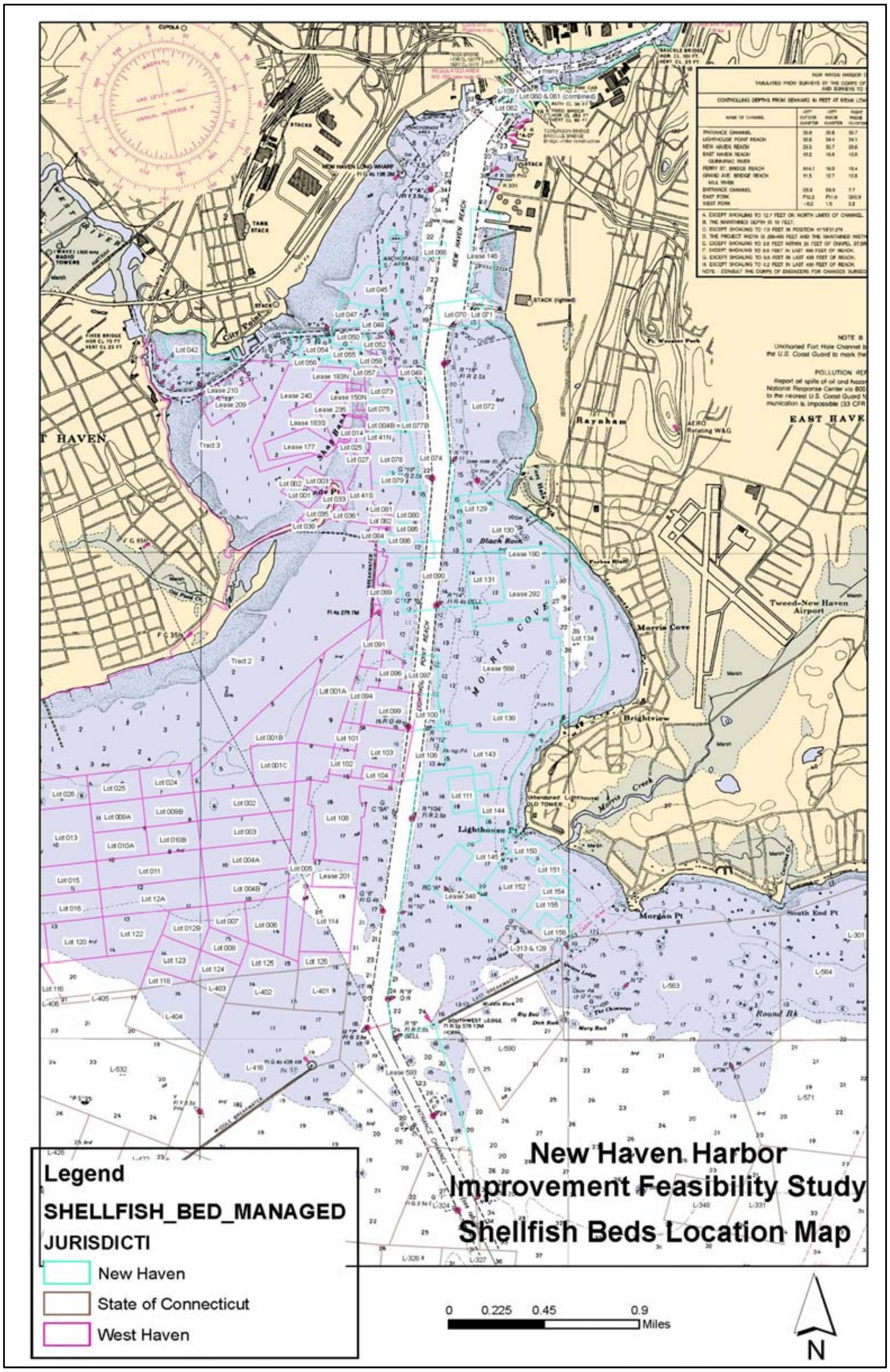


Figure 3-2: Managed Shellfish Parcels in New Haven Harbor, CT

3.9.2 Lobster

The lobster populations in Long Island Sound have been in severe decline over the past two decades (CT DEEP 2015b). Modelling and indicators for lobster stock assessments in the Southern New England (SNE) lobster stock have demonstrated that abundance, spawning stock biomass, and recruitment are at historic low levels for the SNE stock (CT DEEP 2015b). The SNE stock has not shown significant signs of rebuilding since harvest restrictions were put in place following the findings of a 2010 assessment of the stock.

While no site specific data for lobster resources within New Haven Harbor are available, the harbor does contain a variety of habitat types that are considered preferred lobster habitat, specifically the breakwater structures in the harbor. Observations made during the multiple bathymetric, ecological, and side scan surveys of the improvement areas and placement areas did not reveal the presence of significant amounts of lobster fishing gear (personal communication with Richard Loyd (USACE), June 2018).

3.10 Birds

3.10.1 New Haven Harbor

New Haven Harbor is an important feeding and resting area for many migrating and wintering shorebirds, gulls and waterfowl. The habitat is typical of a large, shallow urbanized estuary.

Historical studies of the New Haven Harbor, from 1971-1977, reported a total of 125 bird species observed in the harbor (Normandeau Assoc., 1979). The western side of the harbor was used extensively by waterfowl, gulls, and shorebirds. The fewest species were observed in spring and the highest numbers observed in summer and fall. Scaup were the most numerous of the diving ducks, and black ducks the most predominant of the dabblers (Normandeau Assoc., 1979). Other waterfowl species that were abundant in the harbor include horned grebe, canvasback, common goldeneye, and bufflehead. Commonly found shorebirds include black-bellied plover, dunlin, sanderling, semipalmated sandpiper, great black-backed gull, herring gull, ring-billed gull, Bonaparte's gull, and common tern.

A review of The Cornell Lab of Ornithology’s ebird database (https://ebird.org/map/) revealed observations of 346 species from locations abutting New Haven Harbor between 2008 and 2018. Bird species present were similar to those noted above from the historical studies. Species of note from the ebird data include piping plover, red knot, and roseate tern.

3.10.2 Sandy Point Bird Sanctuary

The Sandy Point bird sanctuary is one of the most significant nesting locations for the federally threatened piping plover in Connecticut. It is also contains habitat for least tern and common tern colonies. The area receives significant usage by migrating shorebirds, which roost on the sand spit and sandbars at high tide and forage on the tidal flats at lower tides. It is one of the primary stopover areas for red knot in Connecticut. There is also a small nesting colony of saltmarsh sharp-tailed sparrows in the small tidal marsh, and the area receives significant usage by saltmarsh and Nelson's sharp-tailed sparrows in migration.

3.11 Invasive Species

Invasive species can adversely impact native plant and animal populations by disrupting natural ecosystem functions. Impacts range from impaired recreational uses, fouled boat hulls, and reduced property value to degraded water quality, declines in finfish and shellfish population, and reduced biodiversity. Invasive species that may occur in the project area or in the area of influence include:

Phragmites australis (Common Reed)
Anoplophora glabripennis (Asian Long Horn Beetle)
Hemigrapsus sanguineus (Asian Shore Crab)

Invasive species are generally introduced into ecosystems via direct stocking, aquarium releases, shipping, and bait releases. Of these pathways, commercial shipping is the only direct mechanism related to this project. The principal way aquatic invasive species can enter state 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 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 Connecticut. If discharged into state 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.

3.12 Air Quality

NEPA requires consideration of whether the Proposed Action will have an adverse effect on air quality in the study area. In order to assess the potential for the proposed action to affect air quality, quantitative emissions analyses have been prepared.

Pursuant to the Federal Clean Air Act (CAA) of 1970, the EPA established National Ambient Air Quality Standards (NAAQS) for major pollutants known as “criteria pollutants.” Currently, the EPA regulates six criteria pollutants: ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), particulate matter, and lead (Pb). Particulate matter (PM) is divided into two particle size categories: particles with a diameter less than 10 micrometers (PM10) and those with a diameter of less than 2.5 micrometers (PM2.5). Connecticut adopted the national standards which includes both the primary and secondary NAAQS for the criteria pollutants (EPA, 2018). The NAAQS are two tiered: the first tier (primary) is intended to protect public health; the second tier (secondary) is intended to protect public welfare and prevent degradation of the environment.

Section 176(c) of the CAA requires Federal agencies to ensure that all of their actions conform to applicable implementation plans for achieving and maintaining the NAAQS. Federal actions must not cause or contribute to any new violation of any standard, increase the frequency or severity of any existing violation, or delay timely attainment of any standard.

Attainment

The NAAQS apply to the concentration of a pollutant in outdoor ambient air. If the air quality in a geographic area is equal to, or is better than the national standard, the Environmental Protection Agency (EPA) will designate the region as an attainment area. Areas where air quality does not meet the national standards are designated as non-attainment areas. Once the air quality in a non-attainment area improves to the point where it meets the standards and the additional redesignation requirements in the CAA [Section 107(d)(3)(E)], EPA may redesignate the area as an attainment/maintenance area, which are typically referred to as “maintenance areas.” The CAA requires EPA to designate the status of all areas as being in or out of compliance with the NAAQS. The CAA further defines non-attainment areas for ozone based on the severity of the violation as marginal, moderate, serious, severe, and extreme. The State has developed a State Implementation Plan (SIP) to attain and maintain the standards in the NAAQS. The EPA Green Book, which lists non-attainment, maintenance, and attainment areas, was reviewed to determine the designations for New Haven County in which the proposed project is located. The EPA Green Book shows that New Haven County is designated by the EPA as a moderate non-attainment area for the 2008 8-hour ozone standard. The area is designated as attainment for all other NAAQS (40 CFR §81.307).

3.13 Hazardous, Toxic, and Radioactive Waste

New Haven Harbor is Connecticut's largest commercial port with several possible sources for accidental releases of hazardous waste. The port is a crucial import location for refined petroleum products, which supplies demand within Connecticut and the broader Northeast region, and has several terminals that receive the petroleum products. Several wastewater treatment plants also discharge into New Haven Harbor and its tributaries. Additionally, the areas surrounding the harbor and its tributaries are home to an electricity generating station, various industrial companies, automobile servicing companies, marinas, and recreational and commercial vessel fuel docks.

A review of the CTDEEP hazardous spill record database for areas surrounding New Haven Harbor between 1999 – 2014 indicated measurable spills (i.e., spills capable of being quantified) of diesel fuel, gasoline, home heating oil (#2 fuel oil), hydraulic oils, raw sewage, waste motor oil, and antifreeze. Locations ranged throughout the harbor and its tributaries.

3.14 Noise

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.

New Haven has functioned as an international harbor since colonial times. Over the last 300 years, New Haven 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 New Haven 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, New Haven 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.

New Haven Harbor has the typical noise characteristics of a busy harbor. Sources include recreational and commercial vessel traffic, dredging vessels and dockside 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) (Nightengale 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.

3.15 Coastal Barrier Resources

The Coastal Barrier Resources Act (CBRA) was enacted by Congress in 1982. The CBRA was implemented to prevent development 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. As a deterrent to development, federal insurance is not available for property within designated high-hazard areas. These high-hazard areas are called CBRA Units.

CBRA 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 CBRA 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 two OPAs located within New Haven Harbor, the Morse Park Unit (CT-15P) and the Nathan Hale Park Unit (CT-14P) (Figure 3-3). The Morse Park Unit covers Sandy Point and portions of West Haven Beach to the west of the New Haven Harbor FNP, while the Nathan Hale Park Unit covers Fort Hale Point to the east of the FNP.

Habitats in both units include intertidal sand shoals (estuarine intertidal unconsolidated shore wetlands), shallow open water (estuarine subtidal unconsolidated bottom), marsh (estuarine intertidal emergent wetland), and uplands (dunes and maritime forest). Wetlands of the units provide spawning, nursery, and feeding habitat for commercially and recreationally important species of estuarine-dependent fish and wildlife. The units also provide feeding, nesting, and resting areas for piping plover, terns, shorebirds, and wading birds.

Figure 3-3: Otherwise Protected Areas in New Haven Harbor

3.16 Cultural and Historic Resources

Pre-Contact Period

Archaeologists have typically divided the Northeast, including the southern New England area into three general periods: PaleoIndian, Archaic and Woodland with the latter further subdivided into Early, Middle and Late categories. Each period is defined based on distinctive material culture, land use patterns, and social themes as displayed in the archaeological record (Cherau et al. 2010:15). Current models of sea level rise indicate that the sea level was about 300 feet below its current mean level. Hypothetically, the New Haven Harbor study area was likely located above sea level and was exposed land for occupation by Native peoples throughout the Pre-Contact Period (Cherau et al. 2010:15).

PaleoIndian Period (12,000-10,000 Before Present (BP))

The PaleoIndian period is generally characterized as bands of mobile hunters and gatherers who exploited large game as well as available plant species depending on the availability and distance from glacial lakes, ponds, rivers, streams and wetlands. The only PaleoIndian sites excavated in Connecticut are located on the Housatonic River in Washington, in Seymour, on the Mashantucket Pequot Reservation in Mashantucket, and overlooking the Thames River Valley in Groton (Cherau et al. 2010: 18-19).

Archaic Period (10,000-3,000 BP)

The Archaic Period is characterized as a time of increased exploration and settlement of southern New England along with a more diversified exploitation of animal and plant sources. Hunting and gathering is the primary means of subsistence along with seasonal movements to exploit specific resources in a variety of environments (Cherau et al. 2010:20).

Woodland Period (3,000-450 BP)

In southern New England, the Woodland Period is characterized by an increased use of ceramic vessels for food storage and preparation and the introduction of horticulture in the form of crops such as corn, beans and squash. Regionally, sites are larger in size and complexity and display a pattern of increased sedentism. Coastal shell midden sites increased in frequency during this period and indicate greater exploitation of coastal areas and resources along beaches, bays, estuaries, and salt marshes with increased use of shellfish. This subsistence pattern continued well into the Contact Period (Cherau et al. 2010:28-29).

Southern New England has been home to Native American people going back at least about 12,000 years before the present day. At least 12 Tribes are documented for the region, with the Quinnipiacs being one of the coastal Tribes that inhabited the southern half of the Central Valley region of Connecticut (Cunningham 1995:12).

Historic Context

New Haven was first visited by the Dutch before the arrival of English settlers. In 1614, the Dutch referred to the location of New Haven as “Red Mount.” The area was originally known as Quinnipiac from the name of the local Indian Tribe who also provided the name for the nearby river on the eastern boundary of New Haven. The community of New Haven was originally settled by a group of more than 250 Boston colonists led by John Davenport and Samuel Easton. In 1638, Davenport and Easton claimed the coastal land between Saybrook and Fairfield then known as Quinnipiac. This purchase included all lands within the former limits of the old towns of New Haven, Branford, and Wallingford and the towns of East Haven, Woodbridge, Bethany, Meriden, North Branford, Cheshire, Hamden, North Haven and Orange (Cherau et al. 1997:73).

Commerce and trade flourished during the Colonial Period (1675-1775) with the construction of warehouses and wharves for the West Indies trade. Yale University, originally known as the Collegiate College, was established in Saybrook in 1717 and moved to New Haven and renamed Yale University. It was the third college established in the colonies after William and Mary and Harvard. New Haven became one of the leading manufacturing centers of central Connecticut during the Early Industrial Period (1830-1850). Industrial growth helped improve the transportation system with the construction of railroads and bridges across the Connecticut River. The Farmington Canal was constructed in 1835; however, by the mid-1840's, plans were made to convert the canal to a railroad (Cherau et al. 2010:43,46).

Industrial development in the late 19th Century included arms production, hardware and machine tools. New Haven became the center for the production of arms with the Winchester Repeating Arms Company in 1870 and the Marlin Firearms Factory. Following World War II, suburban developed altered the rural landscape of New Haven and surrounding towns. Housing developments and industrial parks replaced farmland and the interstate highway system was initiated in 1956 with the construction of Interstates 95 and 91. Today, New Haven and the surrounding New Haven County are densely populated and the economy is characterized by agricultural, commercial, industrial and recreational pursuits (Cherau et al. 2010:47-8).

Previous Studies

USACE 1981 Feasibility Study

USACE completed a Feasibility Report for New Haven Harbor channel improvements in 1981. As part of this study, a cultural resources reconnaissance was conducted by staff archaeologist, John Wilson and others. No historic properties were identified. The shoreline, particularly on the west side of the harbor, has been so disturbed by harbor development that it no longer has historic archaeological significance. Deposition within the harbor, especially at the confluence of the Mill and Quinnipiac Rivers, has likely covered any potential underwater Native American archaeological sites with overburden of an unknown depth. Additionally, commercial oyster harvesting within the harbor has also disturbed sediments to some extent. However, due to sea level rise along the Connecticut, the possibility of submerged Native American sites on what was previously dry land is possible in undisturbed areas. Historic artifacts from nearby Fort Nathan Hale, on the eastern side of the harbor and currently on the National Register of Historic Places, are possible and should be brought to the attention of the dredging team.

Although Native American sites were recorded for the general New Haven Harbor area, none were recorded specifically within the project area. Most of the recorded sites were located on the Quinnipiac, Mill and West Rivers flowing into the harbor as well as on the eastern shore. However, any sites on the eastern shore were likely destroyed by industrialization. An archaeological sensitivity map completed as part of the 1981 cultural resources reconnaissance indicated high sensitivity at the confluence of the Quinnipiac and Mill Rivers and in the vicinity of Fort Nathan Hale on the eastern shore. Areas of medium sensitivity include the East Shore Park and Lighthouse Park shorelines, also in the eastern shore (Wilson 1981: 5-18 and Figure 2).

PAL Long Island Sound 2010

During preparation for the Long Island Sound (LIS) Dredge Material Management Plan (DMMP), USACE was required to conduct background research and develop a cultural resources inventory for historic, archaeological, and underwater archaeological properties along LIS including the coast of Connecticut, New York and Rhode Island. The DMMP Area of Potential Effect (APE) also included New Haven Harbor. In addition to preparing a Geographic Information System (GIS) database for all historic properties that are included or eligible for inclusion on the National Register of Historic Places (NRHP), this inventory also provided archaeological sensitivity maps for terrestrial and underwater archaeological resources within the project APE.

Within the city of New Haven, one district and eight individual properties are designated as National Historic Landmarks. Twenty-one districts (two of which are located in both New Haven and Hamden) and 29 individual properties are listed or eligible for listing in the NRHP. An additional seven districts (one located in both New Haven and Hamden) and 27 individual properties are listed in the State Register of Historic Places (Cherau et al. 2010:88).

According to Public Archaeology Laboratory's (PAL) 2010 inventory, a total of 23 Pre-Contact and Post-Contact Period sites have been recorded for New Haven, only one of which has been determined eligible for the NRHP. The Pre-Contact sites consist primarily of Archaic and Woodland Period camps in coastal locations around New Haven Harbor and associated river confluences. The Post-Contact Period sites are primarily industrial sites from the 17^{th} to the 20^{th} Centuries, including the Cruttenden Carriage Works which has been determined to be eligible for the NRHP (Cherau et al. 2010:88).

There are eight reported shipwrecks and obstructions in the vicinity of New Haven Harbor, with the waters surrounding New Haven characterized as having moderate archaeological sensitivity (Cherau et al. 2010:89).

3.17 Aesthetics and Recreation

New Haven Harbor supports a recreational fleet based at the marinas along the harbors tributaries (West River and Quinnipiac River). There are also harbor access points (e.g., power-boat ramps, canoe and kayak ramps, parks, and trails) along both the eastern and western shorelines. The number of existing and projected deep-draft vessels transiting the harbor is of minimal concern to recreational traffic as the majority of the recreational traffic occurs outside of the Main Channel. No recreational facilities are included in the proposed project.

New Haven Harbor and its associated beaches, intertidal flats, marshes, open water areas are valuable resources that are utilized by the public as fishing areas, recreational boating areas (including boat launching), hiking areas, and public swimming areas. The park lands (see Section 3.1) and trails that border New Haven Harbor provide access to scenic views of the harbor and Long Island Sound.

3.18 Socioeconomics

New Haven

In 2015, 130,322 people and 49,771 households resided in the city of New Haven. Of the 49,771 households in New Haven, 28.9% are owner occupied. The median value of owner-occupied housing units was $191,800. The median gross rent is $1,100. The average household size was 2.43. The racial makeup of the town in 2013 was 32.0% White, 33.1% African American, 0.2% Native American, 4.8% Asian, 0.1% Pacific Islander, 26.9% Hispanic or Latino, and 2.9% from two or more races. Of the town population, 48.2% were male and 51.8% were female; 7.1% were under 5 years, 22.8% were 5 years to 19 years, and 9.2% were over 65 years. The median age is 30.3. The median household income for the city of New Haven was $37,192 and the per capita income was $23,527. Approximately 26.6% of the population were below the poverty level (U.S. Census Bureau 2015a; www.city-data.com/city/New-Haven-Connecticut 2014).

The population per square mile in 2010 was 6,947.9 and the land area in square miles is 18.68. The population with a high school diploma in percent of people 25+ years is 83.0%. Those holding a bachelor's degree or higher in percent of people 25+ years is 34.4%. Unemployed population in 2013 was 13.8%. Persons without health insurance under 65 years of age is 14.0%. Those working in the civilian labor force being 16 years or higher is 64.0%, and of these 61.9% were female.

West Haven

In 2016, 54,843 people and 19,961 households resided in the city of West Haven. Of the households in West Haven, 55.5% are owner occupied. The median value of owner-occupied housing units was $193,800. The median gross rent is $1,085. The average household size was 2.6. The racial makeup of the city in 2017 was 64.0% White, 20% African American, 0.3% Native American, 4% Asian, 7% Hispanic or Latino, and 4.5% from two or more races. Of the town population, 50% were male and 50% were female; 5.1% were under 5 years, 19.9% were 5 years to 19 years, and 13.2% were over 65 years. The median household income for the city of West Haven was $50,831 and the per capita income was $26,197. Approximately 15.4% of the population were below the poverty level (U.S. Census Bureau 2017; https://www.census.gov/quickfacts/fact/table/westhavencityconnecticut/PST045217).

The population per square mile in 2010 was 5170.2 and the land area in square miles is 10.75. The population with a high school diploma in percent of people 25+ years is 87.4%. Those holding a bachelor's degree or higher in percent of people 25+ years is 21.9%. Persons without health insurance under 65 years of age is 11.2%. Those working in the civilian labor force being 16 years or higher is 67.1%.

3.19 Sediments

The following section describes the sediments found within the possible dredged material placement locations. A description of the New Haven Harbor sediments to be dredged by the proposed improvement dredging project can be found in section 2.3.5.

<u>Shellfish Creation Area</u>

The sediments in the shellfish creation area are predominately fine grained silts and clays. Table 3-7 provides the grain size distribution of the existing sediments in the area. A small area of hard bottom habitat was identified in the southwestern portion of the site (Figure 3-4).

Table 3-7: Summary of Grain Size Results, New Haven Harbor Shellfish Creation Area

Sample ID	%Cobble	%Gravel		%Sand			%Fines
		Coarse	Fine	Coarse	Medium	Fine	
Station 8	0.0	0.0	0.0	0.2	0.9	2.7	96.2
Station 9	0.0	0.0	0.0	0.1	1.7	5.8	92.3
Station 10	0.0	0.0	0.0	0.0	0.6	8.4	91.0

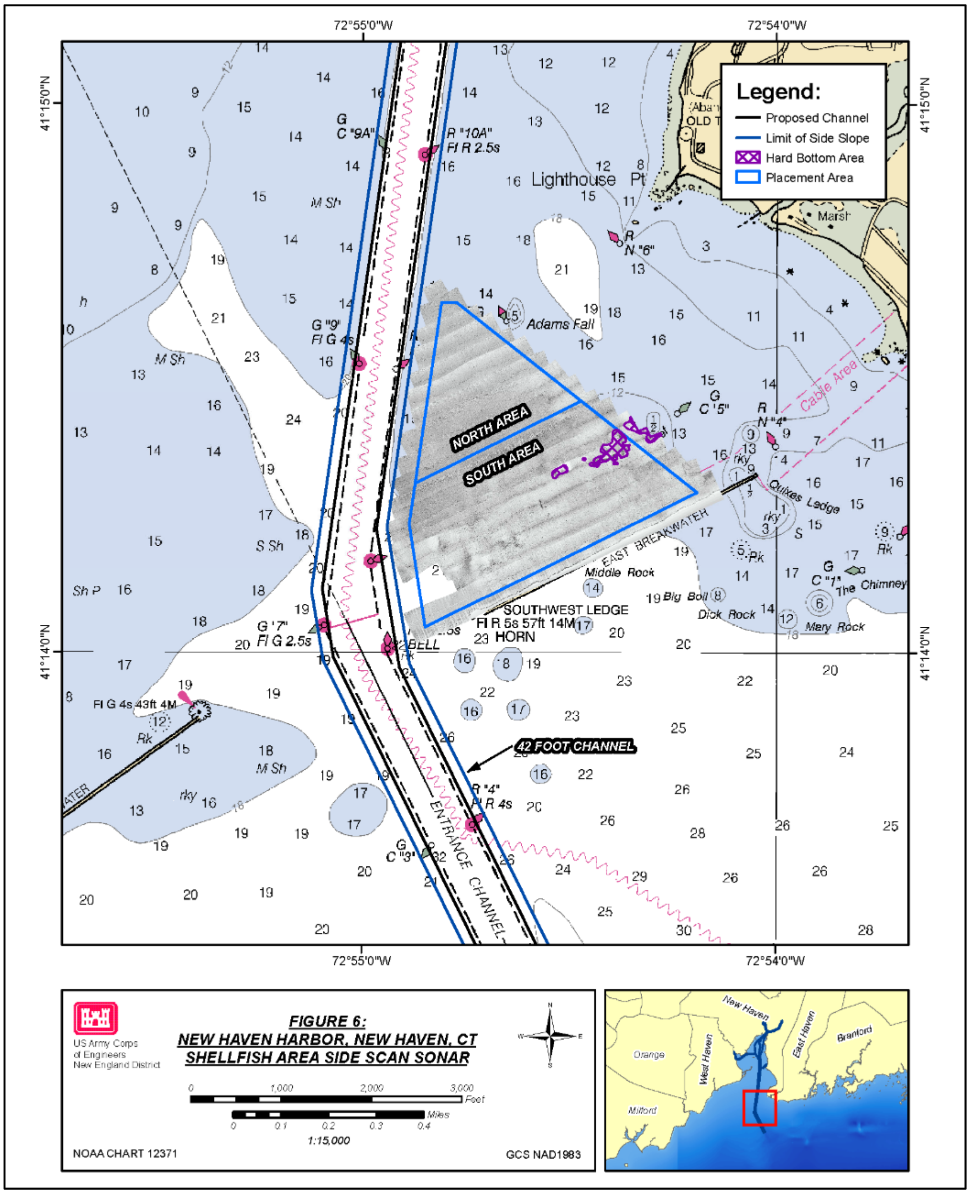


Figure 3-4: Shellfish Creation Area

<u>West River Borrow Pit</u>

The sediments in the West River Borrow Pit (Figure 3-5) are predominately fine grained silts with some fine sands. Sediment type was determined by side scan sonar and visual descriptions of sediment grabs.

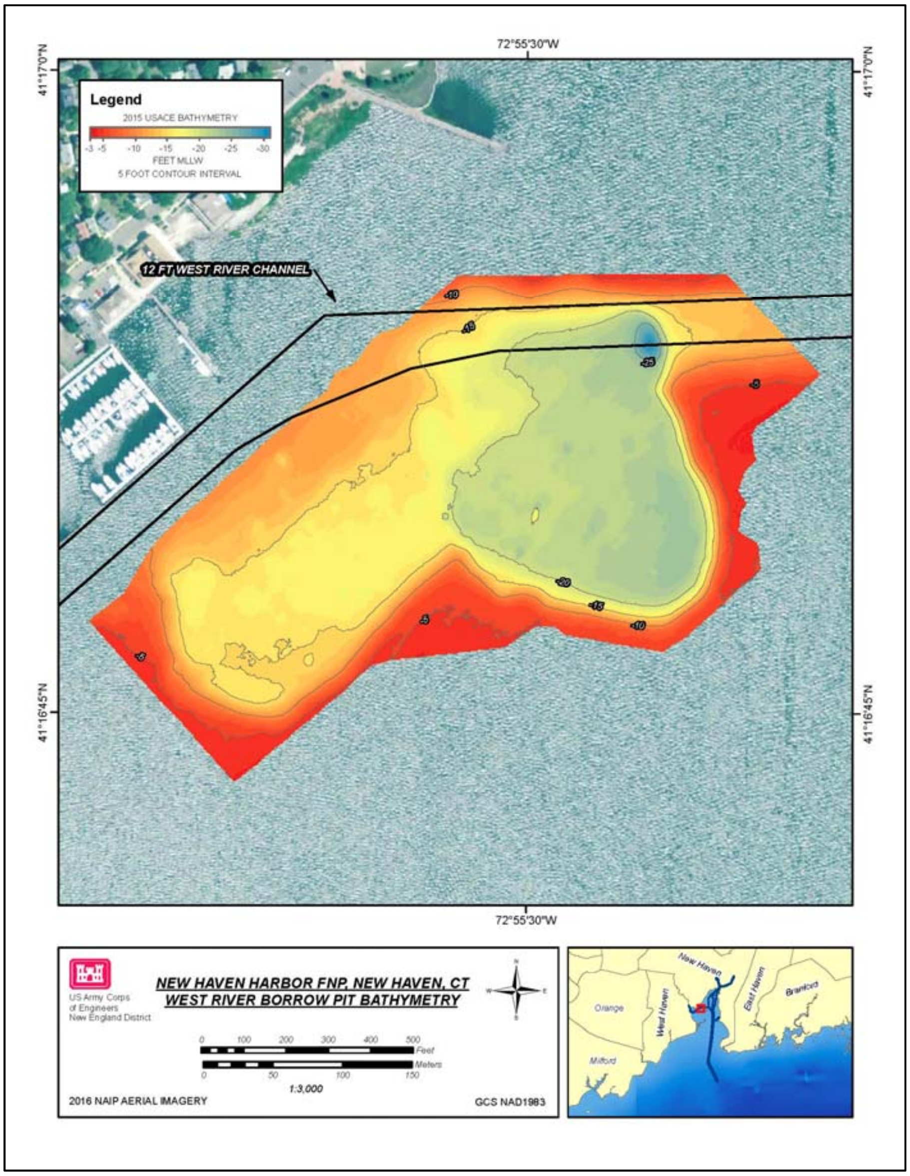


Figure 3-5: West River Borrow Pit

<u>Morris Cove Borrow Pit</u>

The sediments in the Morris Cove Borrow Pit (Figure 3-6) are predominately fine-grained sands and silts. Sediment type was determined by sediment profile imaging performed by the USACE DAMOS program in 2011 (AECOM, 2012).

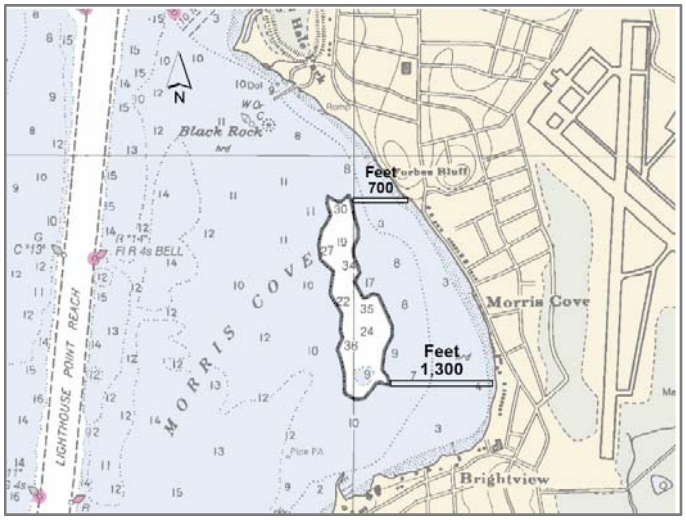


Figure 3-6. Morris Cove Borrow Pit.

Rock Placement Area

The sediments in the rock placement area (Figure 3-7) are predominately fine-grained sands and silts. Sediment type was determined by side scan sonar and visual descriptions of sediment grabs.

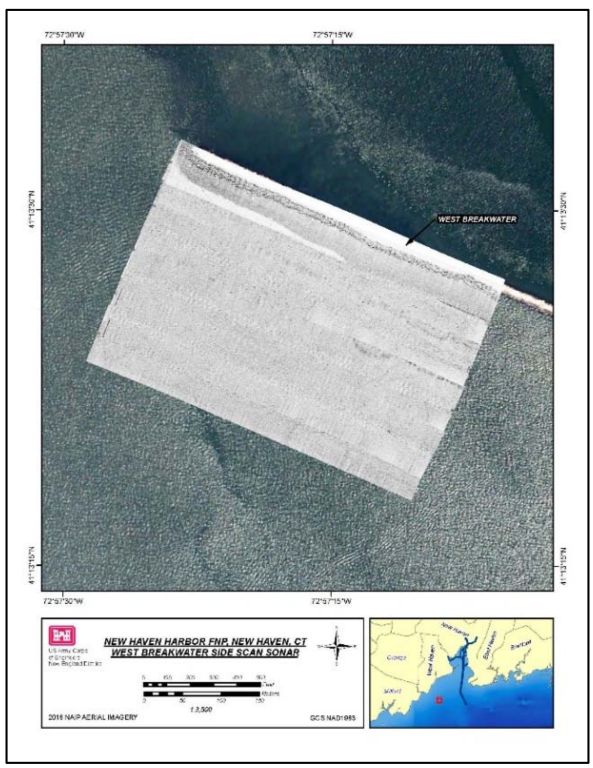


Figure 3-7: Rock Placement Area

Sandy Point Salt Marsh Creation Area

The surficial sediments in the salt marsh creation area (Figure 3-8) are predominately fine-grained sands and silts. Sediment type was determined by visual descriptions of sediment grabs as well as core samples taken for archaeological analysis.

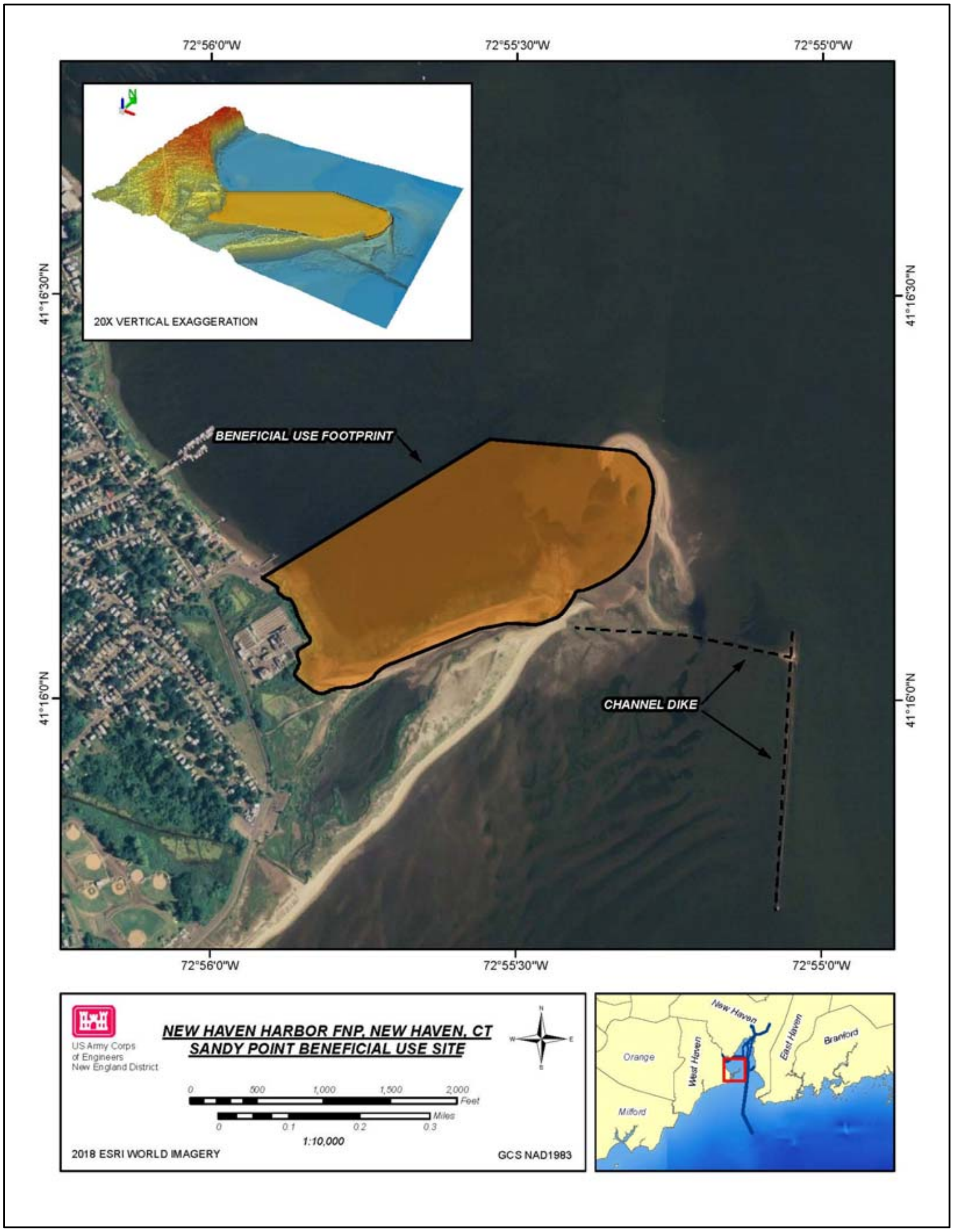


Figure 3-8: Sandy Point Salt Marsh Creation Area

<u>CAD Cell</u>

The sediments in the location for a potential CAD cell (Figure 3-9) are predominately fine-grained sands and silts. Sediment type was determined by side scan sonar and visual descriptions of sediment grabs.

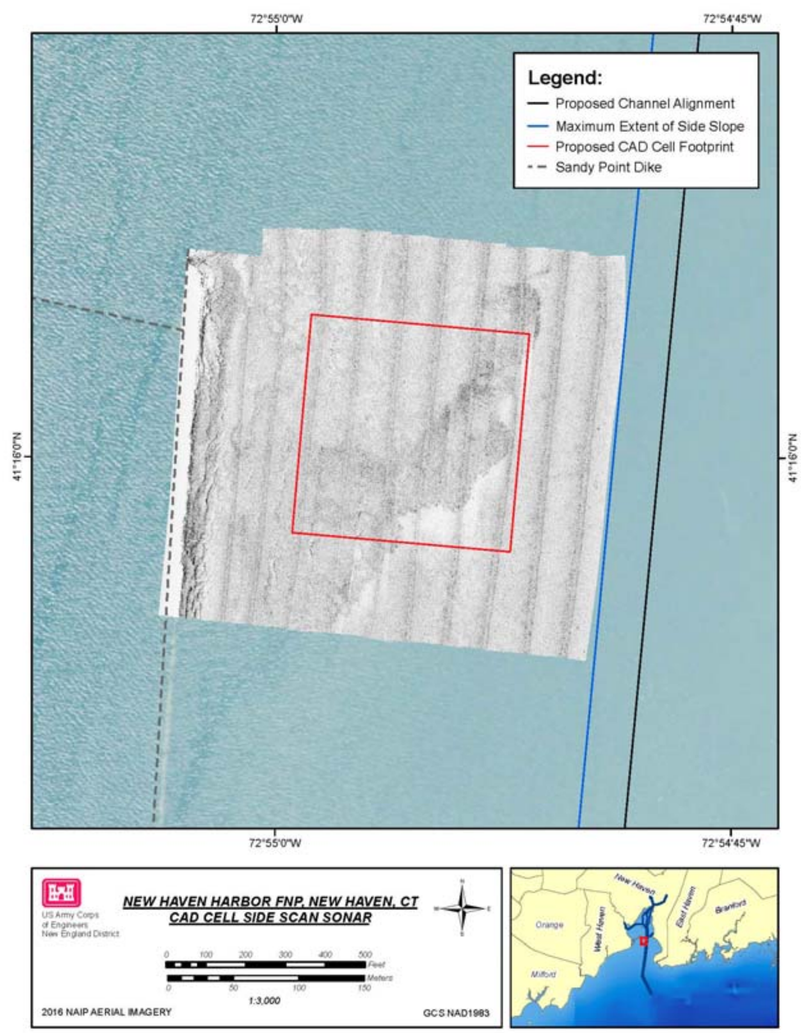


Figure 3-9: Location of potential CAD cell

4.0 PLAN FORMULATION

4.1 Navigation Inefficiencies

The purpose of USACE deep draft navigation projects is to lower transportation costs. This is done through providing conditions that allow for better utilization of present vessels, or by use of larger, more efficient vessels. Currently, New Haven Harbor has inadequate depth in the Federal channel, which results in significant tidal delays for larger vessels, some light-loading and lightering of vessels, and restrictions in the size of vessels that can be used to bring cargo to the port.

4.2 Problems and Opportunities

Problems: Navigation transportation delays & inefficiencies occur due to inadequate Federal project depth (main channel and turning basin). Large ships delay transit to use high tide to transit the channel, light load at their ports of origin, and/or lighter outside the harbor (anchorage 4 miles off shore in Long Island Sound). Lightering operations can be adversely affected by the weather and this causes additional delays. Lightering of liquid petroleum products also carries a risk of spills and environmental impacts in Long Island Sound.

Problem #1: Transportation inefficiency

- Large ships experience transit delays or have to lighter due to existing depth of channel
- Existing channel depths limit ship cargo capacity and thus terminals cannot take advantage of economies of scale

Problem #2: Maneuverability concerns

- Existing channel dimensions are not optimal for large ships increasing the risk of an accident

Opportunities: An opportunity provides a chance to create a future desirable condition and potential ways to address the specific problems within the study area.

Opportunity #1: Navigation Efficiency

- Eliminate or reduce navigational restrictions and inefficiencies (i.e., channel depth)

Opportunity #2: Improvements to Main Ship Channel

- Increase maneuverability for large ships (i.e., bend easing)

Opportunity #3: Beneficial Use

- Work with Non-Federal interests for beneficial use of dredged material including habitat creation and coastal resiliency

4.3 Planning Objectives

The problems and opportunities identified for New Haven Harbor led to the specific planning objectives stated below. These objectives provide focus for the formulation of alternatives, and reflect desired positive changes in comparison to the without-project conditions. Planning objectives for the 50-year period of analysis are:

- Reduce existing tidal delays and lightering, and reduce reliance on light loading
- Improve the efficiency of operation for tankers, bulk carriers, and general cargo ships over the 50-year period of analysis
- Accommodate any identified growth in bulk and liquid cargo
- Provide navigation conditions that support a shift to large ships
- Improve maneuverability of the deep-draft navigation at New Haven Harbor
- Consider beneficial use of dredged material

4.4 Planning Constraints

Planning constraints are restrictions that limit the planning process and the available scope of solutions to the identified problems, or that limit consideration of opportunities. Alternative plans are formulated in a manner that meets the planning objectives while avoiding the planning constraints. Planning constraints may be physical (bridges, landmasses, utilities), institutional (legal or legislative), economic, environmental, or cultural resources. The following constraints were identified for the New Haven Harbor study and will be considered during the plan formulation and evaluation process.

- Open water placement of dredged materials in Long Island Sound is limited to EPA designated sites under the Marine Protection, Research and Sanctuaries Act, consistent with the January 2016 LIS DMMP and FPEIS.
- Minimize to the extent practicable any impacts of channel modifications with New Haven Harbor's shellfish Industry
- Avoid or minimize negative impacts to the Environment and Natural Resources including but not limited to protected species, essential fish habitat, water quality, and cultural resources

4.5 Future Without-Project Conditions

The future without project alternative or no-action alternative is the condition expected to occur in the project area in the future should no-action be taken by the Federal government to improve the existing Federal navigation project at New Haven Harbor. The future without project conditions is compared to the with-project conditions (study alternatives) to identify project benefits and environmental effects of the alternatives. A 50-year period of analysis is used from the time the project is operational and begins to accrue benefits.

In the future without project condition it is assumed that the port at New Haven will continue to operate. The future without a navigation improvement project assumes that the existing channel would be maintained at the authorized depth of -35 feet MLLW. The tidal delays and lightering currently experienced would continue. Without an improvement project, shippers would continue to be limited in the size of vessel they can use to call on the port, leaving them unable to achieve the economies of scale of larger vessels. Many shippers, particularly of bulk commodities, prefer to use larger vessels with lower overall costs per ton, particularly for trips over long distances (from South America or Europe). Without a project, the degree to which commodities brought to port can be shipped on the most cost-effective vessels would be limited by the 35-foot authorized channel depth. This will impact commercial navigation at the Port. The quantitative analysis of transportation cost for the without project condition is presented in Section 5.5 of this report and in the Economic Appendix.

4.6 Formulating Alternative Plans for Navigation Improvements

Plan Formulation Rationale - Plans formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Management measures are the "building blocks" for all alternative plans. They are specific actions, ideas, programs, regulations that can be taken to address objectives. Management measures for New Haven Harbor were crafted through discussions between the Project Delivery Team (PDT) and stakeholders, review of past New Haven Harbor reports, and review of other USACE navigation reports. Measures identified were then screened qualitatively against criteria of effectiveness (contributes to planning objectives), efficient (cost-effective measure), and environmental concerns.

4.6.1 Non-Structural Navigation Improvement Measures

Utilize Favorable Tides

Ship operators and pilots use higher tides to allow movement of ships that cannot pass through channels at low stages of the tide. Constrained deep-draft ships (ships with drafts in excess of 31 feet) must wait for higher tide to move in the main channel. This delay results in additional transportation costs. Pilots prefer to bring the large ships in with good visibility conditions due to the width of the channel. Although no ship grounding has occurred to date, there is a risk that deeper draft ship relying on the tide for water depth could ground if delayed during transit. This practice is already in place and is expected to continue in the future without project condition.

Lightering

At times ship operators offload, or lighter, a portion of their oil cargo or bulk cargo to barges in Long Island Sound prior to entering the port. This technique is used when arrival ship draft does not allow transit over the 35-foot deep channel even at high stages of the tide. After offloading, both lightened ships and barges deliver their cargos to harbor terminals. Although this practice adds expense to transportation costs, lightering does allow for economies of scale with large ships for ocean transit. Lightering of petroleum products increases the risk of a spill. This practice is already in place and is expected to continue in the future without project condition.

Utilize Other Ports and Intermodal Transport

Alternative delivery sites and methods would divert traffic from the New Haven Port waterways to other locations. New Haven Harbor is the busiest port in of Connecticut. The port has the dense array of receiving, handling, and distribution facilities and serves a significant percent of the petroleum market in the area. Shifting to another state and trucking is possible but economic market forces appear to favor continued use of New Haven Harbor even with current navigation efficiencies. Increased use of truck transport to move cargo would result in greater air pollution emissions relative to navigational transport of commodities and add truck traffic to the crowded Interstate 95.

4.6.2 Structural Improvements

The locations of the existing channel and terminals limited the formulation of practicable alternatives. The current Federal channel passes through the breakwaters then heads directly to the terminals. The improvement project measures considered are to deepen the existing Federal channel with incidental widening for ship safety and provide a deeper turning basin with incidental widening for ship safety. Table 4.1 provides the initial screening of measures for navigation improvement. From this screening, navigation improvement alternatives are identified to carry forward to the Evaluation and Analysis Phase.

Table 4-1: Screening of Measures

Measure	Effective (Reduce Transportation Cost at Harbor)	Efficient	Environmental Concerns	Carry Forward
Utilize high tide (~6 foot tide range)	Yes, allows for use of deeper draft ships with delays	Yes, but delays reduce benefit	Episodic, grounding may cause impacts	Yes, part of without project alternative
Lightering	Yes, allows for use of deeper draft ships with transfer of cargo in LIS	Yes, but lightering costs reduce benefit	Episodic, transfer of petroleum products may result in a spill	Yes, part of without project condition
Utilize other Ports with deeper channels and Intermodal Transportation	No, Increased handling of cargo with use of distant ports	No, Investments in infrastructure at New Haven is lost	Long term, increased air pollutant emissions due to increased truck traffic	No
Deepen channel and turning basin with incidental widening	Yes, provides deeper channel and turning basin for large ships	Yes	Short-term impacts during construction	Yes

The final array of alternates carried forward into detailed evaluation are listed below. The alternatives consider project depths from -37 feet to -42 feet MLLW. Detailed costs and benefits were developed for depths of -37 feet, -38 feet, -40 feet and -42 feet MLLW. Costs and benefits for -39 feet and -41 feet were extrapolated from values developed for adjacent depth increments. The FNP project features to be deepened under each alternative include the entrance channel, main ship channel including northern portion of the maneuvering area, and turning basin. The channel reaches, channel bend at the breakwaters, and the turning basin would also each be widened under the several depth alternatives.

Final Array of Alternatives Carried Forward

- No Action or Continuation of Future Without-Project Condition
- Alternative 1: Deepen project features to -37 feet - widen channel, turning basin, and bend
- Alternative 2: Deepen project features to -38 feet - widen channel, turning basin, and bend
- Alternative 3: Deepen project features to -40 feet - widen channel, turning basin, and bend
- Alternative 4: Deepen project features to -42 feet - widen channel, turning basin, and bend

The above improvement alternatives were combined with the dredged material disposal options identified for the project and identified locally supported beneficial use. A Long Island Sound DMMP was completed in January 2016 by the USACE and US EPA that included evaluation of potential disposal sites for New Haven Harbor Improvement dredged material. This DMMP was used as the starting point to develop the dredged material placement options including beneficial uses for the dredged material. See Section 5.2 below.

5.0 ALTERNATIVES

5.1 Navigation Improvement Alternatives

Once the initial screening of measures was completed and the focused array to carry forward identified the details of the alternatives were refined. This information is discussed below. Each alternative plan was verified relative to the four criteria described in the 1983 Principles and Guidelines of completeness, effectiveness, efficiency, and acceptability.

- Completeness: The extent to which plan includes all the necessary project components (channel deepening and incidental widening) to obtain the desired results.
- Effectiveness: The extent to which the plan meets the primary objective of reducing costs and inefficiencies associated with the current federal navigation project. The plans reduce the need for lightering, and awaiting favorable tide conditions, thereby significantly improving navigation efficiency. The plans also meets the objective of improving navigation safety or larger ships by providing sufficient channel and turning basin width.
- Efficiency: The extent to which the plan is the most cost- effective means of meeting the identified objectives.
- Acceptability: The alternative plan is viable with respect to applicable state and federal laws and regulations.

5.1.1 Channel and Turning Basin Depth

Improvements to the existing navigation ship channel and turning basin were carried forward. The basic investigation was the cost of deepening and widening the existing 35-foot project to allow passage of the larger tankers and bulk vessels. The study considered incremental channel deepening of the project. The range of depth considered were commensurate with the existing shipping practices and vessel sizes In addition the turning basin would also require deepening and expansion to safely accommodate ships as the ships are turned seaward after leaving the berths. Four alternative plans at depths of 37, 38, 40 and 42 feet MLLW were evaluated.

5.1.2 New Haven Design Vessel

The design vessel is identified based on input from the terminal operators and harbor pilots regarding the vessels that use the harbor and data on sizes of vessels currently using the harbor, and expected to continue to use the harbor. Liquid tankers and the bulk carriers are the primary movers of commodities in and out of the harbor.

The largest tanker vessels calling at the Port of New Haven are Panamax tankers and the second largest vessel class and more common tanker vessel size is the medium range tanker. The largest bulk carrier vessels calling the Port of New Haven are Panamax bulk carriers. The second largest vessel class and more common vessel size is the Handymax bulk carrier. Deep draft vessel sizes that commonly visit the New Haven Port are shown below in Table 4-2.

Table 4-2: Deep Draft Vessel Sizes that Commonly Visit the New Haven Port

	DWT	LOA	Beam	Draft	
Tanker	35,000-50,000	551-624	88-106	33.0-44.3	Petroleum Products; General Cargo; Chemicals; Primary Iron & Steel Products
Tanker	50,000-60,000	598-715	105-106	39.4-44.3	Petroleum Products; Chemicals; General Cargo
Bulk	40,000-50,000	590-685	96-106	35.3-40.5	Sulphur (Dry), Clay & Salt; Scrap Metal; Chemicals; General Cargo; Primary Iron & Steel Products
Bulk	50,000-60,000	616-647	105-106	36.5-42.5	Sulphur (Dry), Clay & Salt; Scrap Metal; Primary Iron & Steel Products; General Cargo

For the design of channel improvements, the design vessel size selected was length overall (LOA) of 700 feet and beam of 106 feet. The design vessel was chosen to ensure the designed channel with improvements would be able to safely accommodate the larger vessels that are likely use the harbor, although in rare cases an even larger vessel could use the harbor.

5.1.3 Channel Width

Deep draft ship traffic into and out of New Haven is currently one-way. Based on pilot and shipper input and future number of vessel calls the probability of two or more vessel wishing to use the channel at the same time is small and one-way traffic for New Haven is considered adequate.

A 500-foot inner channel design width and 600-foot outer channel design width were incorporated into each of the four channel and turning basin deepening alternatives based on engineering evaluation (EM 1110-2-1613 – 31 May 2006) and consultation with the New Haven Pilots. (See Appendix D for engineering calculations.) The wider channel is needed in the outer harbor to account for the fact that navigation in the entrance channel may be adversely affected by rough seas. New Haven entrance channel is known to have frequent fog that can cause visibility problems.

5.1.4 Channel Bend at the Breakwaters

Other navigation difficulties include safely maneuvering today's larger ships within the confines of the existing channel, most notably at the channel's bend between the breakwaters. The existing channel bend at New Haven is 35 degrees and about 560 feet wide and passed between the middle and eastern breakwaters. The channel cross section of the bend is asymmetric. This means that the channel cross section has different bank conditions on each side of the channel centerline. The banks are very steep and strong bank forces effects are experienced. Ships entering the harbor drift away from channel centerline toward the steep bank. The bank conditions are even stronger for the larger ships. Larger ships (drafting greater than 31 feet) must navigate through the bend under high current conditions. With the existing approach, inbound vessels favor the east side of the channel, lining up nearest the red buoys, in anticipation that they will be set by the east to west flood current and experience bank suction at the bend, which pulls their stern to the west. In order to make this turn and straighten up to make the next set of navigation buoys, ships have to make full use of their rudder and engine, leaving little room for adjustment or error.

The channel bend widening dimension was selected based on engineering calculations and consultation with the New Haven pilots to safely accommodate the larger vessels that enter the channel. For evaluation of the alternatives the bend was winded from 560 feet to 700 feet.

5.1.5 Array of Alternatives

The developed Alternatives 1, 2, 3, and 4 (Table 4-3) all address the chief navigation problems under study, namely the lack of adequate ship channel depth and turning basin dimension to safely accommodate the larger vessels using the harbor and that will continue to use the harbor in the future. Alternatives 1, 2, 3, and 4 would all result in navigation benefits derived from projected savings in the cost of transporting commodities on the improved waterway. The cost would be reduced with the use of larger vessels to obtain efficiencies of scale. More efficient use of existing vessels would also occur because of reductions in tidal delays and lightering.

Table 4-3: Array of Navigation Improvement Alternatives

Alternative	Deepen the Channel and Turning Basin Depth (Feet MLLW)	Inner Harbor Channel Width (Feet)	Outer Harbor Channel Width (Feet)	Width in Bend at Breakwaters (Feet)
No Action	35	400	500	560
Alt. 1	37	500	600	Increase width to 700
Alt. 2	38	500	600	Increase width to 700
Alt. 3	40	500	600	Increase width to 700
Alt. 4	42	500	600	Increase width to 700

The developed alternatives were verified against the four P&G formulations criteria (see Table 4-4). All plans in the focused array meet the criteria except for the “No Action Alternative”. However, this alternative is carried forward through evaluation phase as required by NEPA.

Table 4-4: Alternatives Verified - P&G Criteria

Alternative	Completeness	Effectiveness	Efficiency	Acceptability
	Includes all actions (including those of others) to achieve outputs	Provide navigation transportation cost savings	Likely Cost Effective means of achieving objectives	Plan is viable with respect to applicable state and federal laws and regulations
No Action	No	No	No	Yes
Alt. 1	Yes	Yes	Yes	Yes
Alt. 2	Yes	Yes	Yes	Yes
Alt. 3	Yes	Yes	Yes	Yes
Alt. 4	Yes	Yes	Yes	Yes

5.2 Dredged Material Placement Sites

Recently a new DMMP) (USACE 2016) addressed the placement of dredged material from multiple dredging centers in the Long Island Sound including the New Haven Harbor area. The PDT reviewed the recently completed DMMP and worked with stakeholders to identify sites that would meet the Federal Standard for dredged material placement and/or provide the opportunity for beneficial use of the dredged material. The Federal Standard for dredged material placement is defined in USACE regulations as the least costly dredged material placement alternative (or alternatives) identified by USACE that is consistent with sound engineering practices and meets all federal environmental requirements, including those established under the Clean Water Act (CWA) and the Marine Protection, Research, and Sanctuaries Act (MPRSA). If a beneficial use is selected for dredged material placement and that beneficial use happens to be (or be part of) the Federal Standard or base plan option for the project (because it is the least costly alternative that is consistent with sound engineering practices and meets all federal environmental requirements), the costs of that beneficial use are assigned to the navigational purpose of the project and are shared with the Non-Federal sponsor according to the navigation project depth. Beneficial use project costs exceeding the cost of the Federal Standard (or “base plan”) option become either a shared Federal and Non-Federal responsibility, or entirely a Non-Federal responsibility, depending on the type of beneficial use. In summary, while the Federal Standard establishes the limits of Federal participation for navigation purposes (called the Base Plan). The USACE has authorities to share in incremental costs beyond the Base Plan to achieve beneficial use of dredged material for ecosystem restoration and beach nourishment.

5.2.1 Previous Federal Channel Maintenance Dredging

Maintenance of deep-draft project features since construction in 1950 has occurred nine times with smaller additional actions over the years to remove unclassified hard materials. All maintenance materials removed from the New Haven Harbor FNP since the 1970s have been placed at the CLDS. Over a 50-year period nearly 4.5 million CY have been dredged and placed at CLDS. Most recently, in 2013-2014, approximately 830,000 CY of shoal material was removed from the -35-foot MLLW main harbor channel.

5.2.2 Dredged Material Management Plan

The USACE completed DMMP for Long Island Sound in January 2016. The DMMP recognized that actual decisions on the recommended plan for a project would be made when a particular Federal navigation project was investigated with more specificity in the future. The Federal Base Plan for disposal of material from the main channels at New Haven Harbor, as identified in the January 2016 LIS DMMP and FPEIS was open water placement at the Central Long Island Sound Disposal Site. While this feasibility study will examine that and other alternatives, there is disagreement between the States of Connecticut and New York on the acceptability of open water placement in LIS. The June 2016 Final Rule by EPA modifying the designation of the Central Long Island Sound and Western Long Island Sound dredged material disposal sites called for creation of a Steering Committee and Regional Dredging Team to review dredged material placement proposals, provide comments to regulatory agencies, and help promote beneficial uses of dredged material to reduce over time reliance on open water placement. Non-government organizations active in CT and NY are both opposed to and in favor of continued open water placement.

The DMMP provides an initial screening of sites for dredged material disposal such as beneficial use (e.g., marsh creation, beach nourishment, historic disposal mound capping), open water placement, and upland placement for the New Haven Harbor Navigation Improvement project. Placement sites were screened based on cost and environmental criteria, the dredged material placement sites identified in the DMMP for New Haven are:

- Beach Placement of any sand at nearby beaches or near shore
- Use as Fill for Coastal Resiliency Projects in the New Haven Harbor Area
- Morris Cove Borrow Pit Fill
- Marsh Creation at Sandy Point Dike
- Open Water Placement at Central Long Island Sound Disposal Site (CLDS)

In addition to the above, four sites or alternatives were added in the scoping phase of this project:

- Oyster Habitat Creation at the East Breakwater
- West River Borrow Pit Fill
- Rock placement at West Breakwater
- And targeted Open Water at CLDS to cover historic disposal mounds

In the "Evaluation and Analysis" phase of this study, additional information was gathered on the characteristics of the dredged material and the potential dredged material placement sites to determine disposal alternatives for the project. Based on conducted efforts and the finding that materials to be removed are mostly silts, clay, and fine sand resulted in the elimination of the beach placement sites and the elimination of the use of the material for fill for coastal resiliency projects. Based on cost and compatibility analysis the disposal sites that are included in the Plan are filling the Morris Cove and West River Borrow Pits, oyster habitat creation at the east breakwater, rock placement at the west breakwater (rock reef), and covering historic disposal mounds at CLDS. An opportunity is also included to create a salt marsh at the Sandy Point Dike.

5.2.3 Beach Nourishment

Beach nourishment is the practice of using dredge material (mainly sand) from dredge areas to nourish adjacent beaches. This alternative generally uses a hydraulic pipeline or hopper dredge vessel to dredge the sediments from the shoaled areas and pump/place the material onto the beach or sandbar just offshore (near-shore placement). Beach disposal was considered for the proposed project, however, the sediments to be dredged consist primarily of silts and clays. These fine grained sediments are not compatible with the sediments on the beaches in the region around New Haven, CT.

5.2.4 Use as Fill for Coastal Resiliency Projects

The majority of the sediment to be dredged for the improvement project consists of fine grained material (silts and clays). This material is not suitable for structural fill.

5.2.5 Morris Cove Borrow Pit

Morris Cove, located in New Haven Harbor, contains an existing borrow pit created decades ago when sand and gravel were removed to be used as fill for the Interstate Highway 95 (I-95) embankment in New Haven. The sediments were excavated along a north-northwest to south-southeast axis, resulting in a submerged depression approximately 650 feet wide and 2,450 feet long. Currently, water depths in the vicinity range from about -10 feet MLLW adjacent to the Morris Cove borrow pit, to about -31 feet MLLW within the deepest portion of the borrow pit. Morris Cove has twice been used by the U.S. Coast Guard to place suitable fine-grained materials dredged from its LIS Station. The capacity of the Morris Cove borrow pit for the potential deposition of dredged material in the future remains quite large. Approximately 623,000 cy of silty dredged material is recommended to be strategically placed within the pit to fill it to a depth of -11.5 feet MLLW roughly even with the surrounding ambient bottom.

A number of studies have been performed at the Morris Cove borrow pit dating back more than 30 years to evaluate the potential use of the pit for placement of dredged material. These include bathymetric surveys, a dye study, video transects, a sediment-profile imaging survey, a current meter study, and water quality investigations (USACE 2016). In summary, these investigations have determined the following:

- Ecological functionality is diminished in the deeper areas of the pit due to trapping of organic matter and resulting periodic anoxic conditions. The benthic system surrounding the pit is healthy, suggesting that returning to pre-borrow pit depths (i.e., filling it) would return the area to a healthy benthic habitat.
- The tidal currents and potential wave climate over the borrow pit are low enough such that if filled, scouring of the surface is unlikely.
- Lower salinity in the bottom waters of the pit was noted only in a limited number of measurements. Hence, a large and continuous discharge of groundwater to the pit is not expected.

- The National Marine Fisheries Service (NMFS) has also identified Morris Cove as an important spawning and nursery area for a variety of commercially important fish species, including winter flounder. NMFS has expressed concern regarding the presence of the existing borrow pit within Morris Cove. Their concern aligns with the above bullet concerning the ecological functionality of the pit.

Use of the pit for placement of material from New Haven harbor would involve transporting material from the adjacent New Haven channel by scow to the site. This site is close to the dredging area and avoids the longer haul distance to CLDS. This site is a viable placement alternative for material found suitable for open-water placement. This site was retained as a beneficial use site for placement of dredged material.

5.2.6 West River Borrow Pit

This site is located near the West River just south of the river channel. This site was identified to the USACE by the Harbor Master in West Haven at the public meeting in January 2018. The USACE investigated the site and determined that about 87,000 cy of dredged material could be used to fill the pit. This is closer than transport of the material for placement at CLDS. This site is a viable placement alternative for material found suitable for open-water placement. This site was retained as a beneficial use site for placement of dredged material.

Filling the pit will restore the original depth of the sea floor in this area and create habitat suitable for recolonization by benthic organisms. In the current condition, the pit is likely to slowly fill with the sediments. Decomposition of the organic material in the pit may result in anaerobic conditions and generally poor water quality due to limited circulation in the pit.

5.2.7 Shellfish Habitat Creation Area

New England District Staff and Mr. David Carey of the Connecticut Department of Agriculture, Bureau of Aquaculture identified the area behind the east breakwater as a potential new oyster bed area. The area behind the breakwater ranges from elevation -13 feet MLLW to -25 feet MLLW. The existing substrate within this area is silty, and for oyster bed establishment, the substrate must be a sandy material. The disposal recommendation for the New Haven Deep Draft improvement project is to place a minimum of 2-foot thickness of sandy dredge material within the proposed placement area to encourage oyster bed development. Utilizing a recommended 2-foot depth of sandy material placed on top of the native silty material, the East Breakwater Oyster Bed has a capacity of beneficially re-using all of the of sandy dredge material (see Table 5-2).

5.2.8 Sandy Point Wetland Creation Area

CTDEEP proposed Sandy Point Marsh as a potential disposal alternative. The concept of this disposal alternative is to beneficially reuse dredged sediment for the purpose of creating new tidal wetland (salt marsh) area and shoreline erosion mitigation at Sandy Point. The Sandy Point project site is located along the western shore of the inner New Haven Harbor, just north and in the lee of a spit of land known as Sandy Point, in the vicinity of the West Haven Water Pollution Control Facility at 1 First Avenue, West Haven. The spit that extends along the southern boundary is currently undeveloped and is identified as a bird sanctuary.

A stone dike constructed by the USACE in the 1880s extends east from the end of the spit with an outer leg parallel to the entrance channel. The dike was constructed as a control feature to assist in keeping the channel from shoaling. An outfall pipe from the wastewater treatment plant extends through this area and discharges in deeper water offshore. Maintaining both the bird sanctuary and the outfall pipe will be important considerations during the design phase of this project.

The concept for Sandy Point wetland creation area is to establish a structural perimeter boundary, fill the area with suitable silty dredged material through either mechanical or hydraulic means, and plant wetland vegetation. The goal of the proposed disposal area would be to place the sediment to an elevation where intertidal wetland plant species would thrive. At the Sandy Point site, the constructed perimeter of the entire wetland creation cell would be approximately 7,834 linear feet with the overall area measuring approximately 73.2 acres. Assuming a target elevation for the surface of the wetland of approximately 3.6 feet NAVD88, the elevation would need to be raised by a range of 2.5 feet to 6.5 feet within the wetland creation area. This would enable the cell to receive a total of approximately 843,500 cubic yards of dredged sediment. This project would restore a portion of the historical area of salt marsh to that section of shoreline.

The containment will need to resist wave forces to ensure that the material stays within the marsh, and does not wash away. Options for containment included coconut fiber coir logs and fillable geotubes. Diking with sheetwall, rock, and other structural methods of containment were screened out due to their high cost of construction. Fillable geotubes were considered more resistant to wave forces over time than coir logs and were selected as the containment method for the tentatively selected plan.

The containment geotubes can be filled in place in water and dredged materials can be deposited within the containment footprint. Hydraulic placement techniques were assumed for filling the wetland cell. It should be noted that wetland cell construction requires a highly ordered and controlled sequence of dredge material placement to assure that wetland cells are not overloaded beyond the quantities required to achieve the target wetland surface elevation. Further, the time allotted for wetland cell development (i.e. placement of dredged materials, grading and initial planting) is a function of dredged material thickness. Greater dredged material thickness will increase the time required to reach a stable surface ready for planting and will decrease the probability of achieving any particular target surface elevation as dredge materials consolidate.

5.2.9 Rock Reef Creation Area

The proposed plan recommends that the rock removed from the improvement dredging project be placed at the seaside toe of the existing west breakwater (see Figure 5-1.). All of the removed rock will be placed on the western portion of the west breakwater to avoid existing shellfish leases. There are no existing shellfish leases in that area.

5.2.10 Open Water Disposal

The nearest U.S. Environmental Protection Agency (EPA) designated open-water dredged material disposal site is the Central Long Island Sound Disposal Site (CLDS) located about 6 miles from New Haven Harbor breakwaters. Disposal of material at the CLDS is managed by the Corps and EPA, in accordance with the requirements of the Marine Protection, Research, and Sanctuaries Act (MPRSA) and the Clean Water Act (CWA). The CLDS is also subject to long-term monitoring under the New England District's Disposal Area Monitoring System program (DAMOS). Through this monitoring, the Corps has determined that no significant impacts occur at this site from disposal of dredged material. This site has been used for disposal of dredged material during past maintenance of the harbor and will continue to be monitored in the future. There are additional benefits of utilizing the improvement dredging material at CLDS Disposal Site. The improvement dredge material can be used to restore historic mounds within the disposal site. The site has a remaining long-term capacity of at least 20 million cy. (DMMP 2016)

5.2.11 Confined Aquatic Disposal (CAD) Cell

The material proposed to be dredged from the harbor (inside the breakwaters) is composed of mainly silt and clays and primarily has been determined to be suitable for unconfined open water placement (see Suitability Determination Appendix J). However, about 13 percent of the material near the turning basin requires further testing to determine suitability of the material for open water placement. If after additional testing, material is determined to be unsuitable then it would be disposed of in a CAD cell in New Haven Harbor. A potential CAD cell location near the channel inside the harbor has been identified (see engineering Appendix D). A CAD cell is an underwater pit dug into the harbor bottom in to which dredged material is placed. The majority of material dug from the CAD cell is of higher quality (suitable for unconfined open water placement) and has the potential for beneficial use (see above alternatives).

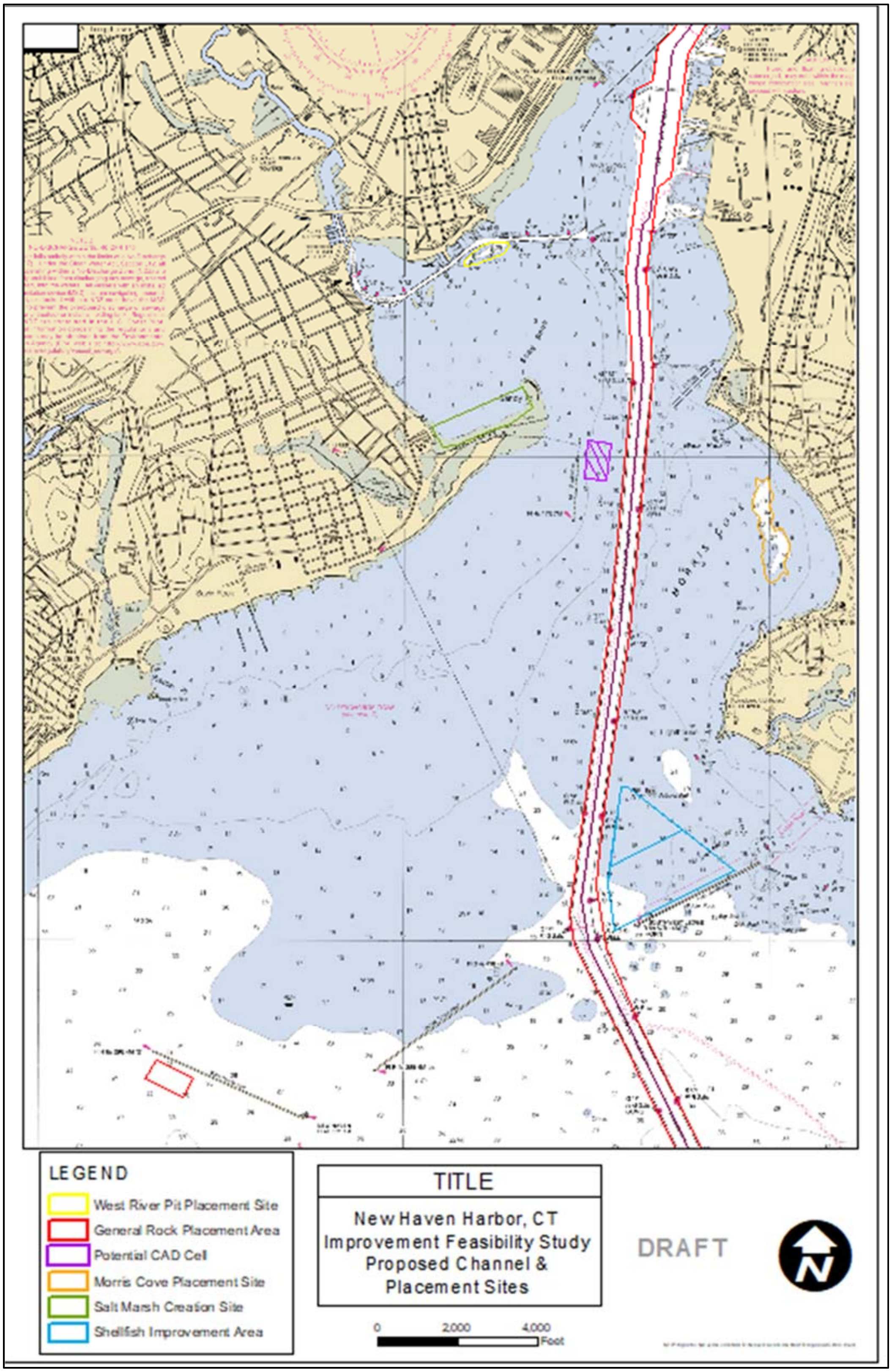


Figure 5-1: Proposed Channel and Dredged Material Placement Sites

5.3 Dredged Material Quantity Estimates

5.3.1 Dredge Quantity Estimates by Alternative

Quantities of improvement material to be removed for each alternative is estimated using the hydrographic surveys made in 2000 and 2014 for the project and the proposed channel alignment. These quantities are shown in Table 5-1. Also shown are the quantities for estimated rock to be removed within the vicinity of the bend at the breakwaters. The approximate bedrock surface was created from existing bedrock information for the project. (See Civil Engineering Appendix D.) Over depth allowances for dredging was 2 feet in all areas. Concurrent with the improvement dredging some Federal maintenance dredging would be required to restore the existing project to its authorized depth of -35 feet MLLW. Improvement quantities provided below do not include the current Federal maintenance quantity of 109,700 cy shoal material.

Table 5-1: Alternative Quantity Estimates

37-FT PROJECT	**Dredging Quantities (CY)**			**Dredging Areas (SF)**
	Cut	2-Feet OD	Total	
Total Improvement Dredging	930,800	1,181,600	2,112,400	9,760,100
38-FT PROJECT	**Dredging Quantities (CY)**			**Dredging Areas (SF)**
	Cut	2-Feet OD	Total	
Total Improvement Dredging	1,534,700	1,242,300	2,777,000	10,707,600
40-FT PROJECT	**Dredging Quantities (CY)**			**Dredging Areas (SF)**
	Cut	2-Feet OD	Total	
Total Improvement Dredging	2,804,900	1,463,700	4,268,600	15,686,700
42-FT PROJECT	**Dredging Quantities (CY)**			**Dredging Areas (SF)**
	Cut	2-Feet OD	Total	
Total Improvement Dredging	3,727,000	1,560,800	5,287,800	18,784,275

5.3.2 Placement Site Quantities

Table 5-2 and 5-3 includes the quantity of dredged material for the indicated alternative and the identified placement sites. For New Haven Harbor, the least cost placement option is open water disposal at CLDS (DMMP, 2016). However, the PDT was able to identify beneficial use placement sites inside New Haven Harbor that are least cost as they are close to the dredging site and no additional efforts are required to place the material at these sites. These sites are part of the Federal Base Plan for placement of dredged material from the improvement project. These sites provide for reduction in open water placement in Long Island Sound. The PDT also identified the opportunity to create a salt marsh at Sandy Point Dike. This salt marsh site does require additional work for dredged material placement and is more expensive than taking the material to CLDS (~$5.50/cy-increased cost).

Table 5-2: Federal Base Plan Placement Sites

Site/Alternative	37-FT	38-FT	40-FT	42-FT
	CY	CY	CY	CY
CLDS	1,274,090	1,879,890	3,173,490	4,096,776
Oyster Habitat	120,600	169,900	351,300	434,100
Rock Reef	6,600	16,100	32,700	45,815
Morris Cove Borrow Pit	623,310	623,310	623,310	623,310
West River Borrow Pit	87,800	87,800	87,800	87,800
	2,112,400	2,777,000	4,268,600	5,287,801

Table 5-3: Placement Sites with Salt Marsh Creation Beneficial Use

Site/Alternative	37-FT	38-FT	40-FT	42-FT
	CY	CY	CY	CY
CLDS	433,659	1,039,459	2,333,059	3,256,345
Oyster Habitat	120,600	169,900	351,300	434,100
Rock	6,600	16,100	32,700	45,815
Morris Cove Borrow Pit	623,310	623,310	623,310	623,310
West River Borrow Pit	87,800	87,800	87,800	87,800
Salt Marsh Creation	840,400	840,400	840,400	840,400
Total	2,112,400	2,777,000	4,268,600	5,287,801

5.4 Evaluation and Comparison of Alternative Plans

The Project Team used specific economic decision criteria to evaluate and compare plans against each other to determine which plan to select. The 1983 Principles and Guidelines for Water and Related Resources Planning dictates that the national economic development benefit (NED account) be the primary decisions criteria for selecting a solution. This criteria is based on an estimate of costs and benefits for each alternative and selection of the plan that reasonably maximizes net benefits. Development of costs and benefits for each alterative is discussed below. The Team also considered three additional accounts established in the Principles and Guidelines 1983 to display and compare project effects. These are the environmental quality/impacts, regional economic development, and other social effects accounts. (U.S. Water Resources Council, 1983)

5.5 Analysis of Cost of Alternatives

USACE Cost Engineering PDT member developed cost estimates for each alternative first by assuming the Federal Base Plan placement sites and second adding in the beneficial use option of salt marsh creation at Sandy Point Dike. Cost estimates include construction costs (dredging and dredged material placement costs), planning, engineering and design, construction supervision and administration, and contingencies. Costs are displayed in Table 5-4a and 5-4b and briefly described below. For additional detail on cost estimates by plan, see the Appendix F. Cost estimates are at October 2018 price level.

Table 5-4a: Cost of Alternatives –Federal Base Plan

NEW HAVEN HARBOR, CONNECTICUT Cost of Alternative Plans - Federal Base Plan	37-FT Improvement	38-FT Improvement	40-FT Improvement	42-FT Improvement
FEDERAL BASE PLAN				
Construction Cost	$25,061,000	$38,634,000	$52,274,000	$67,403,000
PED	$1,302,000	$2,008,000	$2,717,000	$3,503,000
Construction Management	$1,302,000	$2,008,000	$2,717,000	$3,503,000
PROJECT FIRST COST	$27,665,000	$42,649,000	$57,707,000	$74,409,000
USACE Cable Enforcement Action	$32,648,000	$32,648,000	$32,648,000	$34,880,000
LERR	$0	$0	$0	$0
COST W/CABLE COST	$60,313,000	$75,297,000	$90,355,000	$109,289,000
LSF, Berth Deepening Cost	$800,000	$1,070,000	$2,000,000	$2,800,000
TOTAL (no IDC)	$61,113,000	$76,367,000	$92,355,000	$112,089,000

Table 5-4b: Cost of Alternatives –Beneficial Use Plan

NEW HAVEN HARBOR, CONNECTICUT Cost of Alternative Plans - With Salt Marsh Creation Beneficial Use Plan	37-FT Improvement	38-FT Improvement	40-FT Improvement	42-FT Improvement
BENEFICIAL USE PLAN				
Construction Cost	$31,239,000	$42,562,000	$58,714,000	$73,920,000
PED	$1,623,000	$2,212,000	$3,051,000	$3,842,000
Construction Management	$1,623,000	$2,212,000	$3,051,000	$3,842,000
PROJECT FIRST COST	$34,485,000	$46,986,000	$64,816,000	$81,604,000
USACE Cable Enforcement Action	$32,648,000	$32,648,000	$32,648,000	$34,880,000
Salt Marsh Creation Site LERR	$157,000	$157,000	$157,000	$157,000
COST W/CABLE COST	$67,290,000	$79,791,000	$97,621,000	$116,641,000
LSF, Berth Deepening Cost	$800,000	$1,070,000	$2,000,000	$2,800,000
TOTAL (no IDC)	$68,090,000	$80,861,000	$99,621,000	$119,441,000

5.5.1 Costs

Construction

Construction costs were developed for each alternative in MCACES/MII and include all major project components. The construction cost estimates for dredging operations were developed using the Corps of Engineers Dredge Estimating Program (CEDEP) and transferred into MCASES/LII estimating program. CEDEP estimates include costs for mobilization and demobilization, construction plant (dredge, scows, tugs), cost of fuel, labor, insurance, materials, overhead, bond and profit. CEDEP inputs include consideration of the type of material to be dredged, efficiency of dredging operation, and haul distance. The drilling and blasting program includes costs for mobilization and demobilization, and all other costs associated drilling and blasting the rock.

The construction cost estimates includes a contingencies estimated by the USACE cost engineer using a cost and schedule risk analyses. Risk considered in estimating contingencies include construction contract modifications, restricted work windows due to environmental conditions , differing condition with the possibility of CAD cell construction, drill and blast and equipment assumptions.

Planning, Engineering and Design (PED)

PED cost estimates include design phase project management, planning and engineering including collection of additional borings, additional agency coordination, and preparation of plans and specifications, costs for reviews, and pre-construction contracting activities.

Construction Management Costs

Cost estimates include project management, contract administration, construction supervision and inspection, engineering during construction and pre-dredge and after-dredge surveys and monitoring.

Real Estate Costs

The area to be dredged and the open water placement areas for the Federal Base Plan disposal sites required for construction are below the ordinary high watermark of the navigable watercourse. Therefore, navigational servitude applies and would be invoked for the project. A temporary and permanent easement to construct the salt marsh beneficial use site is required and the cost is estimated at $157,000. (See Real Estate Plan, Appendix G.)

Cable Relocation Cost

For the channel deepening improvements up to -40 feet MLLW (37, 38, 39, and 40-Feet) there is an enforcement action cost to bring the Cross Sound Cable into compliance with the -48 Foot MLLW embedment depth required under its Federal and state permits. For dredging alternatives deeper than 40 feet (i.e. a -41 or -42-Foot improvement), there would be an additional cost to relocate the existing cable out of the Federal Navigation channel. The cable owner Cross Sound Cable, LLC (CSC) provided cost estimates for these actions. Cable relocation costs provided are indicative pricing and detailed engineering and design have not been conducted by either the USACE or the CSC and this number is for planning purposes only. (Indicative Pricing in letter from CSC, dated September 7, 2017.)

Aids to Navigation

No new aids to navigation are planned for the improvement project. It is anticipated that US Coast Guard will relocate the existing aids to navigation as part of their maintenance of the existing aids.

Local Service Facilities

For the purpose of estimating the associated costs of the alternatives it was assumed that the benefiting terminals would dredge the deep draft berths to the project channel depth plus 2 feet of overdepth. Deepening the berths was discussed with the terminal operators at site visits in October 2016. The terminal operators agreed to pursue berth deepening as required to realize the benefits of a deeper channel. Cost estimates for berth deepening are included for the alternatives cost analysis and will be refined for the selected plan during the project optimization phase.

5.5.2 Annualized Costs of Alternatives

Annual costs consist of amortization of the cost of the alternative and any increase in annual maintenance attributed to the improvement. Amortizing the costs used a 50-year period of analysis for navigation improvements and the FY 2018 interest rate of 2.75 %. Annualized costs including IDC are provided below for each alternative.

Interest During Construction

For economic analysis purposes, the estimated cost of the project included for interest during construction (IDC) to account for the lost opportunity cost of construction funds over the period of construction, yielding the total investment cost. IDC is included for economic analysis purposes only and is not included in total project costs for budgeting or cost-sharing purposes. IDC was calculated based on the Office of Budget and Management (OMB) rate for Federal water projects for FY18 of 2.75 percent and is included in Table 5-5a and 5-5b below.

Table 5-5a: Annualized Cost of Alternatives Federal Base Plan

Alternative	Project Costs	IDC	Total Investment	AAEQ Total Investment	AAEQ OMRR&R	Total AAEQ
37-FT	$61,113,000	$1,152,000	$62,265,000	$2,306,000	$126,000	$2,432,000
38-FT	$76,367,000	$1,775,000	$78,142,000	$2,894,000	$166,000	$3,060,000
40-FT	$92,355,000	$2,402,000	$94,757,000	$3,510,000	$254,000	$3,764,000
42-FT	$112,089,000	$3,098,000	$115,187,000	$4,267,000	$343,000	$4,610,000

Table 5-5b: Annualized Cost of Alternatives Beneficial Use Base Plan

Alternative	Project Costs	IDC	Total Investment	AAEQ Total Investment	AAEQ OMRR&R	Total AAEQ
37-FT	$68,090,000	$1,436,875	$69,370,000	$2,569,464.80	$126,000	$2,696,000
38-FT	$80,861,000	$1,957,750	$82,660,000	$3,062,000	$166,000	$3,228,000
40-FT	$99,621,000	$2,700,667	$102,162,000	$3,784,000	$254,000	$4,038,000
42-FT	$119,441,000	$3,400,167	$122,680,000	$4,544,000	$343,000	$4,887,000

5.6 Analysis of Economic Benefit of Alternatives

The economic benefit analysis was performed by the USACE Deep Draft Navigation Planning Center of Expertise (DDN-PCX) for the study. The HarborSym model was used for the New Haven Harbor modifications analysis. The model was developed by the USACE Institute of Water Resources in cooperation with the DDN-PCX. It is a planning level, general-purpose model to analyze the economic impacts of various waterway modifications within a harbor. It is a Monte Carlo simulation model that replicated vessel operations within the channel under various scenarios, including existing and future ”without” project conditions as well as “with” project alternatives. See Appendix C for more information the HarborSym model.

There are three primary effects from channel deepening that lead to changes in the future fleet at the Port of the New Haven. The first is an increase in a vessel’s maximum practicable loading capacity. Channel restrictions limit a vessels capacity by limiting its draft. Deepening the channel reduces this constraint and the vessel’s maximum practicable capacity increases towards its design capacity. This increase in vessel capacity results in fewer required vessel trips to transport the forecasted cargo. The second effect of increased channel depth is the increased reliability of water depth, which encourages the deployment of larger vessels to New Haven. The third effect is a consequence of the second. The increase in larger vessels displaces the less economically efficient vessels.

Transportation cost benefits were estimated using the HarborSym Economic Reporter, a tool that summarizes and annualizes HarborSym results from multiple simulations. This tool collects the transportation costs from various model run output files and generates the transportation cost reduction for all project years, and then produces an Average Annual Equivalent (AAEQ) benefit. Transportation costs were estimated for a 50-year period of analysis for the years 2023 through 2072. Transportation costs were estimated using HarborSym for the years 2023, 2033, 2043, and 2053. The present value was estimated by interpolating between the modeled years and discounting at the current FY 2018 Federal Discount Rate of 2.75 percent. Estimates were determined for each alternative project depth.

Table 5-6 provides the annual transportation costs and the AAEQ transportation cost saving benefits. For detailed information, see the economic analysis provided in Appendix C.

Table 5-6: AAEQ Transportation Cost Savings Benefits

Alternative	AAEQ Transportation Cost	AAEQ Transportation Cost Reduction Benefit
Future Without Project	$64,740,000	
37-FT	$62,033,000	$2,707,000
38-FT	$62,484,000	$2,257,000
39-FT (Extrapolated Value*)	$60,127,500	$4,613,500
40-FT	$57,771,000	$6,970,000
41-FT (Extrapolated Value*)	$57,737,500	$7,003,000
42-FT	$57,704,000	$7,036,000

*Extrapolated values provided for 39 and 40 foot-depths to display values at 1-foot increments.

5.7 Determination of the NED plan

The NED plan is that plan which reasonably maximizes net annual benefits. The net annual benefits of an improvement plan are equal its annual benefits minus its annual costs. The annual benefits, annual costs, benefit to cost ratio (BCR), and annual net benefits for each alternative were evaluated and compared using outputs calculated at the FY18 discount rate of 2.75 percent.

Table 5-7 shows the summary for this economic analysis. The alternatives that reasonably maximize the net annual benefits is the 40-FT improvement alternative and is the NED plan. Net benefits equal $3,206,000 and return a benefit cost ratio around 1.9 at the FY18 discount rate.

Table 5-7: Summary of Benefits and Costs

Alternative	Total AAEQ Costs	Total AAEQ Benefits	Total Net Benefits	Benefit/Cost Ratio
37-FT	$2,432,000	$2,707,000	$275,000	1.1
38-FT	$3,060,000	$2,257,000	-$804,000	0.7
39-FT*	$3,412,000	$4,613,500	$1,201,500	1.4
40-FT	$3,764,000	$6,970,000	$3,206,000	1.9
41-FT*	$4,187,000	$7,003,000	$2,816,000	1.7
42-FT	$4,610,000	$7,036,000	$2,427,000	1.5

*Extrapolated values provided for 39 and 40 foot-depths to display values at 1-foot increments.

5.8 Additional Accounts

Environmental Quality Account (EQ)

Environmental effects of the implementation of the improvement alternatives are all similar and are not anticipated to have significant environmental impacts. Environmental effects of navigation improvement versus no action are discussed in detail in Section 7 of this report. The no action alternatives would continue the risk of an oil spill due to existing and increased lightering operations. The improvement alternatives would both decrease the likelihood of an oil spill occurring due to lightering and improved maneuverability of the channel. Positive environmental effects of the improvement alternatives are using dredged material beneficially to create habitat within the New Haven Harbor area.

Regional Economic Development Account (RED)

The improved navigation alternatives would also have positive regional economic effects (RED benefits). The transportation costs savings of the alternatives would be seen in lower costs of bringing products to manufacturers and consumers in New Haven area and the larger service area of the port. The report would remain viable and continue to provide marine commerce benefits to the local economy. All channel deeping alternatives will provide an RED benefit. With the deeper channel alternatives providing a greater benefit as the transportation cost savings increase with depth (See Table 5-7 above).

Other Social Effects Account (OSE)

In the Other Social Effects (OSE) category, the most significant benefit would be the improved maneuverability through the bend at the entrance to the harbor. The risk associated with navigating the bend with the larger ships would be eliminated. This would help ensure reliable and efficient deliveries of petroleum products and raw materials to the region. The benefit is similar for all the deepening alternatives as all include the bend widener.

5.9 Identification of the Tentatively Selected Plan

Based on the decision criteria of maximizing the net economics benefits and consideration of the EQ, RED, and OSE accounts the navigation improvement project tentatively selected plan is the 40-FT plan (NED plan). The 40-Foot improvement alternative returns net benefits of $3,206,000 and a BCR of 1.9. (Note: these numbers are refined in Section 6.0 below to reflect the results of the ship simulation study.) The selected plan also includes the beneficial use opportunity to create about 70 acres of salt marsh at Sandy Point Dike using the dredged material. The Non-Federal sponsor is willing to pay their share of the increment above the Federal Base Plan to use the dredged material to create the 70-acre salt marsh.

6.0 TENTATIVELY SELECTED PLAN (TSP)

6.1 TSP Components

The tentatively selected plan (TSP) for the New Haven Harbor Navigation Improvement project is the 40-Foot improvement project with the salt marsh creation beneficial use site. The TSP consists of the following General Navigation Features (GNF) improvements:

- Deepen the channel, maneuvering area, and turning basin from - 35 to -40 feet, MLLW
- Widen the turning basin to the north 200 feet (refined design)
- Widen the inner channel from 400 to 500 feet
- Widen the entrance channel from 500 to 600 feet
- Widen the channel bend near the East Breakwater from 560 to 800 feet (refined design)

The TSP involves dredging about 4.27 million cubic yards (cy) of ordinary improvement material and removing 43,500 cy of rock. Seven open water sites are included for placement of the material. These sites are:

- Morris Cove Borrow Pit
- Oyster Habitat Creation site at the East Breakwater
- West River Borrow Pit
- Rock placement site at West Breakwater (rock reef)
- Salt Marsh creation at Sandy Point Dike

- Open Water Placement at Central Long Island Sound Disposal Site (CLDS) with targeted placement to cover historic disposal mounds
- Potential CAD cell if needed

CLDS is an authorized dredged material disposal site designated by the Environmental Protection Agency under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). In addition, open water beneficial use sites within New Haven Harbor are proposed for placement of the dredge material within New Haven Harbor. Beneficial use sites include creating oyster habitat, filling old underwater borrow pits, creating rock reef habitat, and creating salt marsh habitat.

The material proposed to be dredged from the harbor is composed of mainly silt and clays with some fine sand in the entrance channel. Most of the material has been determined to be suitable for unconfined open water placement (see Suitability Determination Appendix J). However, there is about 13 percent of the material near the turning basin that requires further testing to determine suitability of the material for open water placement. Supplemental sampling and testing will be conducted in Fall 2018 for the refined turning basin design and results will be coordinated with EPA and CTDEEP to determine suitability for open water placement. If after additional testing of the material in this area, some is determined to be unsuitable for open water placement then it would be disposed of in a confined aquatic disposal (CAD) cell constructed in New Haven Harbor near the channel.

Salt Marsh Creation Beneficial Use Site

The opportunity to use some of the dredged material that would go to CLDS to create about 70 acres of salt marsh was identified during the feasibility study. This salt marsh creation site represents an increase in cost for the project due to the need to construct a perimeter dike and mobilize a hydraulic dredge to pump material to the site. However, the Non-Federal Sponsors support the salt marsh creation site and are willing to share in the incremental cost above the Federal Base Plan.

TSP Design Refinements

Following selection of the TSP, the USACE refined the TSP design based on ship simulation study conducted at the USACE's Engineer Research and Development Center (ERDC), Coastal Hydraulics Laboratory (CHL) Coastal Hydraulics Lab. See Appendix K and discussion in the Coastal Engineer Appendix. Design refinements for the ship simulation study were additional widening of the bend at the breakwater (800 feet versus initial proposes 700 feet) and widening the existing turning basin 200 feet to the north rather that moving it fully to the north. Further refinement and optimization of the TSP design will occur after public and agency review. Table 6-1 provides the dredged material quantity estimates for the refined design.

Table 6-1: TSP, Dredged Material Quantity Estimates

TSP, 40-FT Plan, Refined Design	Dredging Quantities (CY)		
	Cut to Design Depth	2-Foot Overdepth	Total CY
Entrance Channel	278,300	240,000	518,300
Bend (Ordinary Material)	475,300	161,300	636,600
Interior Channel	1,537,400	776,000	2,313,400
Maneuvering Area	377,700	274,600	652,300
Turning Basin	117,900	40,200	158,100
Total Improvement Dredging - Ordinary Material	2,786,600	1,492,100	4,278,700
Bend (Rock) (Required Cut to El 42)	24,900	18,600	43,500
All Improvement Material	2,811,500	1,510,700	4,322,200

6.2 Construction Methodology and Schedule

Several types of dredges can be used to remove material from deep draft navigation channels, including hydraulic pipeline dredges, hopper dredges, and various types of mechanical bucket dredges. New Haven Harbor improvement project would use both a mechanical dredge and a hydraulic pipeline dredge.

Mechanical dredging involves the use of a barge-mounted crane with a clamshell bucket, or a backhoe arm to dig the material from the harbor bottom. Typical dredging buckets come in various sizes from five cubic yards to thirty or more cubic yards. The material is placed in a scow for transport to the disposal site by tug. For open-water or ocean disposal, a split-hull scow is generally used for ease of disposal and to minimize the discharge plume. Material at the disposal site is typically discharged using preset coordinates monitored by the tug. This point dumping is intended to form a discrete mound of dredged material at the disposal site to minimize possible off-site migration and assist in monitoring the disposal operation and post-disposal activities at the site such as benthic recolonization. For the proposed beneficial use involving burial of sites within the, then a series of smaller overlapping mounds would be created.

6.3 Cross Sound Cable

There is a submarine power and fiber optic cable located in the New Haven Harbor Existing Federal Navigation channel. The cable is owned by Cross Sound Cable, LLC (CSC) and is made up of a bundle of cables that provide 330 MW of high voltage direct current and internet and phone data transfer. The cable connects from a terminal in New Haven, Connecticut to terminal in Shoreham, New York a distance of about 25 miles across Long Island Sound.

The USACE Regulatory Program (see note) issued a Section 10 permit for construction of the cable in 2002 and approximately 5 miles of the 25 mile long cable is located in the Federal navigation channel. The permit required the cable be buried to a depth of at least -48 feet MLLW in the Federal channel. The cable burial relied on the jet plow method where high-pressure water is used to fluidize the sea floor to create a trench for the cable to fall in to. During construction with the jet plow, a small length (700 feet) in the Federal channel, was not embedded to the required -48 feet MLLW due to encountering ledge and hard material that obstructed the achievement of the required embedment depth. The USACE granted CSC a permit amendment that requires CSC to meet the -48 feet MLLW installation depth, at their cost, when corrective action is required by USACE. The Regulatory program is actively engaged with CSC to achieve the embedment depth required in the permit. Regulatory is attempting to resolve this issue informally, however, they are prepared to refer the enforcement action to the Department of Justice.

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*Note: The U.S. Army Corps of Engineers (USACE) has the power to regulate Non-Federal use of navigable waters under Section 10 of the River and Harbor Act of 1899.

6.4 Real Estate Considerations

The ship channel and turning basin dredging areas and the dredged material placement sites required for project construction are below the ordinary high watermark of the navigable watercourse. Therefore, navigational servitude applies and would be invoked for these features of the project. The navigation servitude is the dominant right of the Government under the Commerce Clause of the U.S. Constitution (U.S. CONST. Art. I, §8, cl.3) to use, control and regulate the navigable waters of the United States and the submerged lands hereunder for various commerce-related purposes including navigation and flood control. The Federal Government's rights under the navigation servitude exist irrespective of the ownership of the banks and bed of a stream below the ordinary high water mark.

The proposed plan's navigation improvement features will be constructed by water based equipment and will not require acquisition of real estate interests for access. Any contractor bidding the project will be required to make their own private arrangements for access via any of the many private piers in the Harbor.

For the salt marsh creation site the Non-Federal sponsor must acquire a temporary work area easement for 2 years (access, staging, mobilization) (0.24+/- acre) and permanent road easement (3.77+/-acres). This land is owned by the City of West Haven. The Non-Federal sponsor will be required to furnish the temporary and permanent easements.

The harvesting of shellfish is an intensive aquaculture industry in the subtidal areas of New Haven Harbor. Shellfish species commercially managed and harvested in New Haven Harbor include the eastern oyster (Crassostrea virginica) and the hard-shell clam (Mercenaria mercenaria). The Connecticut Department of Agriculture's Bureau of Aquaculture (BOA) manages the shellfish beds under agreements with the New Haven Harbor municipalities (New Haven, West Haven, and East Haven). The BOA monitors and governs all parcels of seafloor within New Haven Harbor, as well as those outside of the breakwaters. There are 20 shellfish parcels that are in the channel improvement project area and 4 in the CAD cell area. These are highlighted in the Shellfish Parcel Map included in Real Estate Report (Appendix G). Aquaculture leases in the project area are subject to navigation servitude.

6.5 Aids to Navigation

No new aids to navigation are planned for the project There are multiple existing buoys that mark the Federal channel, turning basin, and maneuvering area. The United States Coast Guard (USCG) maintains the navigation aids. Aids would be reset by the USCG to reflect the widened channel and turning basin. Resetting the existing aids is accomplished during each maintenance dredging operation for the project, and would be required for as part of the USCG periodic service of the aids even if no improvement dredging were planned. No new aids will be required for the improvement project which would occur concurrent with maintenance of the existing project.

6.6 TSP Refined Cost Estimate

The TSP project cost was calculated for the refined deign for both the Federal Base Plan disposal sites and with the Beneficial Use placement site i.e. salt marsh creation at Sandy Point Dike. Table 6-2 provides the project first costs and details of the cost estimates including the Total Project Cost Summary sheets are provided in the Cost Engineering Appendix F. The total project cost for the Federal Base Plan is $65.9 million and with the Beneficial Use, i.e. salt marsh creation, the cost increases to $70.6 million. The incremental difference in costs is $4.7 million. The salt marsh creation site is more expensive than dredged material placement at CLDS but provides for the creation of 70 acres of salt marsh habitat. This increased cost is about $67,000 per acre of salt marsh created. The construction costs for the salt marsh creation include the mobilization of the hydraulic dredge plant, pumping of dredge material to the creation site, and the cost for a geo-tube perimeter to contain the dredge material at the placement site until the salt marsh grasses are established.

Table 6-2: TSP, Project First Cost Summary

Project First Cost Summary TSP (40-FT Plan, Refined Design) (Oct. 2018 price level)		
Cost Account and Feature	Federal Base Plan ($)	Beneficial Use Plan - Salt Marsh Creation ($)
12 Navigation Ports and Harbors		
Mobilization/Demobilization	3,236,000	5,920,000
Entrance Channel	6,513,000	6,568,000
Bend (Ordinary)	4,781,000	4,822,000
Bend (Rock)	19,668,000	19,832,000
Interior	18,585,000	19,601,000
Maneuvering area	5,904,000	5,954,000
Turning Basin	1,130,000	1,140,000
Total	59,817,000	63,837,000
01 Lands and Damages	0	160,000
30 Planning, Engineering and Design	3,044,000	3,372,000
31 Construction Management	3,044,000	3,248,000
Project First Cost	**65,905,000**	**70,617,000**

6.7 Operation and Maintenance

Maintenance of the improvement project will require periodic dredging of shoaled material similar to what is currently done for the existing Federal Navigation project. For the existing project, over the last 63 years between 1950 and 2013, USACE records indicates a shoaling rate about 88,000 cy annually. The increase in cross section associated with the channel deepening is expected to have negligible effects on the resulting channel shoaling rate. However, for the purposes of the cost analysis it was decided to allocate a small increase to the current shoaling rate equal to 1 percent of the improvement dredging volume. This shoaling rate may be refined as the study progresses. The frequency of maintenance dredging would remain at 10 years.

The DMMP 2016 identified the Central Long Island Sound Disposal Site (CLDS) as a least cost placement site for maintenance dredging of fine-grained material from the New Haven Harbor project. However, future maintenance dredging would also consider any identified beneficial use opportunities consistent with disposal requirements at CLDS. The disposal capacity at CLDS of 20,000,000 cy is sufficient to accommodate the maintenance dredging of the harbor.

6.8 Annual Cost and Benefits TSP Refined Design

Table 6-3: TSP, Refined Design Benefits and Cost, Federal Base Plan

NEW HAVEN HARBOR, CONNECTICUT Average Annual Equivalent (AAEQ) Benefits and Costs TSP (40-FT Plan, Refined Design) FEDERAL BASE PLAN (October 2018 price level, 50-year Period of Analysis, 2.75 %)**	
Project Improvement Investment Cost	
GNF, Project Construction First Cost	$65,905,000
Lands, Easements, ROWs	none
New Aids to Navigation	none
Cable Enforcement Action Cost	$32,648,000
Total	$98,553,000
Interest During Construction	$2,744,000
LSF, Berth Deepening Cost	$2,000,000
Total Investment Cost	$103,297,000
AAEQ Investment Cost	3,826,000
Annual Increased Maintenance Dredging	<u>$510,000</u>
Total AAEQ Cost	$4,336,000
Total AAEQ Cost	$4,336,000
AAEQ Benefits	$6,970,000
Net AAEQ Benefits	**$2,634,000**
Benefit-Cost Ratio	**1.6**

** Note: Numbers may be adjusted as a result of public, agency, and USACE reviews and further analysis of costs and benefits.

6.9 Federal and Non-Federal Project Costs

Cost sharing for the improvement project will be done in accordance with Section 101 of WRDA 1986, as amended. See cost apportionment in Table 6-4 below.

Table 6-4: Federal and Non-Federal Project Costs

New Haven Harbor Navigation Improvement Project TSP (40-FT Plan, Refined Design) Federal and Non-Federal Cost (October 2018 Price Level)			
Item	**Federal Cost**	**Non-Federal Cost**	**Total Cost**
General Navigation Feature (GNF) 75% Federal/ 25% Non-Federal			
Construction	$44,863,000	$14,954,000	$59,817,000
PED	$2,283,000	$761,000	$3,044,000
Construction Management	$2,283,000	$761,000	$3,044,000
GNF, Construction Cost	$49,429,000	$16,476,000	$65,905,000
Lands, Easements, Rights of Way, and Relocations	$-	$-	$-
GNF, Project First Costs	$49,429,000	$16,476,000	$65,905,000
Beneficial Use (BU) Incremental Cost (Salt Marsh Creation) 65% Federal / 35% Non-Federal			
Construction	$2,613,000	$1,407,000	$4,020,000
PED	$213,000	$115,000	$328,000
Construction Management	$133,000	$71,000	$204,000
Lands, Easements, Rights of Way, and Relocations	$-	$160,000	$160,000
BU, Incremental Cost	$2,959,000	$1,753,000	$4,712,000
Total Project First Costs - GNF and BU	**$52,388,000**	**$18,229,000**	**$70,617,000**
Other Items			
Non-Federal Sponsor, Additional 10% Payment	$-	$6,590,500	$-
Aids to Navigation 100% Federal – US Coast Guard	$-	$-	$-
Local Service Facilities - Port Berthing Areas 100% Non-Federal	$-	$2,000,000	$2,000,000
Cable Enforcement Action (Permit Compliance) 100% Non-Federal (CSC LLC.)	$-	$32,648,000	$32,648,000

For the GNF, the Non-Federal Sponsor is required to provide 25 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -20 MLLW but not in excess of -50 MLLW. Also, the Non-Federal sponsor is required to pay an additional 10 percent of construction costs plus interest, less any credit afforded by the Government for the real property interests and relocations, over a period not to exceed 30 years. (Section 101 of WRDA 1986, as amended) The cost share for the incremental cost of the Beneficial Use Plan above the Federal Base Plan (lease cost disposal option) is shared 65 percent Federal and 35 percent Non-Federal sponsor. (WRDA 1986, as amended, Section 103 subsection a to d). The terminal owners would be responsible for the cost of berth deepening. Cross Sound Cable LLC (CSC) would be responsible for cost of bringing the cable into compliance with the USACE permit.

6.10 Relative Sea Level Change

There are no bridge clearance concerns associated with the project. The biggest potential risk associated with RSLC is inundation to the local service facilities (LSF), including piers, cranes, and utilities serving the berthing areas. Based on readily available data for the terminals, the current facilities are high enough to avoid inundation at mean high water for all RSLC scenarios (low, intermediate, and high) through 2070. In addition, in 2070 terminal deck elevations are also expected to be above the 99% AEP water level (one-year storm elevation) under the low and intermediate RSLC scenarios. However, the LSF at Magellan Pink Tanks, is expected to be below the one-year storm water level under the high RSLC scenario by 2070. Overall, this assessment indicates there is a low risk to the LSF at the project over the 50-year project life.

Sea level change will increase the navigable depth of the channel over time and, given the low sedimentation rate of the waterway, reduce the amount of Operations & Maintenance dredging required to maintain the authorized channel depth. However, the amount of sea level change alone would not significantly improve conditions in the waterway to achieve project objectives. See Coastal Appendix E for additional discussion of RSLC.

6.11 Financial Analysis of Non-Federal Sponsor's Capabilities

The Non-Federal Sponsor's Self-Certification of Financial Capability checklist has been provided to and discussed with the Non-Federal Sponsor. The Non-Federal Sponsor will provide the Self-Certification of Financial Capability, signed by their chief financial officer for inclusion with the final Feasibility Report when it is submitted to USACE Headquarters.

6.12 Status of Non-Federal Sponsor

The Connecticut Port Authority and the New Haven Harbor Port Authority are the Non-Federal Sponsor for the implementation of this navigation improvement project. The Non-Federal sponsor fully supports the proposed improvement project and views the proposed improvement project to be crucial to the Harbor's existing and future operation.

The Non-Federal Sponsor understands its responsibilities under the future Project Partnership Agreements required to design and implement the project. The Non-Federal Sponsor will provide letter of support for inclusion in the final report that states their concurrence with and support for the recommended plan, their intent to execute the required design and project partnership agreements for the project.

6.13 Risk and Uncertainty

6.13.1 Dredged Material Placement at CLDS

There is disagreement between the States of Connecticut and New York on the acceptability of open water placement in LIS. The June 2016 Final Rule by EPA modifying the designation of the Central Long Island Sound and Western Long Island Sound dredged material disposal sites called for creation of a Steering Committee and Regional Dredging Team to review dredged material placement proposals, provide comments to regulatory agencies, and help promote beneficial uses of dredged material to reduce over time reliance on open water placement. Non-government organizations active in CT and NY are both opposed to and in favor of continued open water placement. A challenge for the New Haven Harbor navigation improvement feasibility study is to consider the various points of view regarding the acceptability of placement of dredged material in Long Island Sound and balance this with the cost of placement in order to select and recommend an implementable plan. Full consideration of practicable beneficial uses of dredge materials, in cooperation with willing and capable sponsors, will be a key to a successful project recommendation. Several beneficial use sites for dredged material inside the harbor these are included in the TSP.

6.13.2 Removal of Rock at Southwest Ledge Area

The entrance channel as it passes between the east and middle breakwaters bends to a more northerly alignment along the natural channel course to reach the upper harbor. The area where the breakwaters converge and the channel bends is at an area known as the Southwest Ledge. Previous channel deepening and widening near the Southwest Ledge has required removal of hard material. Reflection and refraction surveys were completed in August 1987 during the previous preconstruction engineering and design efforts. Some of the areas were interpreted to contain bedrock above elevation -45 feet MLLW. This area will likely require blasting of rock to deepen the channel. The current study is relying on existing geotechnical information to estimate rock quantities this area. To reduce the uncertainty regarding rock quantities additional boring will be collected during PED and to verify the quantity of rock to be removed.

7.0 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

7.1 Protected Managed Lands

No Action Alternative

Under the No Action Alternative, no changes to managed lands surrounding New Haven Harbor would occur.

Preferred Alternative[2] (TSP)

The proposed project will have no significant effects on Lighthouse Point Park, East Shore Park, Fort Hale Park, or the Long Wharf Nature Preserve. The proposed project may temporarily interfere with the scenic views of the harbor from the parklands during construction. However, upon completion of the project and removal of construction equipment, the scenic views will be restored.

The project will affect the Morse Park, Morse Beach, and the Sandy Point areas. The creation of salt marsh in the vicinity of those areas will convert subtidal and intertidal areas within the parks to marshland. The beach areas of Morse Park and Morse Beach will be converted to salt marsh and will be permanently lost. The beaches of the Sandy Point area will be temporarily impacted by construction activities (i.e., accessing the beach areas during the construction of the salt marsh), however long-term impacts to the Sandy Point beach areas are not expected.

7.2 Water Quality

No Action Alternative

Under the no action alternative, the water quality in New Haven Harbor would remain unchanged. The harbor would continue to have a Class SB water quality designation. Turbidity (suspended sediments), dissolved oxygen levels, and nutrient concentrations in the harbor would continue to be similar to the conditions described in Section 3.2.

Preferred Alternative

7.2.1 Water Quality Classification

The proposed project is not expected to change the long-term water quality classification of New Haven Harbor. Short-term impacts to turbidity, dissolved oxygen, and nutrients (discussed

[2] For purposes of this study and to conform to NEPA requirements, the TSP may also be referred to as the preferred alternative.

below) are anticipated. However, the water quality classification in New Haven Harbor is expected to remain as Class SB during and upon completion of the proposed project. The designated uses of Class SB waters are marine fish, shellfish and wildlife habitat, commercial shellfish harvesting, recreation, industrial water supply, and navigation (CT DEEP, 2017).

7.2.2 Turbidity

Turbidity – Mechanical Dredging

Portions of the dredging efforts are proposed to be performed with a mechanical clamshell dredge. This action will remove and suspend some of the bottom sediments, causing localized increases in turbidity and sedimentation. Numerous studies (ranging over decades) have been conducted to document levels of suspended sediments and sediment plume distances associated with mechanical dredging and are discussed below.

New London Harbor Monitoring Example

Analysis of the spatial and temporal persistence of the turbidity plume from the dredging of silts was quantified in 1977 from dredging the Thames River/New London Harbor channels (Bohlen et. al., 1979). The conclusions of this study defined the measurable suspended sediment plume as extending 700 meters downstream. Analysis of the composition and concentration of the plume indicated the majority of material suspended occurred within 300 meters of the dredge. Suspended material concentrations closest to the dredge ranged from 200 mg/l to 400 mg/l resulting from suspension of approximately 1.5 to 3.0% of the substrate in each bucket load. Suspended material concentrations were reduced by a factor of ten within the first 200 meters downstream of the dredge. Surface concentrations returned to normal 250 meters downstream of the dredge. Mid-water and near bottom concentrations returned to background levels 700 meters downstream of the dredge.

Previous New Haven Harbor Monitoring

Sediment plumes were monitored during a maintenance dredging effort of the New Haven Harbor FNP between October 1993 and January 1994 (USACE, 1996). Dredging of silty material from New Haven Harbor was conducted with an enclosed mechanical bucket. The two major objectives of the New Haven monitoring were to: 1) establish the background suspended solids concentration before and after dredging, and 2) document the movement of the dredge plume relative to fisheries resource areas. The results of the survey revealed that background suspended sediments in the harbor average 8 mg/l prior to dredging efforts, and that during dredging, numerous aperiodic short duration spikes of 100 mg/l were seen.

The study also concluded that there were dredge-induced sediment plumes, and that the plumes did travel outside of the navigation channel. However, these excursions onto the shoal areas outside the channel only occurred when the dredge was in the immediate vicinity (i.e., dredging the side of the channel directly adjacent to the shoal areas).

The study also noted that monitoring detected several long duration (1-3 days) - high suspended sediment perturbations (concentrations reaching 700 mg/l) that could not be related to dredging operations. Evidence from meteorological data and wastewater effluent records indicate that these high suspended sediment events were likely the result of winds and wind-generated waves, alone or in combination with discharges from wastewater treatment plant outfalls.

The study concluded that dredged induced sediment resuspension was found to be a minor perturbation to the much longer duration, larger amplitude events associated with wind, wind-waves, and effluent discharges from outfalls. The effects of dredge related spikes in suspended sediments on the winter flounder spawning grounds (i.e., the shoal areas outside the channel), and the regional water quality in general, appear to have been limited in duration and of relatively low amplitude (USACE, 1996).

Boston Harbor Monitoring Example

Monitoring was conducted in 1996 for dredging of the surface silty material during construction of a confined aquatic disposal (CAD) cell for the Boston Harbor Navigation Improvement Project. This monitoring included: 1) documentation of the spatial and temporal distribution of the sediment plume for the four extremes of tidal currents (high water slack, maximum ebb, low water slack, maximum flood) on two days within the first week of dredging; 2) collection of water samples from the lower half of the water column at two locations – 1,000 feet up current of the dredging and 500 feet down current from the dredging; and 3) analysis of water samples for TSS.

During dredging, turbidity measurements ranged from 3-5 NTU (Nephelometric Turbidity Units) at the reference station 1,000 feet up current from dredging the silty surface material using an environmental bucket. Turbidity was only slightly elevated at the station 500 feet down current of the dredging ranging from 4-11 NTU. TSS ranged from 4-5 mg/l at the reference station and from 5-9 mg/l at the down current station. No plume was visible at the surface outside the immediate area of the dredging operation, and no significant plume was detected in the water column (ENSR, 1997).

Monitoring of turbidity plumes in 1998 associated with the dredging of silty maintenance material from Boston Harbor was also performed (USACE/Normandeau, 1998b). Mapping of the turbidity associated with use of a closed mechanical bucket (i.e., an environmental bucket) to dredge silty material in Boston Harbor was performed during periods of high and low water slack and during maximum flood and ebb tides. The mapping required generation of plan views of turbidity at mid-depth and near bottom extending from 300 feet up current to 1,000 feet down current of continuous dredging operations. Generation of a cross section of turbidity located 300 feet down current of the dredging was also required. Near bottom turbidity values were highest for all measurements with values no higher than 100 NTU approximately 300 feet down current of the dredging operation. Mid-depth turbidity was much less, and all values returned to background levels (10-20 NTU) between 600 and 1,000 feet down current (ENSR, 2002).

The monitoring studies noted above show that turbidity plumes associated with mechanical bucket dredges are produced during dredging, however they are generally limited to the immediate vicinity of the dredge. Therefore, while suspended sediment plumes will be produced during the construction of the proposed project, they are not anticipated to significantly impact water quality.

Turbidity – Hydraulic Dredging

Hydraulic dredging equipment will be used to remove silty material from the channel that will be used for marsh creation at the Sandy Point beneficial use site. Re-suspension of fine–grained material during hydraulic dredging is usually restricted to the vicinity of the dredge head and decreases rapidly with increasing distance from the operation. The cutterhead pipeline dredge is capable of removing sediments with relatively small amounts of resuspension extending beyond the immediate vicinity of the dredge.

A cutterhead could suspend 25-250 mg/l of silty sediments within 100 to 400 feet downcurrent of the dredge (Hayes, 1986). The discharge of material at the end of the hydraulic pipeline at the placement area has the potential to suspend large amount of silt and clay. However, the anticipated methodology involves using the hydraulic dredge to fill geotubes in place with the silty material. The geotubes will be designed to retain all fine-grained material. Once the geotubes are filled, they will create a containment structure which will ring the perimeter of the marsh creation area. Hydraulic dredging will then be used to fill the area within the geotube containment area to elevations appropriate for salt marsh creation. Best management practices will be used to keep suspended sediments within the geotube containment area and minimize impacts to adjacent subtidal softbottom habitats.

Turbidity – Blasting

Blasting of rock from the proposed project will produce short term increases in turbidity as silts and clays overlaying and in the vicinity of each blast event are suspended during the underwater explosions and the release of gasses from the fractured rock. Teleki and Chamberlin (1978) reported elevated short-term turbidity levels associated with blasting in glacial tills in the shallow waters of Lake Erie, however elevated turbidities lasted only a matter of hours before returning to ambient conditions. Blasting activities are generally limited to one to two blasting events per day as the process of drilling holes, loading explosives, setting charges, and removing divers must be done sequentially and therefore requires significant time to accomplish. Therefore, blasting is not anticipated to contribute to significant levels of turbidity for extended periods of time during construction of the proposed project.

7.2.3 Dissolved Oxygen

The resuspension of sediments by dredging activities has the potential to depress dissolved oxygen concentrations in the water column. Dissolved oxygen concentrations were monitored during dredging of parent materials to construct CAD cells in Boston Harbor in conditions similar to New Haven Harbor (ENSR 1997). Dissolved oxygen concentrations during CAD cell construction varied by a maximum of 0.6 mg/l between the upstream reference and downstream monitoring stations and never dropped below the level specified in the water quality standards of 5.0 mg/l for Class SB waters or 6.0 mg/l for Class SA waters. While small decreases in DO are expected during dredging operations, no long-term impairment to DO is expected from the dredging process.

Deepening and widening of federal navigation channels can result in lower dissolved oxygen (DO) concentrations due to changes in water dynamics. The change in elevation within the New Haven Harbor navigation channel is not expected to cause a significant difference in DO levels as this area is well flushed by the tides and currents passing in and out of New Haven Harbor.

7.2.4 Nutrients

The proposed project would not result in an increase of nutrients into New Haven Harbor waters. However, dredge operations can increase nutrient concentrations in the immediate vicinity of the dredge as sediment bound nutrients are disturbed during material removal. The effect of releasing sediment bound nutrients would be temporary and minor. The proposed project would not affect nutrient concentrations, nutrient loading, or nutrient cycling within New Haven Harbor waters.

7.3 Wetlands

No Action Alternative

Under the no action alternative, wetlands in the vicinity New Haven Harbor would remain unchanged, subject to projected sea level changes.

Preferred Alternative

Dredging Impacts

In general, the majority of New Haven Harbor navigation channel is shallow subtidal estuarine water with surficial sediments dominated by silt. No impacts to salt marsh areas or other wetlands in the New Haven Harbor system adjacent to the dredging operations are anticipated.

Beneficial Use Impacts

Beneficial use of the material to be removed by the proposed project is expected to create approximately 73 acres of salt marsh wetland in the New Haven Harbor system. Figure 7-1 depicts a conceptual location for the salt marsh. As noted in Section 3.3, the New Haven Harbor system has lost significant amounts of wetland due to marsh filling for development. The addition of 73 acres of salt marsh to the system will positively benefit fish and wildlife resources in the area by adding to the diversity of habitat available in the area. The addition of salt marsh to the system would also benefit the communities that neighbor New Haven Harbor by increasing the habitat complexity of the harbor and increasing the system's ability to deal with coastal storms, sedimentation, and water quality issues.

The creation of the 73 acres of salt marsh would displace approximately 67 acres of shallow subtidal (ranging between 0 to 4 feet deep MLLW) soft-bottom habitat and approximately 6 acres of intertidal mud/sand flats that currently exist in the 73 acre footprint. As the majority of New Haven Harbor is shallow subtidal soft-bottom habitat, the conversion of the area to salt marsh would not significantly diminish the availability of subtidal soft-bottom habitat in the system.

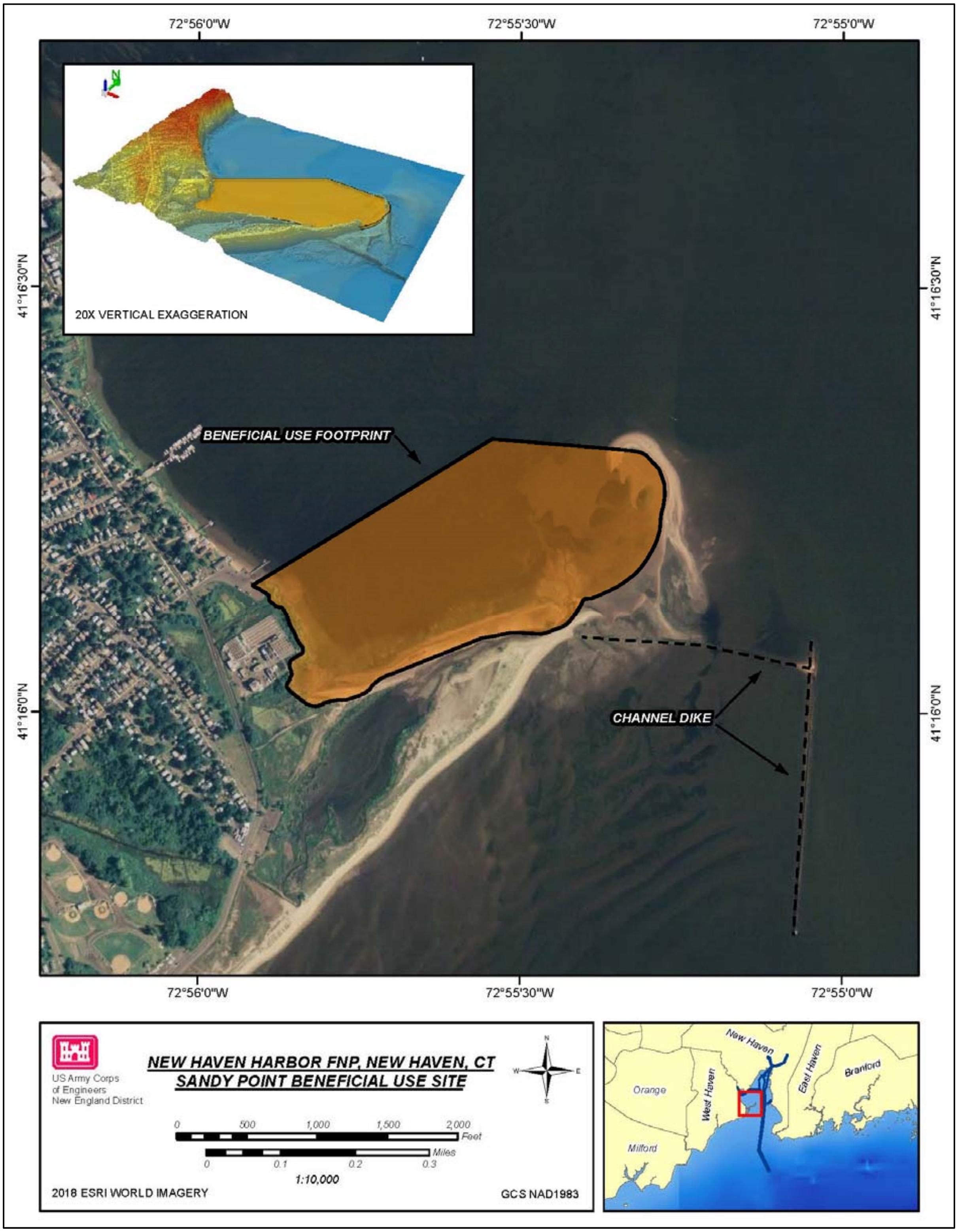

Figure 7-1: Location of Salt Marsh Creation Area in New Haven Harbor, CT

7.4 Benthic Habitat

No Action Alternative

The No Action Alternative will have no effect on the benthic habitats of New Haven Harbor.

Preferred Alternative

Dredging Impacts

Most shallow benthic habitats in estuarine systems are subject to deposition and resuspension events on daily or even tidal time scales (Oviatt and Nixon, 1975). Many organisms have behavioral or physiological responses to sediments that settle on or around them. Many organisms avoid the area of disturbances while others have a tolerance to attenuated light conditions or anaerobic conditions caused by partial or complete burial. Direct effects of sedimentation include smothering, toxicity (exposure to anaerobic sediment layers), reduced light intensity, and physical abrasion, whereas indirect effects include changes in habitat quality (Wilber, et al., 2005).

Studies of burial of estuarine invertebrates found species specific responses. According to Hinchey et al. (in Berry, et al., 2003), the responses varied as a function of motility, living position and inferred physiological tolerance of anoxic conditions while buried. The deposition of dissimilar sediments has a greater impact on organisms than sedimentation of like materials (Maurer, et al., 1978, 1986). In the New Haven Harbor navigation channel, the benthic community already experiences and has adapted to sedimentation stress caused by resuspension of sediments due to natural processes (e.g., storms and tides) as well as anthropogenic influences (e.g., large vessel traffic). Monitoring of previous dredging activities in New Haven Harbor and in Boston Harbor (Boston, Massachusetts) have shown that sediment plumes settle out predominantly in the dredge area (see Section 7.1) limiting the extent of additional stress to the system. The Boston and New Haven monitoring studies did however show that, to a limited extent, sediment plumes can extend outside of the navigation channels and can produce short-term increases in turbidity.

Turbidity impacts are dependent on the concentration and the duration of the suspended sediments (Clarke and Wilber, 2000; Suedel 2015). Motile benthic organisms (e.g., lobster and crab) can generally avoid unsuitable conditions in the field and, under most dredging scenarios, encounter localized suspended sediment plumes for exposure durations of minutes to hours, unless the organism is attracted to the plume and follows its location. Although adult bivalve mollusks are silt-tolerant organisms (Sherk, 1972 in Clarke and Wilber, 2000), they can be affected by high suspended sediment concentrations. Hard clams (Pratt and Campbell, 1956 in

Clarke and Wilber, 2000), and oysters (Kirby, 1994 in Clarke and Wilber, 2000), exposed to fine silty-clay sediments have exhibited reduced growth and survival, respectively. Suspended sediment concentrations required to elicit these responses and mortality, however, are extremely high, i.e., beyond the upper limits of concentrations reported for most estuarine systems under natural conditions, as well as typical concentrations associated with dredging operations (See Section 7.1). Sublethal effects, such as reduced pumping rates and growth, were evident for adult bivalves at concentrations that occur under natural conditions, but may be of a short-term (i.e. hours to days) duration, for example, during a storm (Schubel, 1971; Turner and Miller, 1991 in Clarke and Wilber, 2000). The egg and larval stages of benthos (e.g., shellfish) are more sensitive to suspended sediment impacts than adults. Estimates of suspended sediment impacts to these pelagic, early life history stages must consider the local hydrodynamics of the dredging site, which strongly influence the likelihood of extended exposure to suspended sediment plumes (Clarke and Wilber, 2000, Suedel et al 2015).

The benthic community in the navigation channel will be eliminated by direct removal from deepening efforts. Additionally, the benthic communities in the current side slopes of the channel will be eliminated by widening efforts. Once dredging is completed, the benthic community of the channel and side slope areas is expected to begin recolonization by recruitment from benthic species in other areas of New Haven Harbor. As the benthic community throughout the existing channel and side slopes is a mix of opportunistic early-successional stage benthic communities and mid-successional stage benthic communities, a return to a similar community following dredging is expected within approximately 1-3 years.

The New Haven Harbor navigation channel is shallow subtidal estuarine water with surficial sediments dominated by silt. The proposed deepening and widening of the project will not alter the habitat type (soft bottom) over the majority of the project area. There are sections of the FNP (approximately 5.8 acres) that contain rock below overlaying silt to the proposed project depth, and therefore may initially be converted from silty bottom to hard bottom during construction. However, given the frequency of maintenance dredging in New Haven Harbor (approximately every 10 years) the conversion to hard bottom habitat is not expected to persist as the FNP shoals in frequently with silty material.

Impacts of Material Placement at All Sites

For over 40 years, studies and monitoring efforts have been conducted in New England to understand the consequences of dredged material placement to benthic habitats and local food webs (Wolf, et al. (2012), Fredette & French, (2004), Valente (2007)). The type and extent of impacts depend on the characteristics of both the dredged material and the habitat at the placement site (Bolam, et al., 2006). Although short-term impacts and long-term changes in habitat due to sediment type and elevation of the seafloor have occurred at studied sites, there is no evidence of long-term effects on benthic processes or habitat conditions (Germano, et al. (2011); Lopez, et al. (2014)).

One of the key biological impacts is the burial of benthic invertebrates where dredged material is deposited. Sediment type, sediment depth, burial duration, temperature, and adaptive features such as an organism's ability to burrow and to survive can affect the ability of organisms to migrate to normal depths of habitation. Benthic disturbance from dredged material placement at designated disposal sites has direct, immediate effects on sessile epifauna and infauna (Germano, et al. (1994), (2011)). Sediment accumulations greater than 6 inches are expected to smother most benthic infauna (Lopez, et al., 2014). Large decapod crustaceans (i.e., cancer crabs, shrimp species, lobster) are able to penetrate deeply into the sediment, which provides them with mechanisms that enable them to survive some burial. Other strong deposit feeders can withstand burial of 4 inches or more (Jackson & James (1979); Bellchambers & Richardson (1995)), while 0.4 inch of sediment can kill attached epifaunal suspension feeders (Kranz, 1974). The greatest impacts from burial occur in the central mound area, where multiple deposits result in the thickest amounts of placed sediment (Germano, et al., 1994). The burial on benthic invertebrate populations is typically a short-term impact, because infauna rapidly recolonize the freshly placed, organic-rich material.

Additional short-term impacts of placement may occur. Small surface-dwelling animals (e.g., some amphipod and polychaete species) may be dislodged and transported to the outer region of the deposit with water and sediment movement. The sediment plume may temporarily interfere with benthic feeding and respiration in the water column.

The physical nature of seafloor sediments defines the type of habitat that is available for benthic organisms to colonize, and thus the types of organisms and benthic community that can live and thrive on the placed dredged material. Potential long-term impacts may include changes in benthic community composition that result from potential alterations in sediment grain size and TOC as well as alterations in seafloor elevation.

Blasting Impacts

The impacts of blasting on the benthic communities of New Haven Harbor, with the exception of the immediate vicinity of the blast, should be minimal. As noted in section 7.1, increases in turbidity are expected to occur in the immediate vicinity of the blasting, however, elevated turbidity levels are expected to be short-term (i.e., a matter of hours). Other impacts from blasting (increased noise and blasting pressure waves) should not affect benthic communities outside of the blasting zone.

Benthic communities in the footprint of the blasting will be eliminated. Soft-bodied invertebrates in the immediate vicinity would be killed, while populations of those in outlying areas would sustain less damage. Damage to hard-bodied invertebrates near the blast site may occur and could include cracked or broken shells and carapaces. Long term impacts are not expected.

7.5 Essential Fish Habitat and Managed Species

No Action Alternative

The No Action Alternative will have no effect on the essential fish habitat and managed species of New Haven Harbor.

Preferred Alternative

Dredging and Disposal

The proposed project would impact EFH for managed species. The habitats affected include shallow subtidal soft bottom habitat, intertidal sand flat habitat, and water column habitat. Effects of the proposed project include death and injury of fishes and forage during dredging operations and subsequent maintenance dredging operations. Direct removal of soft bottom habitats will occur in the dredging areas and direct covering of soft bottom habitats will occur in the placement areas. Indirect impacts due to changes in water quality will occur, however, they are anticipated to be short-term and localized to within hundreds of feet of the dredging and disposal efforts. These effects have been documented in Sections 7.2 7.4, and 7.8. The list below summarizes potential effects of the proposed project on EFH and managed species. Details on the effects to specific groups of managed species associated with certain essential fish habitats can be found in Appendix H of the Final IFR/EIS.

1. 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 between October 1 and February 1 over the course of 2 years) and maintenance dredging (an effect temporary in duration). No one area would experience an extended duration of effects.

2. Indirectly affecting foraging behavior of individuals through production of turbidity at construction/maintenance dredging and disposal sites (an effect temporary in duration).

3. Indirectly affecting movements of individuals around/away from dredging sites due to construction equipment and related disturbed benthic habitats (an effect temporary in duration).

4. Indirectly affecting foraging and refuge habitats by removal of benthic habitat (i.e., soft bottom) (an effect temporary in duration).

Many of the dredging related impacts (i.e., increases in turbidity, changes in fish movement behavior) are common temporary occurrences in estuarine systems like New Haven Harbor. Therefore, these temporary impacts will occur in the No Action alternative. However, the proposed project involves a longer duration of these temporary impacts. As noted, the effects would only occur 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 most species EFHs. Where possible, the above effects have been minimized via project design. An EFH Assessment has been prepared for this project and is presented in Appendix H.

Blasting

Blasting effects to bottom habitats are discussed above in Section 7.4 and effects to fish are discussed below in Section 7.8.

Conclusion

Considering the expected duration and location of the impacts noted above within New Haven Harbor, the Corps has made the determination that the impacts from the proposed action will not significantly impact managed species and their associated EFH.

7.6 Protected Species

No Action Alternative

Under the no action alternative, protected species in the vicinity New Haven Harbor would remain unchanged.

Preferred Alternative

The Corps has made the preliminary determination that no threatened or endangered species are likely to be adversely affected by the proposed project. Impacts to each protected species are presented below.

Sea Turtles

The use of New Haven Harbor by sea turtles is possible but not common. The potential for finding any sea turtle species does increase at the CLDS and the areas used to travel through to get to the disposal site. All of the sea turtle species that have any potential of being in New Haven Harbor and Long Island Sound are endangered species and discussed in the Threatened and Endangered Section in the Affected Environment. Sea turtle's mobility should allow all species that may be present in New Haven Harbor and CLDS during all material placement alternatives (i.e., all dredging and disposal activities) to avoid negative effects. Trained sea turtle observers will be present during any blasting activities and blasting operations will be delayed should any sea turtle species be present. Therefore, the proposed project is not likely to adversely affect any sea turtle species.

Atlantic Sturgeon

As noted in section 3.6, adult and subadult Atlantic sturgeon are known to occur in Long Island Sound, where they are likely to be migrating and possibly foraging opportunistically should suitable forage be available. As Atlantic sturgeon spawn in freshwater portions of large rivers and early life stages are not tolerant to salinity, no eggs, larvae or juvenile Atlantic sturgeon are likely to occur in the action area. While the possibility exists for adults to be present, their mobility should allow them to avoid dredging and disposal activities. Trained fisheries observers will be present during any blasting activities and blasting operations will be delayed should any Atlantic sturgeon (or other large fish and/or large schools of fish) be present. Therefore, the proposed project is not likely to adversely affect Atlantic sturgeon.

Birds

Several threatened or endangered bird species (piping plover, red knot, and roseate tern) are present within the New Haven Harbor project area. Time of year restrictions will be used to avoid impacts to these species. No dredging, disposal, or blasting activities will occur between April 1 and August 31 of any year to avoid protected bird species. The creation of 70 acres of salt marsh to the New Haven Harbor ecosystem will positively benefit these species by providing resting and feeding areas.

Mammals

The Federally threatened northern long-eared bat (*Myotis septentrionalis*) is found across much of the eastern and north central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. While this species is not directly within the project area of the proposed project, the possibility of occurrence in adjacent forested areas is possible. All activities associated with the proposed project will not affect any adjacent forested lands, therefore no impacts to long-eared bats are expected.

The Corps has made the preliminary determination that no threatened or endangered species are likely to be adversely affected by the proposed project. Coordination with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Connecticut Department of Energy and Environmental Protection is ongoing.

7.7 Marine Mammals

No Action Alternative

Under the no action alternative, marine mammal species in the vicinity New Haven Harbor would be unaffected.

Preferred Alternative

Dredging and Placement

Harbor seals have the potential to be found in areas proposed for dredging, the material placement areas, and along the haul route to CLDS, and in CLDS. Harbor seals that wander into the harbor during dredging activities should be able to avoid impact as they are highly mobile and could easily avoid the dredging and placement activities. No significant impacts to harbor seals are expected as a result of the dredging or disposal activities.

Blasting

Although harbor seals are infrequent visitors of New Haven Harbor, they could be potentially be affected by blasting if they should occur too close to the blast site. If present during a detonation, individuals would likely sustain injuries as a result of pressure waves produced by the blast. To avoid this potential impact, a marine mammal observer will be present during all blasting events and will provide guidance to the contractor on when to restrict blasting if a marine mammal is within or in close proximity to the established safety zone (assuming no human safety concerns exist).

7.8 Fish

No Action Alternative

Under the no action alternative, fish resources in the vicinity New Haven Harbor would remain unchanged.

Preferred Alternative

Dredging and Disposal

The proposed project would impact fish species in the project area. Effects of the proposed project include possible death and injury of fish, interference with fish movements, disruption of the forage base, and changes in water quality during dredging operations. As noted in Section 7.4, direct removal of soft bottom habitats will occur in the dredging areas and direct covering of soft bottom habitats will occur in the placement areas. As noted in section 7.2, indirect impacts due to changes in water quality will occur, however they are anticipated to be short-term and localized to within hundreds of feet of the dredging and disposal efforts.

Intermittent, short-term impacts to fish also include disturbance of fish throughout the water column within the localized area during dredging and disposal efforts. Due to their mobility, most fish would be expected to move out of an active dredging area or a dredged material burial area. The sediment plume associated with dredging and the plume following material placement would also have potential short-term water quality impacts that may also have indirect impacts on fish by temporarily altering certain finfish behaviors, such as migration, spawning, foraging, schooling, and predator evasion (O'Connor, 1991). Increased turbidity has also been associated with potential gill abrasion and respiratory damage (Saila, et al. (1971); Wilber & Clark (2001)).

Sediment characteristics and the life stage of species affect how sensitive species are to suspended sediment, with egg and larval stages tending to be the most sensitive (Johnson, et al., (2008); Berry *et al*. (2003), Wilber & Clark (2001)). During material placement, these impacts are limited both in duration and spatially due to the short time needed for dredged material to reach the bottom (Kraus (1991); Dragos & Lewis (1993); Dragos & Peven (1994)). Saila, et al. (1971) also point out that “aquatic animals are able to tolerate high concentrations of suspended sediments for short periods.” Since the tolerance level for suspended solids is high in shallow and mid-depth coastal waters, and fish and lobster may experience major changes in turbidity during storms, Saila, et al. (1971) conclude that mortality due to elevated sediment concentrations in the water column resulting from dredged material placement is not likely.

As noted through this document, concentrations of sediments and the duration needed to cause impacts to fish resources are expected to be short-term and localized and as such, effects to fish sources in the proposed project areas should be minimal.

Blasting

The extent of damage to fish populations by blasting depends primarily on the proximity to the blast and the presence or absence of a swim bladder. Fish with swim bladders (e.g., Atlantic herring) will be unable to adjust to the abrupt change in pressure propagated by the blast. If they are within a zone of influence, fish with swim bladders may be injured or killed. Fish without swim bladders (e.g., winter flounder) are less likely to be injured, and would likely sustain injuries only if they are in the immediate vicinity of the blast. Blasting may displace resident fishes, although this impact is expected to be only temporary. Blasting impacts will be avoided or minimized by the methods discussed in the following paragraphs.

Several precautionary measures, or best management practices (BMPs) will be put in place to avoid or minimize the incidence of injury to fish and marine mammals from blasting. These blasting mitigation measures include:

- Limiting blasting events to a period between October 1 and May 1
- Use of a fish detecting and startle system to avoid blasting when fish are present or transiting through the area;
- Requiring the use of sonar and the presence of a fisheries and marine mammal observer during blasting events;
- Prohibiting blasting during the passage of schools of fish, or in the presence of marine mammals, unless human safety is a concern;
- Using inserted delays of a fraction of a second per blast drill hole, and;
- Placing material on top of the borehole (stemming) to deaden the shock wave reaching the water column.

Given the BMPs noted above to minimize blasting impacts to fish resources, significant impacts from the blasting efforts are not expected to significantly affect fish in the project area.

Winter Flounder

Winter flounder is a Federally managed demersal (bottom dwelling) fish. EFH for winter flounder is contained within the project area. Winter flounder eggs are demersal and larvae are found near the bottom in shallow areas. As noted above, minimal levels of sedimentation can potentially have an adverse impact on early and/or critical life stages of fish as sediments have the potential to bury demersal eggs, while larvae may be trapped or buried by the sediments (Wilbur and Clarke, 2001). To protect these sensitive life stages (i.e., eggs and larvae) of winter flounder, no dredging or material placement activities will occur between February 1 and June 30 of any year.

Winter flounder spawn on various substrates and (within the proposed project area) in areas less than 5 meters deep. In order to quantify the proposed project's effects on the areal extent of winter flounder habitat that would be affected, two specific calculations were made. The first, winter flounder habitat lost, was calculated by measuring subtidal areas that were at depths of 5 meters or shallower and were planned to be deepened by the proposed dredging efforts or filled by the creation of salt marsh. The second, winter flounder habitat gained, was calculated by measuring areas that were deeper than 5 meters (i.e., the borrow pits), but were planned to be filled to depths shallower than 5 meters deep. Table 7-1 below notes the values for each calculation. The net loss of winter flounder habitat, which is due in large part to the creation of 73 acres of salt marsh (66.8 acres of which is flounder habitat), is approximately 18.4 acres. While a net loss of 18.4 acres of shallow subtidal habitat is substantial, New Haven Harbor contains approximately 6,000+ acres of similar habitat within harbor system. Therefore, the project should not significantly jeopardize the harbor's ability to sustain winter flounder populations.

Table 7-1: Losses and Gains of Winter Flounder Essential Fish Habitat in New Haven Harbor from the proposed project

Project Feature or Placement Site	Winter Flounder EFH Lost (acres)	Winter Flounder EFH Gained (acres)
Main Channel and Turning Basin	8.6	0.0
Morris Cove Borrow Pit	0.0	42.0
West River Borrow Pit	0.0	15.0
Sandy Point Marsh Creation	66.8	0.0
Shellfish Habitat Creation Area	0.0	0.0
Rock Placement Area	0.0	0.0
TOTALS	**75.4**	**57.0**

7.9 Shellfish and Lobster

No Action Alternative

Under the no action alternative, shellfish and lobster resources in the vicinity of New Haven Harbor would remain unaffected.

Preferred Alternative

Dredging

Dredging Effects to Resources

The improvement dredging of New Haven Harbor will remove all shellfish and lobster resources in the direct footprint of the dredge. Additionally, the benthic community, which lobsters utilize as a forage source, will also be removed. Shellfish resources in adjacent areas should not be significantly impacted and will serve as a recruitment source following the cessation of dredging. Impacts from elevated turbidity to shellfish resources in the vicinity of the dredging operation should be minimal as the impact area will be highly localized. Several studies have demonstrated that shellfish are capable of withstanding elevated turbidity levels for short time periods (i.e., days) with no significant metabolic consequences or mortality (Wilbur and Clarke 2001; Archambault et al. 2004; Norkko et al. 2006). Adult lobsters are also tolerant of exposure to elevated suspended sediment concentrations (Stern and Stickle 1978). Since the dredging of the project areas will be a short-term effort and reestablishment of shellfish populations in the dredge footprint will recover, impacts to shellfish resources are anticipated to be minimal. Therefore, the proposed project should not have long-term significant impacts to lobster and shellfish resources in the dredging area.

Dredging Effects to Managed Shellfish Parcels

As noted in Section 3.9, the State of Connecticut (Department of Agriculture/Bureau of Aquaculture) manages many parcels of land underwater that are dedicated to shellfish growing and harvesting. Table 7-2 notes each of the parcels that are located within the footprint of the proposed project and the estimated area of the parcel that would be affected by the dredging effort.

The proposed deepening and widening of the New Haven FNP should not pose a significant long-term impact to the shellfishing industry of New Haven Harbor. For those active parcels located within the proposed improvement areas, live shellfish (and/or shellfish shells that are on the seafloor serving as a growing substrate) will be able to be removed prior to dredging and placed elsewhere within the harbor. The practice of relocating shellfish resources is routinely used in New Haven Harbor, as the majority of the harbor is in “conditional relay” harvesting status. Portions of sixteen active lots (noted in Table 7-2), totaling approximately 190 acres will be permanently lost to shellfish growing and harvesting as they will become a part of the New Haven Harbor FNP.

Shellfish Habitat Creation Area

An area (Figure 3-4) behind the east breakwater in New Haven Harbor has been identified as a potential site to place silty-sand from outer New Haven Harbor to create habitat more suited for oyster beds. The placement of approximately 434,000 CY of sand within this area (with the exception of a small portion of hard bottom in the southeast corner of the site) will create approximately 25 acres of oyster habitat. The entire shellfish creation area is located within a State of Connecticut owned shellfish parcel.

Table 7-2: Managed Shellfish Parcels in New Haven Harbor Improvement Project Area

PARCEL NAME	BED TYPE	FISHING STATUS	TOTAL AREA OF PARCEL (ACRES)	TOTAL AREA OF PARCEL IN THE EXISTING FNP (ACRES)	AREA OF IMPACT FROM PROPOSED PROJECT (ACRES)
05-14	Hard Clam/Oyster	inactive	134.7	15.27	15.08
LOT 66	Oyster	active	4.5	2.37	1.05
LOT 49	Oyster	active	30.7	2.47	1.66
LOT 70	Oyster	inactive	14.3	6.73	0.34
LOT 72	Oyster	active	204.8	27.1	8.69
LOT 74	Oyster	active	71.3	50.36	15.4
LOT 90	Oyster	active	61.8	25.45	11.48
LOT 97	Oyster	active	20.1	16.18	7.3
LOT 99	Oyster	active	28.9	6.82	3.7
LOT 100	Oyster	active	10.8	8.79	3.25
LOT 103	Oyster	active	33.7	6.84	4.96
LOT 106	Oyster	active	23.5	14.3	4.78
LEASE 146	Oyster	inactive	31.5	7.56	4.4
324B	Hard Clam/Oyster	inactive	52.8	28.33	10.45
324A	Hard Clam/Oyster	active	41.6	12.84	4.67
LOT 327	Clam	active	55.5	22.84	19.82
LOT 339	Hard Clam/Oyster	active	198.3	67.96	67.96
LOT 343	Hard Clam/Oyster	active	107.9	21.59	21.59
LEASE 568	Clam	active	233.6	18.87	8.57
L-635	Clam	active	89.1	12.06	5.44
L-636	Clam	inactive	50.4	8.13	8.13

Table 7-3: Managed Shellfish Parcels in New Haven Harbor Affected by the Proposed New Haven Harbor CAD cell

PARCEL NAME	BED TYPE	FISHING STATUS	TOTAL AREA OF PARCEL (ACRES)	TOTAL AREA OF PARCEL IN THE EXISTING FNP (ACRES)	AREA OF IMPACT FROM PROPOSED PROJECT (ACRES)
LOT 80	Oyster	Unknown	10.0	0	0.91
LOT 86	Oyster	Unknown	1.0	0	0.67
LOT 89B	Oyster	Unknown	3.5	0	0.57
LOT 90A	Oyster	Active	61.8	0	1.57

7.10 Birds

No Action Alternative

Under the no action alternative, bird resources in the vicinity of New Haven Harbor would remain unchanged.

Preferred Alternative

Dredging, Disposal, and Blasting

As discussed in Section 2.5.15, a very large and diverse bird community exists in the New Haven Harbor area. 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. Placement of dredged material within the marsh creation area may displace individuals using the sites for foraging and resting. However, these impacts are expected to be short-term and limited to the periods of active construction.

The salt marsh creation beneficial use alterative will increase available salt marsh habitat in the New Haven Harbor system. Salt marshes are used by a variety of migratory bird species for nesting, foraging, and loafing/roosting habitats.

7.11 Invasive Species

No Action Alternative

Under the no action alternative, invasive species in the proposed project area would remain unchanged.

Preferred Alternative

Dredging

As mentioned in Section 2.5.16, the major known pathways for non-native species to enter the project area include stocking, aquarium releases, shipping, and bait releases. Commercial shipping, via the use of ballast water and from vessel fouling communities, is the only direct mechanism related to this project. Federal regulations require the shipping industry to implement control of the invasive species introduction pathway through the ballasts of vessels (US Coast Guard, 2012). These regulations should decrease the rate at which invasive species are introduced to United States waters. Additionally, 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 Port of New Haven. 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. Therefore, the proposed project is not anticipated to increase invasive species within the study area.

7.12 Air Quality

General Conformity under the Clean Air Act, Section 176 was evaluated for the New Haven Harbor Navigation Improvement project. As noted in Section 3.12, New Haven County is designated by the EPA as a moderate non-attainment area for the 2008 8-hour ozone standard. Total direct and indirect emission from this project/action are estimated to be at levels that are considered to be de minimus. The calculated volumes are below the conformity threshold value established at 40 CFR 93.153(b) of 100 tons/year of NOx and 50 tons/year for VOCs. Table 7-4 below shows the calculated VOCs and NOx emissions per calendar year for the proposed project. A general conformity record of non-applicability and the associated emissions calculations are located in Appendix L.

Table 7-4: Calculation of Ozone (VOCs and NOx) Emissions per Calendar Year for the New Haven Harbor Navigation Improvement Project

Year	Total NOx (tons)	Total VOC (tons)
2021	79.83	11.28
2022	99.06	14.28
2023	73.71	10.42

7.13 Hazardous, Toxic, and Radioactive Waste

No Action Alternative

Under the no action alternative, the existing conditions noted in section 3.13 would remain unchanged.

Preferred Alternative

Dredging, Disposal, and Blasting

The project is not anticipated to contribute any hazardous, toxic, or radioactive waste material to the New Haven Harbor system.

7.14 Noise

No Action Alternative

Under the no action alternative, the existing noise conditions noted in section 3.14 would remain unchanged.

Preferred Alternative

Impacts of Dredging Noise on Marine Life

Reine et al (2012) found that the majority of underwater sounds produced by hydraulic cutterhead dredging operations were of relatively low frequency (< 1000 Hz). Their study was conducted during rock fragmentation and therefore represented a worst case scenario. The source level was estimated to be between 170 and 175 dB re 1uPa @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.

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 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 New Haven Harbor is predominantly silt/clay mixture, with the exception of hard rock in portions of the Main channel near the breakwaters. According to the Clarke et al

(2002), the peak amplitude for the bucket hitting the rocky, gravel, cobble bottom at Cook Inlet, Alaska was about 40 - 50 dB. Both Doug Clarke and Charles Dickerson, US Army ERDC, stated that this peak amplitude of the bucket hitting sand/silt/mud substrate would be significantly less than 120 dB. Since the substrate composition of New Haven Harbor is predominantly silt/clay material, it is reasonable to assume that the New Haven Harbor dredging would have a lower sound level.

Impact of Dredging Noise on the Human Environment

Maintenance dredging and periodic new work dredging has occurred in New Haven Harbor for over 100 years. For continued maintenance dredging, the dredging equipment is usually present in the Harbor on a 8 to 9-month frequency and that frequency is not expected to change with the proposed project. While there would be an increase in the ambient noise level during the dredging phase of the project, the source of noise is at a distance far enough away from any sensitive receptors that no impact is anticipated. Since dredging does not occur in one position for any extended period of time, there will be no disproportionate adverse impact on any communities adjacent ot the harbor. 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 New Haven Harbor would decrease as a result of the proposed project and that the same number of larger vessels would call on the Harbor regardless of channel depth. The difference being that with a deeper channel, the larger vessels can fully load their cargo and be unrestricted by tide. Without the project, a greater number of vessels would be required to deliver the same amount of commercial goods which would have a greater impact on marine noise. As a result, no adverse impact is anticipated from underwater noise resulting from vessel activity as a result of deepening the Harbor.

Port noise can come from port facilities, cranes, cargo handling equipment, warehousing, vessel repair or maintenance, and engine noise from vessels at berth. The proposed project would not cause an increase in the number of vessels anticipated to arrive in the Port of New Haven. The only change may be in the timing of vessel unloading. In light of these factors, the proposed deepening is not expected to result in adverse noise impacts as a result of port operations.

Blasting Noise

The effects of blasting (including blasting noise) and impacts on environmental resources are noted throughout this EIS.

7.15 Coastal Barrier Resources

There are two OPAs located within New Haven Harbor: the Morse Park unit and the Nathan Hale Park unit. The proposed project would have no effect on the Nathan Hale Park Unit. The project will affect the Morse Park Unit by creating saltmarsh habitat within the unit. However, this action will not violate CBRA as it would not induce development in the unit. Additionally, per 16 U.S.C. § 3505(a), the following exemption criteria is met: "the maintenance or construction of improvements of existing federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the disposal of dredge materials related to such maintenance or construction." The USFWS has concurred that the proposed project will not violate CBRA requirements.

7.16 Cultural and Historic Resources

No Action Alternative

Under the no action alternative, the existing conditions noted in section 3.16 would remain unchanged.

Preferred Alternative

Navigation Improvements

USACE has conducted side scan sonar surveys and obtained vibracore samples of the navigation improvements areas within the New Haven Harbor study area. A possible wreck/obstruction site was located just outside of the main channel and adjacent to the channel side slope (see side scan image in relation to APE). CT SHPO recommends a 150-foot buffer from all sides of the side scan sonar image of the possible wreck site. The current data is inconclusive to determine whether this site is a shipwreck or other obstruction. Since the location is outside of the current improvements to the channel, it will be avoided with an appropriate buffer. However, if impacts to the area cannot be avoided, then an archaeological examination of the site would be required during a later phase of the study to determine whether the location represents a significant historic property eligible for the NRHP.

No other possible wreck sites were identified in the side scan data. The vibracore samples were examined and consisted primarily of organic silts and clays overlying layers of sand or clay. No evidence of habitation surfaces or artifacts of any types were encountered. The overlying material represents a mixed of recently deposited silts and clays and correlates with the presence of a large, urban harbor that is subject to periodic maintenance dredging.

Impacts to historic properties are not expected from the navigational improvements to New Haven Harbor adjacent to the current channel dimensions and a buffer will be established around the possible wreck/obstruction indicated above.

Disposal Sites

The Central Long Island Sound Disposal Site or CLIS is a previously utilized disposal site for dredged material. Disposal of dredged material from the New Haven Harbor navigation improvement project at CLIS is unlikely to impact any significant historic properties.

Beneficial Use Site

Sandy Point Wetland Creation Site

Research conducted as part of the LIS DMMP by PAL (Cherau et al. 2010) identified one potential shipwreck, the Laura S. Hatch, located to the northwest of the Sandy Point Dike. As per SHPO recommendation, a 150-foot buffer will also be required around this site. As the beneficial use site is well to the south (roughly 2,000 feet) and located along the edge of Sandy Point, its use will not impact this possible wreck site. If the dimensions of the beneficial use site change and the buffer cannot be maintained around the shipwreck, further evaluation would be required including archaeological investigation and coordination with SHPO.

Vibracores of the Sandy Point site (a total of 8 cores) were taken to ascertain the stratigraphy of the area and determine if the sediments exhibit stratified deposits and/or artifacts indicative of possible Native American habitation. The 2010 PAL study of Long Island Sound stratified most of the southern New Haven Harbor and surrounding coastal areas as having moderate underwater archaeological sensitivity. A review of the vibracores indicated primarily organic silt and fine sand over dark gray clay silt to the bottom with assorted oyster, clam, and whelk shells throughout the column. This is indicative of coastal wetland deposits in the area. No evidence of soil horizons, habitation levels, or artifacts of any type were identified.

An archaeological survey of the West Haven Water Pollution Control Facility adjacent to Sandy Point was conducted in 2009. Originally built in 1969, the facility was proposing an expansion to the east along the former wetland areas that bordered Sandy Point. Shovel test pits along three transects uncovered primarily fill deposits overlaying the original wetland soils, with thicker fill deposits closer to the existing water treatment plant. The original plant was built with imported fill over wetland soils and this is documented in thick fill deposits containing modern debris in highly disturbed contexts closest to the plant with lesser amounts of debris away from the facility. No further archaeological work was recommended (Archaeological Consulting Services (ACS) 2009:1-2).

West River Borrow Pit

No known or recorded shipwrecks or submerged archaeological sites are located in the vicinity of the proposed West River borrow pit site. As this site has previously been utilized for borrow material and will simply be filled with dredged material, impacts to historic properties are not expected.

A side scan sonar survey of the West River borrow pit conducted during spring 2018 identified 26 vessel moorings, 2 navigation aid moorings, and one submerged vessel. According to the local harbormaster, this is a modern sailboat that sank recently (within the last 20 years). USACE will confirm this information and attempt to identify the actual vessel lost during project design.

Morris Cove Borrow Pit

No known or recorded shipwrecks or submerged archaeological sites are located in the vicinity of the proposed Morris Cove site. This site is also a previously utilized disposal site for dredged material and impacts to historic properties are not expected.

East Breakwater Oyster Habitat Creation Site

No known or recorded shipwrecks or submerged archaeological sites are located in the vicinity of the proposed East Breakwater improvement area. Side scan sonar survey of this area did not identify any possible submerged historic properties or obstructions, with the exception of a linear feature inshore of the breakwater determined to be a cable running from Morgan Point to the Southwest Ledge Lighthouse.

West Breakwater, General Rock Placement Area

No known or recorded shipwrecks or submerged archaeological sites are located in the vicinity of the proposed West Breakwater rock placement area. Side scan sonar survey of the area did not identify any potential historic properties. Impacts to cultural resources are not expected.

Confined Aquatic Disposal (CAD) Site Locations

USACE has selected a location adjacent to the federal channel as a CAD site for dredged material determined to be unsuitable for open water placement from the navigation improvement (dredging) of the channel. There are no known or recorded shipwrecks or submerged archaeological sites within the proposed CAD site. USACE conducted a side scan sonar survey of the CAD site location in spring 2018 and no features of interest were documented.

In all cases, if unanticipated discoveries are found during implementation of the project, USACE will follow the post review discoveries guidance of the Advisory Council's regulations (36 CFR 800.13). No further work will be allowed in the area and coordination with project stakeholders will commence to determine the appropriate course of action for identification and evaluation of the possible historic property.

7.17 Aesthetics and Recreation

The proposed project would not change the aesthetic resources of New Haven Harbor, nor the numerous recreational opportunities. Although the definition of aesthetics is fluid, for the purposes of the present evaluation, the principal aesthetic "targets" include the visual perception of New Haven Harbor's land- and seascapes and historic features. 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 by the proposed project.

The economic analysis for this project determined that the same size vessels would call on New Haven Harbor with or without a project; however the larger vessels would be able to access the harbor more fully with a project than without. This would reduce the number of vessels visible within and outside of the harbor as vessels would not need to wait in deep waters for appropriate tidal conditions.

One notable change to the harbor area would be an increase in salt marsh in the vicinity of Morse Beach and Sandy Point. The creation of this valuable habitat will add an additional natural habitat feature to the harbor's landscape.

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 preconstruction 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.

7.18 Socioeconomics

7.18.1 General

Long-term forecasts for the New Haven County region of Connecticut indicate continued growth of both population and employment, but at slower rates than has been experienced in the past decades (UCONN, 2018). As the port operators associated with New Haven Harbor provide many jobs (directly and indirectly) throughout Connecticut, the proposed project should sustain or increase the economic importance of the port of New Haven. Therefore, no negative effects on the socioeconomic environment are anticipated as a result of this project.

7.18.2 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations was signed on February 11, 1994. This EO is designed to focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities. Environmental justice analyses are performed to identify potentially disproportionately high and adverse impacts from the proposed actions in minority communities and low-income communities and to identify alternatives that might mitigate these impacts.

No significant adverse environmental impacts to minority or low income populations are anticipated as a result of this project. Although the populations surrounding the project area have a larger percentage of minorities and low-income population compared to the rest of the State of Connecticut, this dredging and disposal project is not expected to have a significant human health or environmental effect on any portion of the human population.

7.18.3 Protection of Children

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks was signed on April 21, 1997. A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risk and safety risks. Based on this risk, each Federal agency has been directed by this EO to identify and assess environmental health risks and safety risks that may disproportionately affect children. Each Federal agency is directed to ensure that its policies, program activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The project activities are located in the waters of New Haven Harbor and Long Island Sound, not an area that would be used disproportionately by children. The environmental impacts are generally temporary and contained within the aquatic environment. As discussed in the previous sections, any potential air quality impacts will conform to State and Federal emission standards during construction. Completion of the proposed project will reduce future regional air emissions by reducing vessel numbers transiting New Haven Harbor and thereby slightly decreasing potential health risks from poor air quality.

7.19 Sediments

The following section describes the impacts to the sediments within the improvement project as well as the sediments within the possible dredged material placement locations.

New Haven Harbor Federal Navigation Project

As described in Sections 2.3.4 and 2.3.5, the sediments to be dredged as part of the improvement dredging effort within New Haven Harbor are predominately silt. The outer harbor has sediments composed of fines sands and the area of the main channel that runs between the breakwaters has a fine layer of silt and fine sands upon underlying rock. Upon completion of the improvement dredging project, the various areas of the harbor are anticipated to have sediments similar to pre-dredge conditions. The silty areas in the harbor are expected to remain silt and the portions of the channel with sediments of fine sand are expected to remain fine sand. The areas in which blasting occurs (i.e., in rock) may lose the veneer of overlying silt for a short period of time following blasting and rock removal efforts. Natural deposition and shoaling processes in New Haven Harbor should cover the exposed rock within months of project completion.

Shellfish Creation Area

The sediments in the shellfish creation area will be changed from predominately fine grained silts and clays to sediments consisting of fine grained sands. The fine sands from outer New Haven Harbor will be placed within the shellfish creation area to provide a preferred substrate for oyster growth. A small area of hard bottom habitat identified in the southwestern portion of the site (Figure 3-4) will be avoided.

West River Borrow Pit

The sediments in the West River Borrow Pit (Figure 3-5) are predominately fine grained silts with some fine sands. The silty material from inner New Haven Harbor will be placed in the West River Borrow Pit. Thus, the sediments in the area will be similar to the existing sediments following construction.

Morris Cove Borrow Pit

The sediments in the Morris Cove Borrow Pit are predominately fine-grained sands and silts. The silty material from mid New Haven Harbor will be placed in the Morris Cove Borrow Pit.

Thus, the sediments in the area will be similar to the existing sediments following construction.

Rock Placement Area

The sediments in the rock placement area are predominately fine-grained sands and silts. As this area is planned to receive any rock generated by the proposed project, the sediments in this area will be permanently changed from fine-grained silts and sand to rocky hard bottom interspersed with fine-grained silts and sands.

Sandy Point Salt Marsh Creation Area

The surficial sediments in the salt marsh creation area are predominately fine-grained sands and silts. A containment wall built with dredged material filled geotubes will ring the marsh creation site and material from inner New Haven Harbor will be placed within the containment area. The area will be filled to an elevation conducive to the growth of salt marsh plant species. Therefore, the existing sediments will be permanently converted from subtidal sands and silts to salt marsh sands and silts.

CAD Cell

The sediments in the location for a potential CAD cell are predominately fine-grained sands and silts. Any unsuitable silty material from inner New Haven Harbor will be placed in the CAD cell. Following the placement of material in the CAD cell, the cell would be capped with a layer of suitable silt. Thus, the sediments in the area of the CAD cell will be similar to the existing sediments following construction.

7.20 Cumulative and Secondary Impacts

7.20.1 Cumulative Impacts

The National Environmental Policy Act (NEPA) defines cumulative effects as: “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or Non-Federal) or person undertakes such other actions” (40 CFR 1508.7).

Past actions in New Haven Harbor include the construction of bulkheads, rock revetments, seawalls, and groins along the harbor, the filling of salt marsh and deforestation of forested uplands for residential and commercial development, and the dredging of borrow pits in the harbor for sand and gravel reclamation. Wastewater treatment plants and a power generation station that discharge into the harbor have also been constructed adjacent to New Haven Harbor. The development of a commercial shipping port in inner New Haven Harbor, commercial and recreational navigation in the harbor, and commercial and recreational fishing within the harbor have also occurred. Additionally, New Haven Harbor is an exit point for the Cross Sound Cable, which is an electrical cable that crosses Long Island Sound between New Haven, CT and Shoreham, NY. The parklands that border the harbor have historically been used for various recreational activities such as swimming, hiking, and bird-watching.

Past actions specifically associated with the New Haven Harbor FNP include the construction of the navigation channels and anchorages in New Haven Harbor (dredging and wetland filling) and the construction of the harbor's breakwaters. Additionally, maintenance dredging efforts associated with the New Haven Harbor FNP have occurred approximately every 10 years.

Some past actions (e.g., bulkheading, building seawalls, the filling of salt marshes, and the destruction of maritime forest) have significantly impacted the New Haven Harbor ecosystem by removing valuable habitat and replacing it with commercially and residentially developed properties. Other past actions (construction of waste-water treatment plants and electric generating stations, port development, navigation through the harbor) have impacts to water quality in the harbor which range from short-term impacts (e.g., increased storm water discharge) to long-term impacts (e.g., entrainment of larval fish).

As noted in Section 2.2, the Port of New Haven is presently an active import and export port whose commodities include items such as petroleum products, crude materials, and manufactured goods, so present actions include the operation of the port facilities as well as navigation to and from the port. Other present actions in New Haven Harbor include the discharge of water from waste-water treatment facilities and the electricity generating plant, commercial and recreational fishing, as well as public recreating. Impacts from these actions are generally related to short-term impacts to water quality.

Future activities in New Haven Harbor are anticipated to remain similar to those present actions noted above: port operation, operation of waste-water treatment facilities, commercial and recreational navigation, commercial and recreational fishing, and public recreating. Additionally many terminal operators perform maintenance dredging of their berth facilities, and this is anticipated to continue into the future. The improvement of the FNP in New Haven Harbor will be a major future action and its effects are documented throughout this report. The construction of the improvement project will necessitate the moving of the Cross Sound Cable. This action will likely disturb small portions of the harbor bottom. Future maintenance dredging of the New Haven Harbor FNP is also expected and will likely occur at 10-year intervals. The maintenance dredging effects are anticipated to be similar to the effects noted throughout this report. Generally, most of the cumulative impacts related to the range of present and future harbor actions will occur in the water column (e.g., impacts from discharges) and in the subtidal bottom areas (e.g., disturbed seafloor areas where benthic resources reside). However, the majority of impacts to these areas are short-term in nature and should not significantly contribute to a decline in the ecological or socioeconomic importance of New Haven Harbor.

7.20.2 Secondary Impacts

The proposed Deep Draft Project alternatives would dredge the Main Ship Channel to a depth greater than the currently authorized depth of -35 feet at mean lower low water (MLLW). This would put New Haven Harbor more in line with other similar U.S. coast ports of its size. The Deep Draft Project would allow larger vessels to access the port facilities in an environmentally safer and economically efficient manner, thereby increasing the efficiency of the cargo loaded and unloaded at New Haven Harbor while maintaining existing sailing schedules and port rotations.

This section discusses the secondary, or indirect, impacts likely associated with the Deep Draft Project and the related increases in the sizes of ships calling on the Port of New Haven. Direct effects are caused by the proposed dredging and occur contemporaneously at or near the location of the action. As defined in NEPA, indirect effects:

> "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems." (40 CFR 1508.8)

The Port of New Haven is well established and has experienced a large volume of ship traffic for many years. Within this context, the Deep Draft Project represents a continuation of navigation channel alterations following numerous historical maintenance and improvement projects. Major maintenance dredging generally occurs at a frequency of approximately every 10 years depending on funding. The Deep Draft Project would allow larger, deeper-draft vessels to access New Haven Harbor port facilities in an environmentally safer and economically-efficient manner and for those vessels to carry more cargo. By allowing larger vessels to access the port facilities in an economically-efficient and environmentally safer manner, the Deep Draft Project should not affect bulk carrier or petroleum vessel traffic and maximize existing sailing schedules and port rotations. The array of shipping scenarios is discussed in the economic analysis of project benefits (Appendix C).

As vessel traffic to the port is expressed to decrease, no secondary impact form increased vessel traffic, or secondary impacts to air quality are expected. Total cargo is expected to increase at a growth rate of 1.5 percent per year over the exiting volume. This may lead an increase in truck transportation traffic associated with port activities, which may increase local area traffic impacts and add to air quality impacts.

8.0 ENVIRONMENTAL COMPLIANCE

8.1 Cooperating Agency Request

The National Environmental Policy Act (NEPA) encourages early agency cooperation. A Federal agency which has jurisdiction by law shall be a cooperating agency upon request of the lead agency (the USACE in this instance). In addition, any other Federal agency which has special expertise on environmental issues, which should be addressed in the EIS, may also be a cooperating agency upon request of the lead agency. Where appropriate, the lead agency should also seek the cooperation of the State or local agencies of similar qualifications. Cooperating agencies shall participate in the NEPA process at the earliest possible time, participate in scoping meetings, help prepare information or environmental analyses which the cooperating agency has expertise, and provide staff support as requested by the lead agency (USACE) to enhance interdisciplinary capability. Cooperating Federal agencies that have jurisdiction by law or special expertise include the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, NOAA-Fisheries, and the U.S. Coast Guard. The Connecticut Department of Energy and Environmental Protection and the environmental agencies it oversees, the New York Department of State (which contains New York's Coastal Zone Management Program) and the Mohegan Tribe also have jurisdiction by law or special expertise that is relevant to the proposed project. A letter requesting cooperating agency participation was sent by the USACE to the four Federal agencies, the State agencies, and Indian tribe on December 14, 2016.

Three Federal agencies (USEPA, NOAA-Fisheries, and USCG) agreed to participate as cooperating agencies on this EIS. One Federal agency (USFWS) chose not to be a cooperating agency, but retained their responsibilities to review the proposed project under pertinent laws and regulations. The Connecticut Department of Energy and Environmental Protection agreed to represent the State environmental agencies in the development of the EIS. CT SHPO and the Mohegan Tribe also agreed to participate as cooperating agencies. The New York Department of State declined to be a cooperating agency. See Appendix A for a copy of the correspondence.

8.2 Threatened and Endangered Species Consultation

The USACE has been coordinating the development of this EIS with NOAA-Fisheries, USFWS, and the Connecticut Department of Energy and Environmental Protection in regard to threatened and endangered species. Information on threatened and endangered species was requested during the NEPA scoping meeting to aid in the formulation of project alternatives. During the development of alternatives for the project, the three agencies were briefed individually on project progress through meetings, webinars, and site visits. Consultation with the three agencies is ongoing.

8.3 Essential Fish Habitat Consultation

The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act strengthen the ability of the National Marine Fisheries Service and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed “essential fish habitat (EFH)” and is broadly defined to include “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.”

The USACE has been coordinating the development of this EIS with NOAA-Fisheries in regard to Essential Fish Habitat (EFH). Information on EFH and managed species was requested during the NEPA scoping meeting to aid in the formulation of project alternatives. During the development of alternatives for the project, the NOAA fisheries was briefed individually on project progress. An EFH assessment has been prepared in conjunction with this EIS and is located in Appendix H. EFH consultation is ongoing.

8.4 Coastal Zone Management Consistency Determination

The Coastal Zone Management (CZM) Act of 1972 established a national program to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations" and to "encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone..." (16 U.S.C. 1452, Sec. 303 (1) and (2)). Section 307 (c)(3)(A) of the CZMA provides that "... any applicant for a required Federal license or permit to conduct an activity, in or outside the coastal zone, affecting any land or water use or natural resource of the coastal zone of that state shall provide ... a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity will be conducted in a manner consistent with the program." Similar requirements are included for activities conducted by or funded by a Federal agency.

Federal Consistency Determinations were prepared for the proposed projects for both the state of Connecticut’s and the state of New York’s coastal zone management programs. These determinations address the proposed project’s consistency with all the relevant CZM policies from each state. The determinations are located in Technical Document #3.

8.5 Compliance with Federal Laws, Regulations and Programs

This section describes the Federal laws, regulations, and programs that are relevant to the dredging and placement of improvement material from the New Haven Harbor Federal navigation channel and turning basin.

Federal Statutes

1. *Coastal Barrier Resources Act, 16 USC 3501 et seq.*

Compliance: The project is not located within any Coastal Barrier Resources Act unit and no development is planned as a result of this project, therefore .this project is compliant.

2. *Clean Air Act, as amended, 42 U.S.C. 7401 et seq.*

Compliance: The "general conformity" requirements of Section 17(c)(1) of the Clean Air Act, 42 U.S.C. 7506(x)(1), will be adhered to by limiting construction and using "clean" equipment to avoid exceeding air quality standards or by purchasing emission credits.

3. *Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972) 33 U.S.C. 1251 et seq.*

Compliance: Under Section 401 of the Clean Water Act, any Federal activity that will result in a discharge to waters or wetlands subject to Federal jurisdiction is required to obtain a State Water Quality Certification (WQC) to ensure compliance with State water quality standards. An application will be filed with the State of Connecticut for a WQC pursuant to Section 401 of the Clean Water Act for the placement of dredged material into the Morris Cove and West Haven borrow pits, shellfish habitat creation area, rock placement area, marsh creation area, or CAD cell within New Haven Harbor and/or the placement of material at the Central Long Island Sound Disposal Site. Section 404 of the Clean Water Act governs the disposal of fill, including dredged material into waters of the United States within the three mile territorial sea. This applies to discharges landward of the baseline of the territorial sea and in instances seaward of the baseline when the intent is to fill or nourish beaches. A draft Section 404(b)(1) Evaluation and Compliance Review has been prepared for all the possible placement sites.

4. *Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.*

Compliance: The U.S. Army Corps of Engineers completed a Federal consistency determination pursuant to Section 307 of the Coastal Zone Management Act that determined the proposed project is consistent to the maximum extent possible with the CT and NY Coastal Zone Management program offices. The determinations are provided in technical supporting document #3. Concurrence of the CZM consistency determinations will satisfy the requirements of this statute.

5. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: Project scoping and coordination with the U.S. Fish and Wildlife Service (USFWS) and NOAA Fisheries has yielded no formal consultation requirements pursuant to Section 7 of the Endangered Species Act. Informal consultation with USFWS under Section 7 of the Endangered Species Act for listed piping plovers and terns will be initiated with the release of this Draft EIS. Informal consultation with NOAA Fisheries under Section 7 of the Endangered Species Act for listed sea turtles and Atlantic sturgeon will be initiated with the release of this Draft EIS.

6. Estuarine Areas Act, 16 U.S.C. 1221 et seq.

Compliance: The Chief of Engineers Report will be submitted to Congress.

7. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: Public notice of availability of this report relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

8. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: Coordination with the U.S. FWS, NOAA Fisheries, Connecticut Department of Energy and Environmental Protection, and the Connecticut Department of Marine Fisheries signifies compliance with the Fish and Wildlife Coordination Act.

9. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: Public notice of availability of this report relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

10. Marine Protection, Research, and Sanctuaries Act of 1971, as amended, 33 U.S.C. 1401 et seq.

Compliance: Applicable; project involves the transportation or disposal of dredged material in ocean waters pursuant to Sections 102 and 103 of the Act, respectively. No disposal of materials at the CLDS will occur unless it meets the requirements of MPRSA.

11. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: Coordination with the State Historic Preservation Office and the Mashantucket Pequot and Mohegan Tribal Nations is ongoing.

12. National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 et seq.

Compliance: Preparation of this Environmental Impact Statement signifies partial compliance with NEPA. Full compliance shall be noted at the time the Record of Decision is issued.

13. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

Compliance: This report will be sent to Congress for approval.

14. Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 et seq.

Compliance: Not applicable, project area is not a watershed protection or flood prevention act area.

15. Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 et seq.

Compliance: Not applicable, project area is not a Wild or Scenic River.

16. Magnuson-Stevens Act, as amended, 16 U.S.C. 1801 et seq.

Compliance: Coordination with the NOAA Fisheries and preparation of an Essential Fish Habitat (EFH) Assessment signifies partial compliance with the EFH provisions of the Magnuson-Stevens Act (MSA). Final coordination efforts and total compliance with the MSA will occur following the coordination of NOAA-Fisheries EFH conservation recommendations for the proposed project.

17. Marine Mammal Protection Act of 1972, 16 U.S.C. 1361-1407.

Compliance: Project scoping and coordination with the NOAA Fisheries has yielded no formal consultation requirements pursuant to Marine Mammal Protection Act. Informal consultation with NOAA Fisheries under the Marine Mammal Protection Act for whales, dolphins, and seals will be initiated with the release of this Draft EIS.

18. Archaeological Resources Protection Act of 1979, 16 USC 470 et seq .

Compliance: Not applicable as Federal or Tribal lands are not involved in this project.

19. American Indian Religious Freedom Act of 1978, 42 USC 1996.

Compliance: Not applicable as Federal lands are not part of this project. USACE is consulting with the CT Tribes as required under Section 106 of the National Historic Preservation Act.

20. Native American Graves Protection & Repatriation Act, 25 USC 3000-3013, 18 USC 1170

Compliance: Not applicable as Federal or Tribal lands are not involved. If Native American remains and associated funerary objects are disturbed, USACE would follow the procedures for unanticipated discoveries

Executive Orders

1. Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971.

Compliance: Coordination with the State Historic Preservation Officer signifies compliance.

2. Executive Order 11988, Floodplain Management, 24 May 1977 amended by Executive Order 12148, 20 July 1979.

Compliance: Not applicable; project is not located within a floodplain.

3. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: Applicable. Project will not significantly impact Federal wetlands and therefore complies with the EO.

4. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.

Compliance: Not applicable; project is located within the United States.

5. Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: Not applicable; project is not expected to have a significant impact on minority or low income population, or any other population in the United States.

6. Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, 21 April 1997.

Compliance: Not applicable; the project would not create a disproportionate environmental health or safety risk for children.

7. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.

Compliance: Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, DoD Indian policy, and USACE Tribal Policy Principals signifies compliance.

8. Executive Order 13112, Invasive Species Control, 3 February 1999.

Compliance: The project will not introduce invasive species to the project area and is therefore compliant with the EO.

9. Executive Order 13186, Protection of Migratory Birds, 10 January 2001.

Compliance: Consultation with USFWS signifies compliance.

10. *Executive Order* 13007, Accommodation of Sacred Sites, 24 May 1996

Compliance: Not applicable as Federal lands are not involved. Consultation with Tribes is ongoing under the National Historic Preservation Act.

11. *Executive Order* 13807, Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects.

Compliance: Full Compliance will be met upon issuance of a Record of Decision.

Executive Memorandum

1. Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.

Compliance: Not applicable; project does not involve or impact agricultural lands.

2. White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.

Compliance: Consultation with Federally Recognized Indian Tribes, where appropriate, signifies compliance.

8.6 Environmental Commitments

The following list of actions will be taken to minimize adverse impacts to natural and economic resources:

1) Dredging will occur from October 1 to January 31, where practicable, in the inner harbor (north to the mid-point of Sandy Point) to avoid spawning winter flounder. Dredging south of the midpoint of Sandy Point will occur between October 1 and May 31 to avoid impacts to shellfish resources.

2) Dredging will not occur from June 1 to September 30 to avoid spawning shellfish in New Haven Harbor.

3) Barge overflow, the process of filling the receiving barges with dredged material and allowing them to overflow to reduce the water content of the barge load, will not be allowed.

4) USACE will abide by the conservation recommendations outlined in the US Fish and Wildlife Coordination Act Report and the Essential Fish Habitat conservation recommendations provided by NMFS, where practicable and justified.

5) USACE will commit to coordinating adaptive management and corrective actions related to salt marsh creation placement site.

6) USACE will abide by any 401 Water Quality Certification conditions provided by the state of Connecticut, where practicable and justified.

9.0 PUBLIC REVIEW AND AGENCY COORDINATION

9.1 Authority for Public Review

Public involvement during this study is being conducting in compliance with the following Federal laws and regulations:

- National Environmental Policy Act (NEPA) of 1969**,** as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982);
- U.S. Clean Water Act, Section 404(a);
- Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA, Sec. 1501.7 Scoping and Sec. 1506.6 Public Involvement;
- 30 CFR Part 230 and Engineering Regulation (ER) 200-2-2;
- ER 1105-2-100, Planning Guidance, as amended.

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.

9.2 Scoping and Public Meetings

Two formal public meetings have been held for the project. One was the NEPA scoping meeting held in January 24, 2017 and the second was the public information meeting on navigation improvement alternatives and dredged material disposal sites held in January 19, 2018. Information from these public meetings are included in Appendix A. Two Public Hearings are planned during the review of this draft report.

9.3 Agency Coordination

Federal, state, and local agencies were invited to attend study meetings including an initial agency scoping meeting in January 25, 2017 and to provide comments throughout the study. Several Agencies agreed to participate as a cooperating agency in the development of the EIS. See Section 8.1. Federal, State and local agencies were invited to attend the public information meeting on January 10, 2018 and several site visits and conference calls were conducted during the study.

9.4 Environmental Operating Principles

The USACE Environmental Operating Principles (EOPs) are considered throughout the study process, and will continue to be part of construction and operation of the proposed 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. In accordance with the mandate of this designation and the EOPs, the USACE has proposed a project that supports economic and environmentally sustainable solutions.

9.5 USACE Campaign Plan

USACE Vision: A great engineering force of highly disciplined people working with our partners through disciplined thought and action to deliver innovative and sustainable solutions to the Nation's engineering challenges.

USACE Mission: Provide public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risks from disasters.

Commander's Intent: The USACE will be one disciplined team, in thought, word, and action. We will meet our commitments, with and through our partners, by saying what we will do and doing what we will say. Through execution of the Campaign Plan, the USACE will become a GREAT organization as evidenced by the following in all mission areas: delivering superior performance; setting the standard for the profession; making a positive impact on the Nation and other nations; and being built to last by having a strong "bench" of educated, trained, competent, experienced, and certified professionals.

The D-IFR/EIS 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 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 environment.

10.0 LIST OF PREPARERS

Barbara Blumeris, Project Manager, Planning Division, New England District, U.S. Army Corps of Engineers
Education: Bachelor of Arts degree (B.A.) Boston University, Biology; Master of Science degree (M.S.) University of Massachusetts (Lowell), Biology; Tufts University, Master of Science degree (M.S.) Civil Engineering. Ms. Blumeris is a 2006 graduate of the USACE Planning Associates Program.
Experience: Ms. Blumeris is a Regional Technical Specialist (RTS) in plan formulation responsible for management of project delivery teams and development and evaluation of project alternatives for planning studies including coastal storm risk management, navigation improvement, ecosystem restoration, and watershed studies. Ms. Blumeris has lead Agency Technical Reviews for the Coastal Storm Risk Management, Deep Draft Navigation, and Flood Risk Management USACE Planning Centers of Expertise.
Role in Preparing this EIS: Ms. Blumeris is the project manager and planning lead for the New Haven Harbor Deep Draft Navigation Improvement Study. She is primary author of the Feasibility Report.

Caitlin Bryant, Economist, Deep Draft Navigation Planning Center of Expertise, U.S. Army Corps of Engineers
Education: B.S. in Business Administration/Finance & Economics, University of South Alabama
Experience: Ms. Bryant is an economist in the Deep Draft Navigation Planning Center of Expertise (DDN-PCX) located in the Mobile District. She began her career as a Department of Army Intern in 2014. As a member of the DDN-PCX, Ms. Bryant provides technical services such as economic analyses, Agency Technical Reviews, and research and development.
Role in Preparing this EIS: Ms. Bryant is the lead economist for the New Haven Harbor Navigation Improvement study. She is responsible for economics analysis of study alternatives and providing economic documentation.

Megan Cullen, Civil Engineer, Design Branch, New England District, U.S. Army Corps of Engineers
Education: Ms. Cullen holds a Bachelor of Science degree in Environmental Engineering from Suffolk University as well as a Master of Science degree in Engineering from the University of Massachusetts, Lowell.
Experience: Ms. Cullen is a is a licensed professional civil engineer in the State of Rhode Island working in the Design Branch, Engineering Division, New England District. She has over 5 years of experience specializing in design and analysis of maintenance and improvement dredging, rock removal, deep draft navigation, storm damage reduction studies, beach fills, breakwaters, jetties, and revetments. Ms. Cullen's serves as the civil team lead on a variety of projects, including the

hurricane storm damage risk reduction system (HSDRRS), interior drainage and flood control, and coastal structures.
Role in Preparing this EIS: Ms. Cullen developed the alternative channel alignments and dredge quantities for the project. Ms. Cullen also assisted in developing the beneficial use designs.

Jeffrey A. Gaeta, Senior Cost Engineer, New England District, U.S. Army Corps of Engineers
Education: B.S. Civil Engineering, Northeastern University
Experience: Mr. Gaeta is a registered professional engineer with over six years of cost engineering experience in navigation, flood risk management, and environmental restoration projects.
Role in Preparing this EIS: Mr. Gaeta is the lead cost engineer for the New Haven Harbor Deep Draft Navigation Improvement Study. He is responsible for all cost products to include construction costs, risk-based contingency, construction schedule, and total project cost summaries.

Mark L. Habel, Chief, Navigation and Environmental Studies Section, Planning Division, New England District, U.S. Army Corps of Engineers
Education: B.S. Geology, Northeastern University, 1980. J.D. Suffolk University Law School, 1997.
Experience: Mr. Habel has over 40 years of experience with the Corps of Engineers in marine resource studies and project management for design and construction of navigation and coastal protection projects. Mr. Habel has been the chief of the New England District's Navigation Planning Section from 1985 to 1990 and from 2001 to present. He has been a study manager for several deep draft navigation projects.
Role in Preparing this EIS: Mr. Habel is a technical reviewer of all sections of the EIS.

Aaron D. Hopkins, Environmental Resource Specialist, New England District, U.S. Army Corps of Engineers
Education: B.S. Marine Biology, University of New England
Experience: Mr. Hopkins has over 15 years of experience in marine sediment sampling and analysis, water quality evaluations, coastal monitoring, and oceanographic surveys. He is the Deputy Program Manager for the New England District's Disposal Area Monitoring System (DAMOS) and is responsible for evaluating the impacts of dredged material placement at open-water, nearshore, and confined aquatic disposal sites. He is also responsible for determining the suitability of material from Federal dredging projects for potential placement alternatives.
Role in Preparing this EIS: Mr. Hopkins performed hydroacoustic surveys, underwater video investigations, and collected sediment samples in support of the New Haven Harbor EIS. He also reviewed and analyzed physical, chemical, and biological data to develop the suitability

determination for the New Haven Harbor Improvement Project. Mr. Hopkins performed technical review for multiple sections of the EIS and participated in public outreach events in support of the project.

Lauren Jacobs, Civil Engineer, Design Branch, New England District, U.S. Army Corps of Engineers
Education: B.S. Civil and Environmental Engineering, University of Nevada, Las Vegas
Experience: Ms. Jacobs is a civil engineer with 2 years of experience working on navigation and civil works projects.
Role in Preparing this EIS: Ms. Jacobs developed the updated the channel alignment and dredge quantities following the ship simulation study at the U.S. Army Research and Development Center in Vicksburg, Mississippi. Ms. Jacobs also assisted in developing the beneficial use designs.

Richard B. Loyd, Marine Operations Program Manager, Planning Division, New England District, U.S. Army Corps of Engineers
Education: B.S. Geology and Marine Biology, Northeastern University.
Experience: Mr. Loyd is an environmental scientist with 13 years of experience working on dredging and environmental restoration projects. As the Marine Operations Program Manager for the Environmental Resources Section he is responsible for: sediment sampling and testing; collection, processing, and interpretation of hydroacoustic survey data; and GIS analysis.
Role in Preparing this EIS: Mr. Loyd developed the sediment sampling and testing plan for this EIS, managed the sampling and testing contract, and performed quality control on the sampling and testing data. He was the lead for the side scan sonar, subbottom profiling, and bathymetric survey efforts for the study. Mr. Loyd also provided technical support to project design.

Marcos (Marc) Paiva, Archaeologist/Tribal Liaison, Planning Division, New England District, U.S. Army Corps of Engineers
Education: M.A. Anthropology, Brandeis University; M.A. History/Historical Archaeology, University of Massachusetts Boston; B.A. History, University of Massachusetts Dartmouth.
Experience: Mr. Paiva is the North Atlantic Division Regional Technical Specialist (Archaeology/Tribal Affairs) and has over 27 years of experience in cultural resource management, historic preservation, and regulatory compliance as it pertains to all military and civil works activities conducted by the U.S. Army Corps of Engineers. He was the cultural resources team member for the Boston Harbor Deep Draft Project, Searsport Harbor Navigation Improvement Project and other similar navigation projects and studies.
Role in Preparing this EIS: Mr. Paiva is the cultural resources team member for the New Haven Harbor Navigation Improvement Project Feasibility Study. He is responsible for all cultural resource activities to include: development of historic context, affected environment and

environmental impact sections of the Decision Document; scoping, management and evaluation of any required archaeological studies/surveys and associated report deliverables; and coordination of project activities with project stakeholders and regulators including the CT State Historic Preservation Officer, CT State Archaeologist, and the Mashantucket Pequot and Mohegan Tribal Nations for compliance with Section 106 of the National Historic Preservation Act.

Stephen S. Potts, Senior Geologist, Geo-Environmental Branch, Engineering Division, New England District, U.S. Army Corps of Engineers.
Education: B.A., Geology, Colby College; M.S., University of Massachusetts, Amherst; Ph.D., University of Michigan, Ann Arbor.
Continuing Education: Underwater Blasting, USACE and Academy for Blasting and Explosives Technology.
Experience: Dr. Potts is a Professional Geologist (TN, LA, NY licenses) with over 20 years of experience in the areas of environmental and engineering geology and geophysics. Dr. Potts provides input to project technical issues related to Civil Works, Dam Safety, DERP-FUDS, BRAC, Superfund, and IIS. Projects cover a diverse range of technical issues related to environmental and engineering geology, hydrogeology, contaminant fate and transport, risk and remediation. Dr. Potts served as Project Geologist for marine geologic and geophysical site characterization and blasting specifications development for dredging of the Boston Harbor Deep Draft Improvement Project; Project Geologist for marine geotechnical site characterization and specifications development for widening of Portsmouth Harbor Turning Basin; and ATR Team Leader and Geologist for a number of studies including: Delaware River Main Channel Deepening Dredging and Rock Removal, Jacksonville Harbor, Construction Dredging, Beach Erosion Control and Hurricane Protection Project, Miami-Dade County, Florida, Beach Renourishment 2016, Miami Beach Hotspots; Assunpink Creek Stream Daylighting & Ecosystem Restoration plans and specs; St. Mary's River Sea Lamprey Traps, Draft Integrated Detailed Project Report & Environmental Assessment, Section 506 GLFER; Delaware River Rock Removal blasting plans & specs and Construction Submittals including Operational Blast Plan, Test Blast Plan, & Blasting Safety Plan.
Role in Preparing this EIS: Project Geologist.

Todd Randall, Senior Marine Ecologist, Environmental Resources Section, Planning Division, New England District, U.S. Army Corps of Engineers
Education: M.S., Marine Biology, Southern Connecticut State University, B.S. Biological Science, Southern Connecticut State University
Experience: Mr. Randall has over 30 years of experience in the field of ecology and environmental resource management. Mr. Randall has been a marine ecologist in New England District's Environmental Resources Section for 18 years and his responsibilities include project design and formulation for many of the District's environmental restoration projects, the drafting

of environmental compliance documents (Environmental Assessments and Environmental Impact Statements), and ecological sampling and monitoring.
Role in Preparing this EIS: Mr. Randall is the project ecologist for the New Haven Harbor Deep Draft Navigation Improvement Study. He is the environmental compliance lead and primary author of the EIS.

Lisa R. Winter, Senior Coastal Engineer, Engineering Division, New England District, U.S. Army Corps of Engineers
Education: M.S. Civil Engineering, Johns Hopkins University, B.S. Civil Engineering, Johns Hopkins University
Experience: Ms. Winter is a registered professional engineer and a certified floodplain manager with over 8 years of coastal engineering experience evaluating coastal hazards and designing projects for navigation, flood risk management, and environmental restoration.
Role in Preparing this EIS: Ms. Winter is currently the coastal engineer for the New Haven Harbor Deep Draft Improvement Project Feasibility Study. She is responsible for providing technical input such as water levels, wave heights, and wind and current speeds on the design of the navigation channel improvements. Ms. Winter is also responsible for ensuring plan resilience to climate change and sea level rise impacts.

11.0 RECOMMENDATIONS

This section is draft for review only and will be finalized following public and agency review and plan optimization.

The following text outlines the recommendations for project approval and authorization for implementation.

I recommend that navigation improvements for New Haven Harbor, Connecticut be authorized in accordance with the reporting officers' recommended plan with such modifications as in the discretion of the Chief of Engineers may be advisable. The estimated general navigation features Federal Base Plan project first cost is $65,905,000 (October 2018 price level). The estimated project first cost of the Beneficial Use Plan is $70,617,000 (October 2018 price level). The incremental difference between the Federal Base Plan and the Beneficial Use Plan is $4,712,000 (October 2018 price level).

The estimated Federal and Non-Federal shares of the general navigation features Federal Base Plan project first cost are $49,429,000 and $16,476,000, respectively. In addition to the Non-Federal Sponsor's estimated share of the project first cost, the Non-Federal sponsor must pay an additional 10 percent of the cost of the general navigation features of the project in cash over a period note to exceed 30 years with interest. The additional 10 percent payment is estimated to be $6,590,500 before interest is applied.

Based on (October 2018) price levels the estimated incremental project first cost of the Beneficial Use Plan is $4,712,000. The estimated Federal and Non-Federal shares of the Beneficial Use Plan project fist cost are $2,959,000 and $1,753,000, respectively.

My recommendation is subject to cost sharing, financing, and other applicable requirements of Federal and state laws and policies, including Section 101 of WRDA 1986, as amended. This recommendation is subject to the Non-Federal sponsor agreeing to comply with all applicable Federal laws and policies including that the Non-Federal sponsor must agree with the following requirements prior to project implementation:

a. Provide 25 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -20 MLLW but not in excess of -50 MLLW; plus 50 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -50 MLLW as further specified below:

(1) Provide 25 percent of design costs allocated by the Federal government to commercial navigation in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Provide, during the first year of construction, any additional funds necessary to pay the full Non-Federal share of design costs allocated by the Federal government to commercial navigation;
(3) Provide, during construction, any additional funds necessary to make its total contribution for commercial navigation equal to 25 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -20 MLLW but not in excess of -50 MLLW; plus 50% of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -50 MLLW.

b. Provide all lands, easement, and rights-of-way (LER), including those necessary for the borrowing of material and disposal of dredged or excavated material, and perform or assure the performance of all relocations, including utility relocations, all as determined by the Federal government to be necessary for the construction or operation and maintenance of the GNFs;

c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Federal government for the value of the LER and relocations, including utility relocations, provided by the Non-Federal sponsor for the GNFs. If the amount of credit afforded by the Federal government for the value of LER and relocations, 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 LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;

d. Provide, operate, and maintain, at no cost to the Federal government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Government;

e. Provide 50 percent of the excess cost of operation and maintenance of the project over that cost which the Federal government determines would be incurred for operation and maintenance if the project had a depth of -50 MLLW;

f. 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 and maintaining the GNFs;

g. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

h. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses for a minimum of three years after the final accounting and assure that such materials are reasonably available for examination, audit, or reproduction by the Government;

i. Perform, or ensure performance of, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601–9675, that may exist in, on, or under LER that the Federal government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Federal government determines to be subject to the navigation servitude, only the Federal government shall perform such investigation unless the Government provides the Non-Federal sponsor with prior specific written direction, in which case the Non-Federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the Federal government and the Non-Federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the Government determines to be necessary for the construction or operation and maintenance of the project;

k. Agree, as between the Federal government and the Non-Federal sponsor, that the Non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

l. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law99-662, as amended, (33 U.S.C. 2211(e)) which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the Non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

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

n. Comply with all requirements of applicable Federal laws and implementing regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and Army Regulation 600-7 issued pursuant thereto; and 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (labor standards originally enacted as the Davis-Bacon Act, the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kickback Act);

o. Not use funds from other Federal programs, including any Non-Federal contribution required as a matching share therefore, to meet any of the Non-Federal sponsor's obligations for the project costs unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to the Congress, the State of Connecticut, the Non-Federal sponsor (the Connecticut Port Authority and New Haven Port Authority), 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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Date

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William M. Conde
Colonel, U.S. Army
District Commander

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