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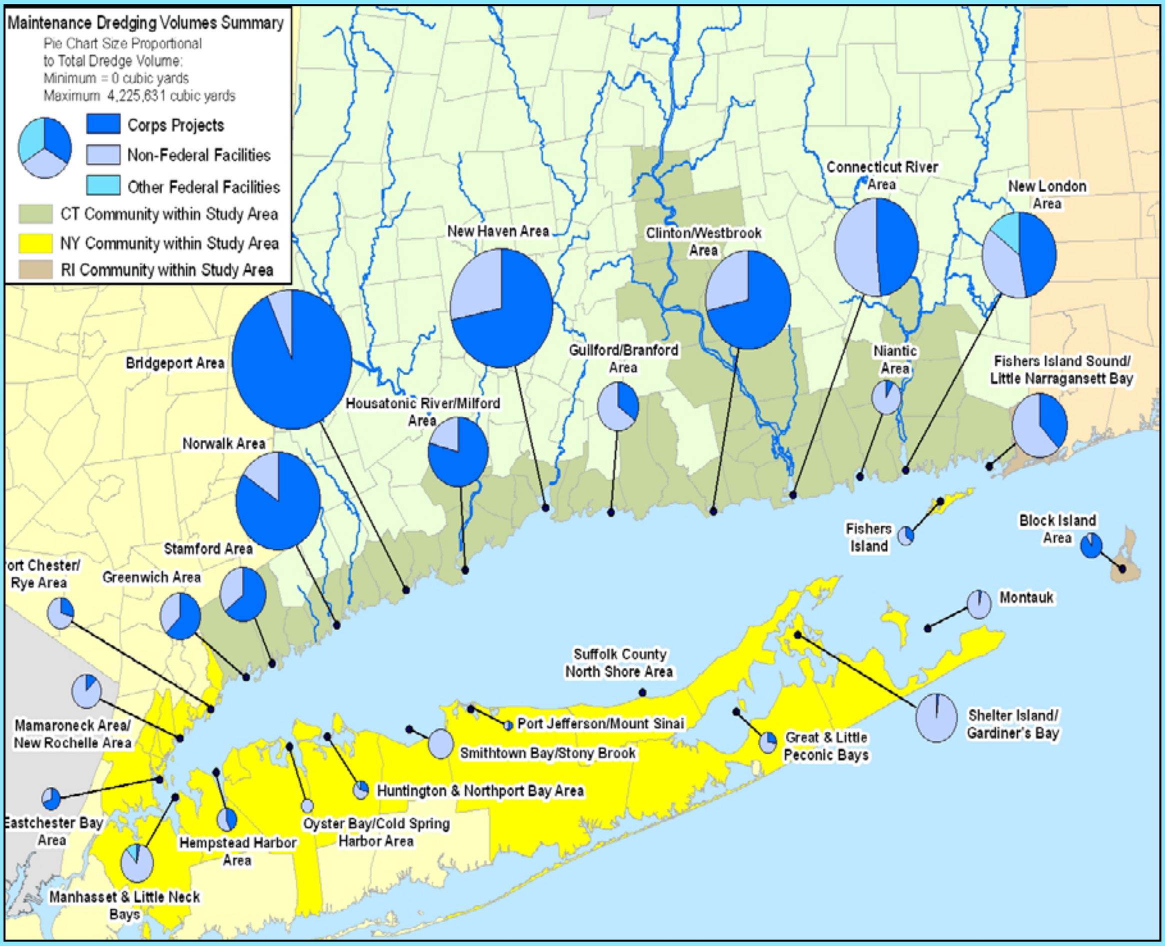
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
LONG ISLAND SOUND
DREDGED MATERIAL MANAGEMENT PLAN
CONNECTICUT, NEW YORK AND RHODE ISLAND



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Programmatic Environmental Impact Statement

for the

Long Island Sound Dredged Material Management Plan

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EXECUTIVE SUMMARY

INTRODUCTION

To facilitate safe navigation and marine commerce in Connecticut, New York, and Rhode Island rivers, harbors, and coastal areas throughout the Long Island Sound region, dredging activities and subsequent management of the dredged material must be conducted to maintain and periodically improve Federally authorized channel depths and widths. Records of dredging activities in the Long Island Sound area extend back to the 1870s, with most of the material being transported to open-water dredged material placement sites in Long Island Sound. Navigation projects led by the U.S. Army Corps of Engineers (USACE) (referred to as USACE or Federal Navigation Projects - FNP) produce most of the dredged material generated in Long Island Sound every year. Other Federal agencies, including the U.S. Navy and U.S. Coast Guard, also periodically generate dredged materials from the maintenance and improvement of their facilities in this region.

This Programmatic Environmental Impact Statement (PEIS) describes the existing environment and assesses the impacts of available or potentially developable dredged material management alternatives for the USACE's Dredged Material Management Plan (DMMP) for Long Island Sound.

The Long Island Sound DMMP study area encompasses the State of Connecticut; Washington County, Rhode Island; and Suffolk, Nassau, Queens, Kings (Brooklyn), New York (Manhattan), Bronx, and Westchester Counties in New York (Figure ES-1). The study area also includes all of the coastal and navigable tributary waters from Montauk Point, New York, west across northern Long Island to the East River at Throgs Neck, and then east through New York and Connecticut to the southern coast of Rhode Island, and southwest across to Montauk Point, New York. All navigable rivers, harbors, and coastal waters on Long Island Sound proper in Connecticut and New York east of Throgs Neck to a line drawn from Westerly, Rhode Island, south to Montauk Point are encompassed, including the waters of the Peconic Bay and Gardiners Bay shorelines in New York; the Fishers Island Sound shores of Connecticut, New York, and Rhode Island; and the Block Island Sound shores of New York and Rhode Island to the area's eastern boundary. The study area does not include New York Harbor itself, but it does include USACE New York District projects east of Throgs Neck to Montauk Point. The Connecticut River below the Hartford navigation project is included, as is the Thames River to Norwich, Housatonic River to Derby, and the Peconic River to Riverhead, New York. The waters of Block Island Sound east of Montauk Point to Block Island and Point Judith are included to the extent that they produce dredged material that may be managed in the region, or provide opportunities to beneficially use dredged material.

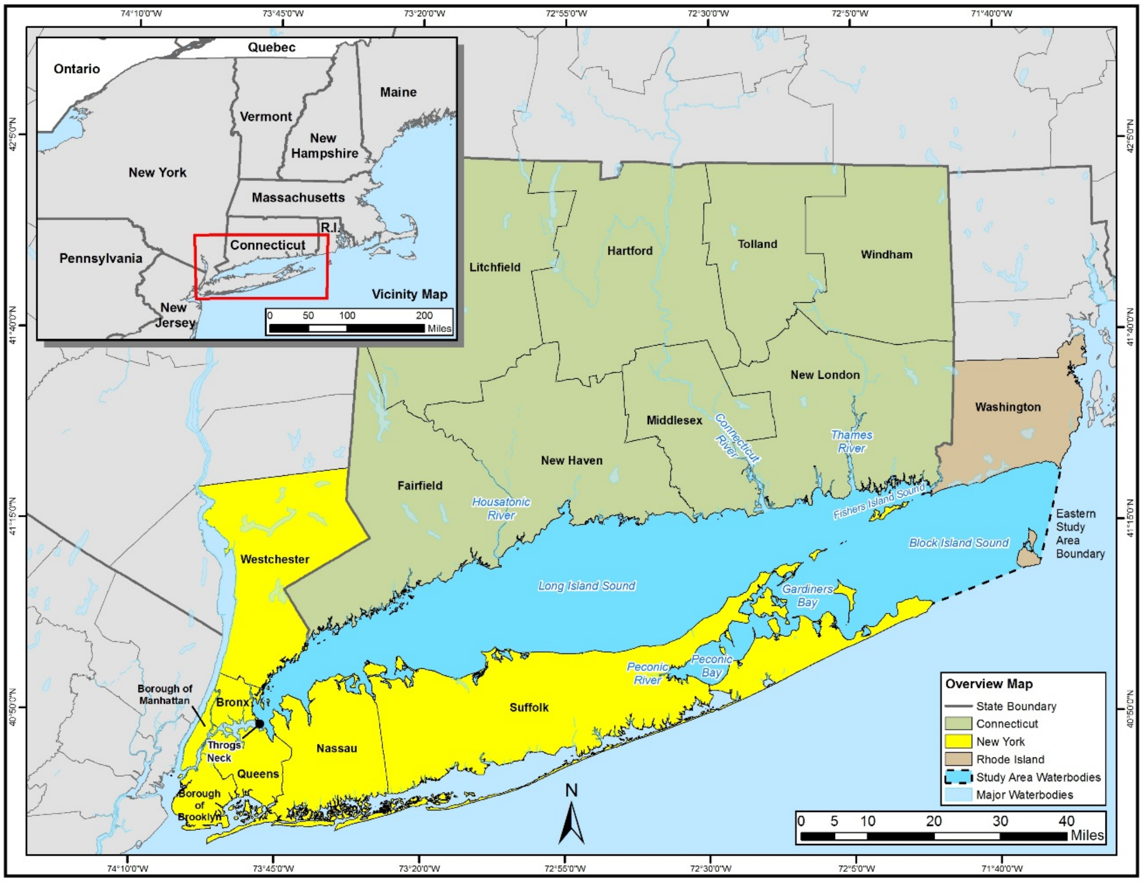

Figure ES-1. Overview of Long Island Sound Study Area.

The Long Island Sound Dredged Material Management Plan

Under USACE Engineer Regulation 1105-2-100, the USACE is responsible for developing a DMMP for USACE Navigation Projects where there is an indication of existing insufficient placement capacity to accommodate maintenance dredging for at least the next 20 years. The USACE conducted a Preliminary Assessment to document the need for a comprehensive DMMP for the Long Island Sound region. The Preliminary Assessment was completed and approved by the USACE in June 2006. In addition, because of the extensive area covered, and because of the funds and time needed to develop a comprehensive DMMP, it was determined that it would be more appropriate to extend the planning period to 30 years.

The Long Island Sound DMMP is an important milestone in the ongoing regional effort to develop a comprehensive plan for dredged material management in Long Island Sound. The purpose of the DMMP is to ensure that dredging needs for USACE Navigation Projects are met and that proper planning may, over time and where practicable, reduce or eliminate the need for open-water placement in the Sound. The Long Island Sound DMMP will identify, evaluate, and recommend, where possible, practicable dredged material management alternatives through a broad-based public process that protects the environment based on best scientific data and analysis, while meeting society's need for safe and economically viable navigation for water-based commerce, transportation, national security, and other public purposes. USACE DMMPs are usually for a single navigation project or for USACE Navigation Projects that are interrelated (e.g., projects in close proximity or common placement areas used) or are economically complementary. However, at the request of the States of Connecticut and New York, a single DMMP encompassing the entire group of dredging projects within Long Island Sound is being prepared to meet the management needs of USACE Navigation Projects, as well as navigation projects for other Federal agencies, in the Sound.

Programmatic Environmental Impact Statement for the Long Island Sound Dredged Material Management Plan

To comply with the National Environmental Policy Act (NEPA), the USACE prepared this PEIS in conjunction with the Long Island Sound DMMP and provided opportunities for public participation. The USACE published the Notice of Intent to develop this PEIS in the Federal Register on August 31, 2007 (72 FR 50332). The specific objective of this PEIS was to evaluate the environmental, economic, socioeconomic, and cumulative impacts of the alternative sites identified in the DMMP with respect to the environment of Long Island Sound region and its tributaries, and provide suggestions for mitigation of the impacts.

Potential placement alternatives evaluated in the PEIS (Section 3.0) include open-water placement, confined placement (in-harbor confined aquatic disposal (CAD); island, shoreline, and upland confined disposal facilities (CDFs); and landfill placement), beneficial use (nearshore berms, beach nourishment, landfill cover, brownfields and other redevelopment, habitat restoration and other applications), and innovative treatment.

By following a programmatic approach to assessing these impacts, decision makers will be able to evaluate different dredged material placement options with full knowledge of potential environmental consequences. The PEIS is an umbrella document that considers generic impacts of options. In the future, as specific alternatives are pursued to implement a given management option, specific project- and alternative-focused NEPA documents, utilizing information presented in this PEIS, will be prepared to address implementation of a given option at a specific location. Also at that time, any needed permits will be acquired for the specific project.

This PEIS was prepared concurrently with the preparation of the DMMP. It was prepared in accordance with NEPA, Council on Environmental Quality regulations (40 CFR 1500 et seq.), and USACE regulations for implementing NEPA (33 CFR Part 230).

PURPOSE AND NEED

The need for a comprehensive DMMP for the Long Island Sound region was recommended in the Preliminary Assessment based on the anticipated volume of dredged material to be generated in Long Island Sound, the lack of existing placement sites to manage those volumes, the request by the Governors of New York and Connecticut for the development of a Long Island Sound DMMP, and use restrictions placed on the designation of two of the open water placement sites (Western Long Island Sound Disposal Site [WLDS] and Central Long Island Sound Disposal Site [CLDS]) (40 CFR 228.15(b)(4)(vi)(D)[1]) by the U.S. Environmental Protection Agency (EPA) in June 2005. The Preliminary Assessment concluded that successful completion of a Long Island Sound DMMP is critical to the USACE's ability to maintain the region's Civil Works navigation projects and provide future navigation improvements to the system of Federal waterways in the Long Island Sound region. Analysis of the economic contribution of navigation-dependent facilities indicated that future maintenance of most of Long Island Sound's USACE Navigation Projects is likely warranted, and that such maintenance is in the Federal interest when examined on a project-by-project basis. Appropriate future cost-effective management methods and capacities must be identified to serve both Federal and non-Federal project needs in this region for the long-term health of the region's economy and environment.

A dredging needs study conducted by the USACE in 2009 for the Long Island Sound and its tributaries examined past dredging activities, quantities, and dredging cycles. Future dredging/placement needs were estimated based on the review of historic information and on information collected as part of a questionnaire sent to navigation-dependent facilities identified within the study area. During preparation of the draft DMMP in 2014-2015, it was recognized that (1) a significant volume of dredging work had occurred in the Long Island Sound region since 2009 including the work done in the wake of Hurricane Sandy, (2) that the 2009 report had not differentiated the types of dredged material in developing its dredging needs timeline, (3) that a number of USACE Navigation Projects, including many from NAN, and up-river/up-harbor segments of larger projects, did not have specific data on historical or projected dredging, and (4) that some USACE Navigation Projects with maintenance frequencies of less than 30 years did not have future projections that included recurring dredging actions. For these reasons the information gathered from the analysis of USACE Navigation Projects and the non-Corps facility survey was updated. Information for the USACE Navigation Projects was revised to reflect recent activities and currently proposed efforts. This mainly involved eliminating dredging completed from the projections, adding newly projected work to later years of

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[1] As quoted in 40 CFR 228.15: "Except as provided in paragraphs (b)(4)(vi)(D) and (E) of this section, the disposal of dredged material at the CLIS [also known as CLDS] and WLIS [also known as WLDS] sites pursuant to this designation shall not be allowed beginning eight (8) years after July 5, 2005, unless a regional dredged material management plan (DMMP) for Long Island Sound has been completed by the North Atlantic Division of the USACE, in consultation with the State of New York, State of Connecticut and EPA, with a goal of reducing or eliminating the disposal of dredged material in Long Island Sound, and the EPA thereafter amends this site designation to incorporate procedures and standards that are consistent with those recommended in the DMMP. 1. Completion of the DMMP means finishing the items listed in the work plan (except for any ongoing long-term studies), including the identification of alternatives to open-water disposal, and the development of procedures and standards for the use of practicable alternatives to open-water disposal. If the completion of the DMMP does not occur within eight years of July 5, 2005 (plus any extensions under paragraphs (b)(4)(vi)(D) and (E) of this section), use of the sites shall be prohibited. However, if the DMMP is thereafter completed within one year, disposal of dredged material at the sites may resume."

the extended DMMP timeframe, and adjusting volume estimates as described below. For the non-Corps dredging work, large projects completed since 2009 were removed from the projections, and dredging center-wide projections of demand were shifted over the revised 30-year period, as was recurring maintenance at those facilities reporting such needs in 2009. Based on the 2015 dredging needs update, a dredging needs volume of approximately 52.7 million cubic yards (CY) is anticipated in Long Island Sound over the 30-year period (Table ES-1).

Table ES-1. Summary of Long Island Sound Dredging Needs by Project/Facility Type

Project/Facility Type	2015-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	30-Year Total
Maintenance Dredging Needs (CY)							
USACE Projects	4,929,900	5,151,900	3,202,700	3,535,600	3,273,000	5,941,400	26,034,500
Other Federal Facilities	163,000	43,200	84,000	50,000	33,200	28,000	401,400
Non-Federal Facilities	2,939,300	2,503,900	1,682,600	1,631,900	1,467,800	1,551,300	11,776,800
TOTALS	8,023,200	7,699,000	4,969,300	5,217,500	4,774,000	7,520,700	38,212,700
Improvement Dredging Needs (CY)							
USACE Projects	1,657,100	5,100,000	450,000	0	0	0	7,207,100
Other Federal Facilities	200,000	150,000	0	0	0	0	350,000
Non-Federal Facilities	4,563,000	1,703,400	426,100	70,700	95,600	91,700	6,950,500
TOTALS	6,420,100	6,953,400	876,100	70,700	95,600	91,700	14,507,600
GRAND TOTALS	14,452,300	14,652,400	5,845,400	5,288,200	4,869,600	7,612,400	52,720,300

DREDGING AND DREDGED MATERIAL CHARACTERISTICS

Periodic dredging ensures safe navigation and marine commerce in Connecticut, New York, and western Rhode Island rivers, harbors, and coastal areas. Dredged material has been generated from the harbors and rivers of the Long Island Sound study area for nearly 150 years to develop and keep navigation channels open for commerce and recreation. The characteristics of the material vary, dredging operations have evolved, and numerous placement options and locations have been established over these years.

The material removed from the navigation channels and harbors has been placed at open-water sites in Long Island Sound since at least the 1870s. While records of dredging activities extend back to this time, placement methods and sites for projects were not systematically recorded until the 1950s; however, there is evidence of continuous use of some sites since 1941. From the 1950s through the early 1970s, about 19 open-water placement sites were active in Long Island Sound. Since the early 1980s, dredged material has been placed predominantly at four placement sites: WLDS, CLDS, Cornfield Shoals Disposal Site (CSDS), and New London Disposal Site (NLDS). These sites were evaluated and chosen to receive dredged material pursuant to programmatic and site-specific EISs prepared by the USACE and/or the U.S. Environmental Protection Agency (EPA). It is estimated that about 17 million CY of material may have been placed at these open-water sites in Long Island Sound from 1982 to 2013.

Since 1977, the USACE, EPA, and the states have evaluated and regulated placement of dredged material in Long Island Sound under the provisions of the Clean Water Act (CWA), amendments to the Federal Water Pollution Control Act, and the Marine Protection, Research and Sanctuaries Act (MPRSA). Since 1972, Federal activities and activities of others carried out under Federal permit are subject to review by the states under their Coastal Zone Management programs. In the late 1970s, in response to concerns over the quality of dredged sediment and a lack of information on suspected impacts of placement, the number of actively used placement sites in the Sound was reduced, leading to the current system of four open-water sites by the mid-1980s. In addition, all Federal projects of any size and all non-Federal projects placing more than 25,000 CY of dredged material into the Sound must comply with the requirements of MPRSA. However, 40 CFR Part 228 supports the goal of eliminating or reducing open-water placement into Long Island Sound; therefore, a wide range of dredged material management options were identified under this PEIS.

For projects proposed under both the CWA and MPRSA, one of the first steps in the permit application review process is for the USACE, working with the state and Federal resource agencies and the applicant, to develop sampling and testing plans to determine the suitability of the material placement. National and regional guidance uses physical, chemical, and biological analyses as necessary to provide effects-based conclusions within a tiered framework regarding potential contaminant-related impacts for determining whether dredged material is suitable for open-water placement; beneficial use (such as beach nourishment, marsh creation, or other aquatic habitat development); placement at an island, nearshore, or upland CDF; use as structural fill; or any other commercial application.

The unique nature of the regulatory requirements in Long Island Sound, specifically the dual application of MPRSA and the CWA, results in differing regulatory approaches for managing dredged material placements, depending on the proponent and the size of the proposed dredging project (see the discussion in Chapter 2 on the Ambro Amendment). Non-Federal projects seeking to place 25,000 CY of dredged material or less are not subject to the requirements of MPRSA and are evaluated consistent with the CWA. Materials from these smaller dredging projects that exhibit potential for adverse impacts may sometimes still be placed in open water under CWA with proper placement management.

Dredging centers were used to determine where the largest quantities of dredged material would originate, as determined from information returned on a dredging needs questionnaire. The centers are based on geographic location and logical points of origin for dredged material placement. The study area was divided into 27 dredging centers. Both USACE Navigation Projects and other Federal agency projects were identified within the study area. Sediment test data from each USACE Navigation Project and some larger non-Federal permit projects were then used to categorize and quantify the types of dredged material from each USACE Navigation Project into sandy materials vs. fine-grained material, and suitable vs. unsuitable (for open-water placement) materials.

An anticipated dredging timeline was then developed for each USACE Navigation Project and separable segment and for other Federal agency projects by material type.

Based on this testing data, the 30-year dredging volume of 52.7 million CY identified in the 2015 dredging needs update is expected to consist of about 29% sand, 65% fine-grained materials suitable for open-water placement, and 6% unsuitable for open-water placement. Of the total volume, 63% is from USACE Navigation Projects, 1.5% is from other Federal agency projects, and 35.5% is from non-Federal dredging activities under permit.

ALTERNATIVES

The purpose of this PEIS is to identify one or more potential environmentally sound, feasible, and practicable alternatives for future long-term use for each of the USACE Navigation Projects and other Federal agency projects in Long Island Sound. The PEIS evaluates the universe of potential alternatives identified in previous studies. In accordance with NEPA, alternatives to open-water placement were considered during the overall EIS process, including containment alternatives (CADs and CDFs), coastal (bar/berm creation and beach nourishment) and upland (landfill capping, Brownfields, and habitat restoration) beneficial uses, landfill placement, treatment technologies, and the No Action Alternative. Based upon the results of the screening evaluation conducted as part of this PEIS (described in Chapter 6), the DMMP identified the likely Federal Base Plan for dredged material placement for each project and segment identified.

Under the No Action Alternative, the option of dredged material placement at a designated open-water placement site would no longer be available. It is impossible to know with certainty how dredging needs of Long Island Sound harbors and waterways would be met if there were no designated open-water placement sites for MPRSA-regulated projects within Long Island Sound. However, several scenarios might reasonably be considered. First, placement site authorization for private projects involving less than 25,000 CY of material would simply continue to be evaluated on a project-specific basis under CWA Section 404. Second, for projects subject to MPRSA §106(f) (i.e., either Federal projects of any size or private projects involving greater than 25,000 CY of material), project proponents would need to pursue one or more of the following courses of action:

(1) Use an alternative open-water site, either inside or outside of Long Island Sound, that has been “selected” by the USACE under MPRSA §103. Such a site would need to be one that has not been in use since the 1992 amendments to MPRSA, or has not had its second five-year period of use expire. EPA would need to concur with the Selection.
(2) Use an existing EPA-designated (MPRSA §102) open-water site outside of the Long Island Sound study area (e.g., RISDS, HARS). EPA would need to concur with any placement at such sites.
(3) Delay dredging until EPA designation (MPRSA §102) of a different open-water placement site within Long Island Sound
(4) Cancel the proposed dredging projects

(5) Study, design, authorize, construct, and use practicable and cost-effective land-based, in-harbor, nearshore, beneficial use, or CDF placement/use alternatives. The type of alternative would vary depending on the size of the project, nature of the material to be dredged, any additional non-navigation benefits of the alternative, non-Federal sponsorship and funding, and the level of Federal participation warranted.

During the process of identifying potential alternative sites, the USACE and EPA, in coordination with the states and with input from the public, reviewed all potential upland, shoreline, and in-water locations where dredged material could be placed in the Long Island Sound area. The study area under consideration (see Figure ES-1) during the review of potential alternatives includes all of Connecticut; Westchester, Bronx, Queens, Suffolk, and Nassau counties of New York, as well as the Boroughs of Brooklyn (Kings County) and Manhattan (New York County), New York; and Washington County in Rhode Island. The Long Island Sound PEIS evaluates only those alternatives located within the study area.

The locations of the alternative sites identified for potential use by USACE and other Federal agency projects in the Long Island Sound area are shown in Figure ES-2.

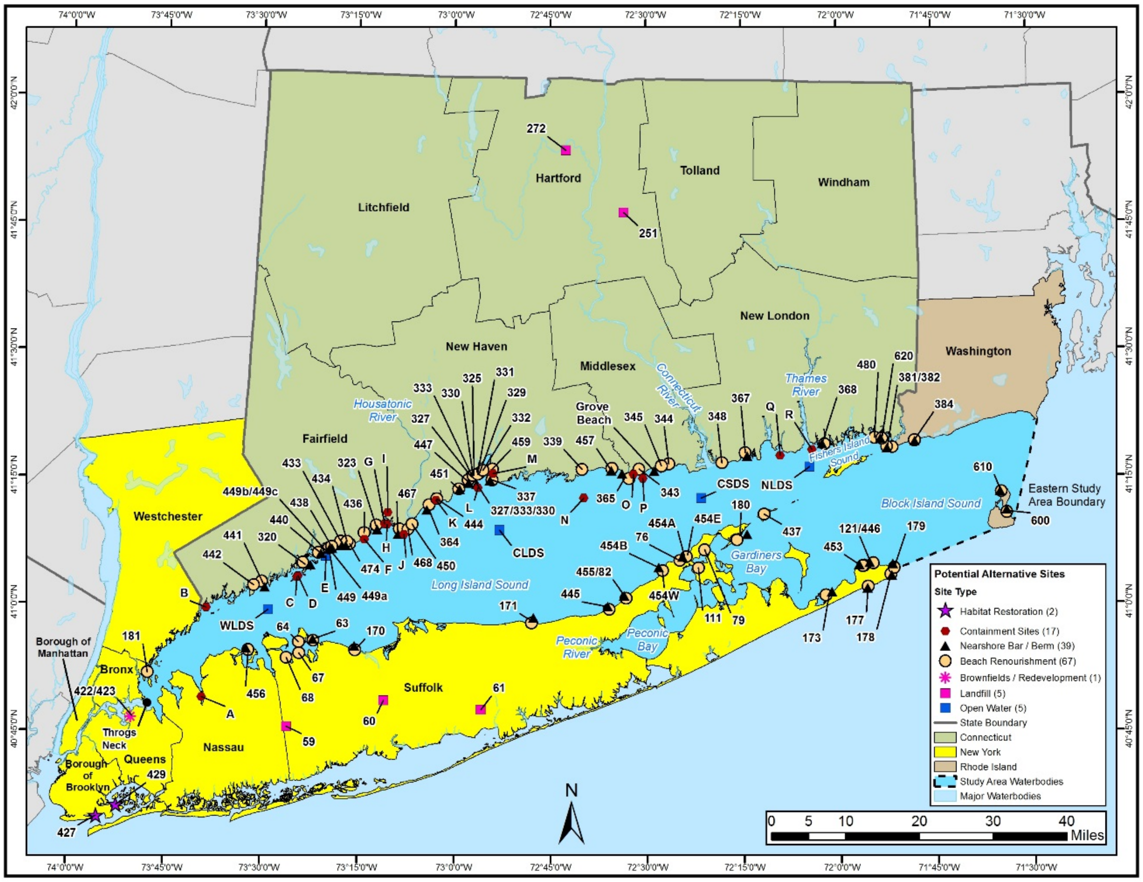

Figure ES-2. Alternative Sites Identified within the Long Island Sound Study Area.

POTENTIAL IMPACTS

To evaluate potential impacts from dredged material placement within the study area, resources were grouped into five categories: physical, environmental, infrastructure, cultural, and socioeconomic resources. The resources impacted depend on the type of alternative being evaluated. Chapter 5 of this PEIS presents information about the generally known impacts of dredged material placement at the various alternative types. Impacts that could result from taking no action and from placement of dredged material at each of the potential alternative sites are also considered. In addition, cumulative impacts of past, current, and future actions are described, as well as possible mitigation steps to avoid, minimize, or reduce potential impacts. Because the impacts are assigned to the alternative *type* of dredged material placement activity rather than to specific dredged material placement sites, impacts are generalized. Positive and negative impacts or consequences are projected and may be short- or long-term in duration depending, in part, upon the material placement schedules for alternative types. This PEIS evaluates and compares the direct, indirect, and cumulative impacts from a qualitative perspective, commensurate with the programmatic level of detail within which this document was developed.

There are several options for the placement of dredged material removed from USACE Navigation Projects within the Long Island Sound study area: confined and unconfined open ocean placement, confined nearshore placement, landfill placement, and beneficial use. While the compatibility of dredged material for the various placement options will need to be determined on a project-by-project basis, the options that would have the lowest impact and greatest benefit are likely to be preferred. Over the past decade, several events have had devastating and costly consequences for Long Island Sound coastal communities and habitats. These events include Hurricanes Sandy and Irene. The increased storm frequency and sea level rise associated with climate change also threaten coastal communities and habitats. Restoration of the coastal habitats would benefit much of Long Island Sound’s wildlife and fisheries species and the livelihoods of the people in these coastal areas.

Potential impacts are summarized as follows:

- General impacts to physical, environmental, infrastructure, cultural, and socioeconomic resources by alternative type (Table ES-2)
- General impacts under the No Action Alternative (Table ES-3)
- Beneficial impacts of dredging and subsequent placement of dredged material (Table ES-4)
- Cumulative impacts and mitigation (Table ES-5).

Table ES-2. General Impacts by Alternative Type.

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
Physical Resources					
Dredged material placed in open water may chance the grain size and/or total organic carbon content within the placement footprint..	Construction of CAD cells and CDFs would alter the existing sea floor and may change the existing sediment grain size and total organic carbon within the footprint.	Upland placement of dredged material would change the land's topography.	No additional physical impacts beyond the current operation and management of the landfill.	Beach nourishment and nearshore berm creation would change the topography in the nearshore and shoreline environment.	Innovative treatment technologies would likely be located in upland sites in former or existing industrial areas and would not result in physical impacts to the environment.
Dredged material placed in open water may alter the topography of the site.	Shoreline CDFs could reduce littoral drift and increase currents and wave energy.	Placement at brownfield sites as clean fill or capping material is not likely to generate additional physical impacts beyond remediation operations.			
Environmental Resources					
Physical changes to sediment characteristics could potentially result in habitat impairment or enhancement.	Excavation and operation of CAD cells and CDFs would destroy and/or bury bottom-dwelling resources living within the footprint area.	The use of dredged material as fill or cap material at brownfield sites could temporarily displace mobile resources such as birds or terrestrial wildlife.	Landfill placement is unlikely to have direct impacts to wetlands, birds, terrestrial wildlife, or threatened and endangered species.	Berms and beach nourishment could impact submerged aquatic vegetation, wetlands, and nearshore benthic, pelagic, and terrestrial species through changes in habitat.	Impacts to aquatic resources from the use of chemical or thermal innovative treatment technologies would be limited to spills during handling, runoff from storage piles, and discharges of effluent.

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
Operation of dump scows and of commuter vehicles could potentially result in air pollutant emissions and adverse noise impacts; however, air quality and noise impacts would be short term and localized and not be significant relative to background levels.	Eventual placement of a cap of suitable dredged material on the CAD cells would limit bioaccumulation of any contaminants in the dredged material and would allow a stable benthic community to develop.	On-road truck operations associated with material transport to and from brownfield sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck routes.	Dredged material placed as waste could potentially affect groundwater and surface water quality in the immediate area.	Environmental impacts from berm creation would be similar to other in-water alternatives.	Technologies that involve placing dredged material on soil for natural or enhanced natural treatment could impact surface water or wetlands.
Potential risks of contaminant bioaccumulation would either remain the same or possibly be reduced through use of risk based evaluations.	Under the CAD cell alternatives, habitat for fish and shellfish could potentially be enhanced because bathymetric variations could increase habitat diversity.		Salt and any leachable chemicals in dredged material may require leachate management practices that prevent erosion or the deposition of material in adjacent resources.	Adverse air quality and noise impacts could be of concern, depending upon the scale and duration of placement activities at selected beneficial use sites, the distance to the placement site, and the sensitivity of the land around these sites.	Air quality impacts would vary by technology however, innovative treatment processes generally include specialized air handling equipment and monitors and would require permitting to meet applicable air quality requirements.
Short-term, localized water quality impacts could occur.	Placement of dredged material in CAD cells would increase turbidity and contaminant concentrations within residual plumes, potentially leading to intermittent, localized, short-term changes in water quality.		Secondary impacts would include effects associated with material dewatering (fluid management, possible equipment emissions) and transportation (emissions).		

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
	During CDF construction, resources in the surrounding environment could be indirectly affected due to sedimentation and increased water column turbidity as well as impacts to air and noise quality.		Noise impacts from operation of equipment and vehicles would be localized and temporary.		
	Water quality impacts during CDF construction would likely be temporary and short-term.		On-road truck operations to and from landfill sites would result in adverse air quality and noise impacts, particularly at nearby sensitive land areas.		
Infrastructure Resources					
Placement of dredged material in open water could potentially affect existing or future infrastructure within Long Island Sound, resulting in inadequate water depths and possible impacts to navigation.	Infrastructure resources present within the footprint of a CAD cell or CDF could be subject to interference or burial, potentially requiring temporary or permanent relocation.	Upland dewatering of material could require truck hauling and the use of public roadways for transit, resulting in potential increased traffic congestion.	Significant, short-term overland transportation resources could be required, depending on the distance between the project site and the landfill location.	Berm creation could change current patterns and wave energy, potentially resulting in erosion or deposition around docks, recreational areas, dredged material facilities, aquaculture facilities, and other coastal structures.	The selected technology and site location would have a considerable effect on traffic impacts to local road networks. Where treatment involved multiple technologies that are not co-located, truck trips would be required to transport material between processing sites.

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
	Direct impacts to ports are not anticipated because shoreline CDFs would be sited to avoid coastal areas where port facilities are present.			Berm creation could bury utilities during placement of dredged material.	The demand for services such as energy, water, and wastewater treatment for operation of innovative treatment technologies would vary depending on the technology and the volume of material processed by the facility. The sufficiency of local suppliers to provide such services would be determined in the siting and permitting processes.
	Short-term impacts to vessel traffic could occur at mooring areas, navigation channels, ports, and recreational areas near, but not within, an alternative site during CDF construction and operation.			If nearshore berms were created at sites close to navigation channels, adverse impacts on navigation could occur due to shoaling.	
				Beach nourishment activities could result in potential impacts to utilities, mooring areas, aquaculture beds, and coastal structures from burial or increased sedimentation.	
				Beach nourishment could encourage more visitations and increased traffic in the immediate area.	

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
Cultural Resources					
Shipwrecks located in or adjacent to potential open-water placement site alternatives would be affected by burial from dredged material placement. Shipwrecks that have not been clearly located or identified could be obscured by burial but would also be protected from disturbance.	Excavation and operation (dredging, filling, and capping) under the in-harbor CAD cell alternatives would destroy and/or bury any cultural resources (such as shipwrecks and archaeological resources) present within the footprint area. However, CAD cells would not be sited or constructed on a footprint that contained cultural resources	It is unlikely that historic districts or archaeological resources are located at landfill placement sites or other nearshore or upland beneficial use sites; therefore, no direct destruction of, or visual impacts to, cultural resources are anticipated under these alternatives.			None
Dredged material placement is not likely to result in increased erosion or displacement of cultural artifacts, but site locations should be selected to avoid conflicts.	Construction and operation of island and shoreline CDFs would destroy and/or bury shipwrecks present within the footprint area.				
	No archaeological sites were identified at any of the island or shoreline CDF alternative sites; therefore, impacts to archaeological sites are not anticipated.				
Cultural and archaeological resources that may have been	CDF construction and operation could result in				

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
present within existing placement sites have been previously disturbed or are currently protected from any further impacts resulting from prior placement activities.	short-term visual impacts to historic districts.				
	Historic districts could be impacted by CDFs because changes in bathymetry could result in wave focusing or increased erosion and channelization along the shoreline where these resources are located.				
	CDFs may provide increased wave and storm protection to shore areas.				
Socioeconomic Resources					
Potential adverse impacts could occur from competing uses of the water system from nearby shipping lanes or aquaculture sites.	Nearby major ferry routes and shipping lanes may be interrupted by construction of CAD cells.	The number of trucks traveling to dewatering sites, landfills and brownfield sites would increase, resulting in additional traffic congestion, noise, highway safety, and air quality impacts to surrounding areas. Adverse effects from transport of clean material to landfill sites would depend on the dewatering site location and the length of travel routes, routes taken, and volume of material transported. Short term adverse aesthetic impacts would be possible during construction of brownfields.		Under the nearshore bar/berm alternatives, shellfish aquaculture could potentially be disrupted or destroyed, resulting in a consequential loss of employment dependent on those aquatic resources.	Siting facilities in existing areas of compatible land use could alleviate or minimize adverse social impacts, environmental justice concerns, and visual impacts.
During material placement, special precautions may need to be imposed on fishing and shipping activity near the alternative sites.	Recreational boating could be interrupted during construction activity.			Waterborne commerce and recreational boating activity could also be disrupted.	

Table ES-2. General Impacts by Alternative Type (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
Nearby oyster and clam beds may be disturbed by material placement actions, with a subsequent loss of employment in the commercial or recreational fisheries dependent upon those sites	Aquaculture of shellfish could potentially be lost or disturbed, with subsequent loss of employment from commercial or recreational fisheries dependent upon those sites.			Submerged pipelines could be within the construction area of the sites and could be at risk if they were disturbed by construction activities.	
Material placement activities could disrupt recreational use or pose boating hazards to the public unless proper precautions were taken.	Placement activities could disturb the aesthetic quality of harbor views in the short term; however, long-term aesthetics are not expected to be impacted because the cells would be submerged under water.			Some short-term aesthetic value losses would be possible during construction of the nearshore bars/berms.	
Placement activities could disturb the aesthetic quality of open-water views in the short term; however, long-term aesthetics are not expected to be impacted because the sites would be submerged under water.				Nourishment of public beaches could result in more visitations and increased traffic in the immediate area.	

Table ES-3. General Impacts Under the No Action Alternative.

<table>
<tr><th>Select New Open-Water Site(s) Inside or Outside of Long Island Sound</th><th>Use Existing Site(s) Outside of Long Island Sound</th><th>Await Designation of Different Site Within Long Island Sound</th><th>Cancel Dredging Projects</th><th>Use Practicable and Cost-Effective Land-Based, In-Harbor, Nearshore, Beneficial Use, or CDF Placement/Use Alternatives</th></tr>
<tr><td colspan="5">Physical Resources</td></tr>
<tr><td>The potential for adverse physical impacts could increase because new open-water locations would likely be in areas where placement has not previously occurred. Sedimentation and erosion would be more likely under this scenario because material would be dispersed over a greater area within or outside of Long Island Sound.</td><td colspan="2">Potential adverse impacts to sedimentation would likely decrease because less material would be placed in Long Island Sound; however, erosion conditions would remain unchanged because erosion is based on the hydrodynamics of Long Island Sound..</td><td>Significant sediment and shoaling would occur in rivers and harbors, resulting in decreased water depths and potential changes in nearshore hydrodynamics.</td><td>Impacts would be similar to those described in Table ES-2 for the various alternative types.</td></tr>
<tr><td colspan="4">Environmental Resources</td><td></td></tr>
<tr><td rowspan="2">Dredged material would likely be dispersed over a greater area or over new areas; therefore, the potential for impacts would be similar to those described above for open-water placement.</td><td colspan="3">The potential for adverse environmental impacts to benthos, shellfish, fish, marine and coastal birds, marine mammals and reptiles, water quality, sediment quality, and bioaccumulation potential would remain unchanged because less material would be placed in Long Island Sound.</td><td rowspan="2">If designated open-water placement sites were not available, some increased level of air emissions could result from vessels or vehicles used to haul dredged material to land-based placement sites.</td></tr>
<tr><td>If open-water sites much farther away had to be used for placement, the longer vessel trips could result in greater air emissions due to the need to use larger barges and more powerful tugs with larger engines.</td><td>If designated open-water placement sites were not available, some increased level of air emissions could result from vessels or vehicles used to haul dredged material to land-based placement sites.</td><td>No direct impacts to environmental resources inside or outside Long Island Sound would occur.</td></tr>
</table>

Table ES-3. General Impacts Under the No Action Alternative (continued).

Select New Open-Water Site(s) Inside or Outside of Long Island Sound	Use Existing Site(s) Outside of Long Island Sound	Await Designation of Different Site Within Long Island Sound	Cancel Dredging Projects	Use Practicable and Cost-Effective Land-Based, In-Harbor, Nearshore, Beneficial Use, or CDF Placement/Use Alternatives
If USACE selected other open-water sites in the region, the travel distances, and therefore emissions, for placement would be similar to current conditions.				
If open-water sites much farther away had to be used, longer vessel trips could result in greater air emissions due to the need to use larger barges and more powerful tugs with larger engines.				
Infrastructure Resources				
The selection of new open-water sites within Long Island Sound could increase impacts to infrastructure resources because placement would occur over a greater area within the Sound.	Infrastructure resources would likely remain unchanged.			
Cultural Resources				
The selection of new open-water sites within Long Island Sound could increase impacts to historic and archaeological resources because placement would occur	Impacts to historic and archaeological resources would likely remain unchanged	Impacts to historic and archaeological resources would likely remain unchanged	Impacts to historic and archaeological resources would likely remain unchanged	Proposed dredged material placement would likely require additional investigations of potential historic and archeological resources at newly chosen alternative sites.

Table ES-3. General Impacts Under the No Action Alternative (continued).

Select New Open-Water Site(s) Inside or Outside of Long Island Sound	Use Existing Site(s) Outside of Long Island Sound	Await Designation of Different Site Within Long Island Sound	Cancel Dredging Projects	Use Practicable and Cost-Effective Land-Based, In-Harbor, Nearshore, Beneficial Use, or CDF Placement/Use Alternatives
over a greater area within the Sound				
Proposed dredged material placement would likely require additional investigations of potential historic and archeological resources at newly selected sites.				
Socioeconomic Resources—Regional Impacts				
• Shoaling would continue and vessels would lose access to harbors and waterways. • The combined impacts on marine transportation and recreational boating would account for the greatest loss in economic activity (93% of the estimated reduction in gross state product). • Ferry-dependent tourism would account for 4% of the estimated loss in annual gross state product. • Cargo traffic costs would increase because of tidal delays. • The likelihood of vessel collisions, groundings, and oil spills would increase. • Loss of access to ports could cause commercial and recreational fishermen to abandon fishing, resulting in negative social and cultural impacts on communities. • In the 20th year of the No Action Alternative, losses in annual gross state product are anticipated to be approximately $853 million, or approximately 15% of the current regional gross state product, from navigation-dependent economic activities. • Eastern and western Connecticut and western Long Island would likely bear the largest impacts in terms of gross state product, each experiencing more than $200 million in reduced gross state product after 20 years.				

Table ES-4 . Beneficial Impacts of Dredging and Placement of Dredged Material.

<table>
<tr><th>Open-Water Placement of Dredged Material (Confined and Unconfined)</th><th>Confined Nearshore Placement of Dredged Material</th><th>Upland Beneficial Use of Dredged Material</th><th>Landfill Placement of Dredged Material</th><th>Coastal Beneficial Use of Dredged Material</th><th>Innovative Technologies</th></tr>
<tr><td colspan="6">Dredging and subsequent placement of dredged material allows for the continued operation of the ports and harbors within Long Island Sound.</td></tr>
<tr><td colspan="5">Employment could increase for barge and tug operators and heavy machinery operators involved in the placement of material.</td><td>The use of innovative treatment technologies could potentially yield significant direct and indirect beneficial impacts through the generation of jobs and tax revenues.</td></tr>
<tr><td>Potential benefits from the implementation of open-water alternatives could accrue to infrastructure resources and to regional employment.</td><td>In cases where CAD cells are constructed using existing pits or depressions on the seafloor, habitat for benthic invertebrates and shellfish could be increased or enhanced when the pit or depression is filled with dredged material.</td><td>Ecological restoration and redevelopment projects (e.g., brownfield redevelopment) would convert degraded sites to publicly accessible areas such as a natural park, providing increased recreational opportunities and decreasing the risk of exposure to site contamination.</td><td>Over time, potential benefits could accrue to man-made resources, regional employment, and personal revenue from the placement of dredged material at landfill sites.</td><td>If feeder berms were constructed, new sediment would be introduced to the littoral system, beaches would be nourished through onshore sediment transport, and nearshore wave energy, and therefore shoreline erosion, would be reduced.</td><td>Innovative technologies could neutralize or remove contaminants from sediment, resulting in products that can be used beneficially as manufactured soil for brownfield remediation, public landscaping, highway projects, landfill daily cover and closure, structural fill, or a growing medium.</td></tr>
</table>

Table ES-4. Beneficial Impacts of Dredging and Placement of Dredged Material (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
Placement of material may increase employment for tug/barge operators and operators of heavy machinery during periods of placement activity.	No change to tax revenue/property values is expected during the lifespan of island or shoreline CDFs. However, depending on their proximity to other land uses and demand for available vacant land, created land masses may produce opportunities for development at the end of the facility's useful life as a placement area.	Restoration activities such as salt marsh re-creation would provide additional habitat and increased coastal resilience in the form of flood control and protection from rising sea levels.		If stable berms were constructed, wave energy along the shoreline would be reduced, resulting in lower shoreline erosion, thereby providing increased protection of infrastructure from wave impacts.	Some end products created through innovation could partially offset project costs through tipping fees or as marketable commodities such as Portland cement replacement or potting soil.
	The construction of CDFs may potentially decrease shoreline wave energy and erosion by modifying the littoral drift, currents, and waves at the CDF location, thereby helping to protect vulnerable shorelines and infrastructure.	Visual aesthetics of redeveloped sites would be improved over the long term.		Reestablishment of beach areas could result in long-term visual aesthetic benefits.	Recycling dredged material through treatment could allow the material to replace nonrenewable "greenfield" deposits of topsoil, sand, and shale.
	Shoreline accretion due to wave sheltering could enhance other shoreline habitats, including those found in marine protected areas and could increase submerged aquatic vegetation.	Employment could increase with the need for truck drivers and heavy machinery operators at origin and destination sites to handle placement material.		Nourishment of beaches could contribute to greater recreational utility and public enjoyment of sites.	

Table ES-4. Beneficial Impacts of Dredging and Placement of Dredged Material (continued).

Open-Water Placement of Dredged Material (Confined and Unconfined)	Confined Nearshore Placement of Dredged Material	Upland Beneficial Use of Dredged Material	Landfill Placement of Dredged Material	Coastal Beneficial Use of Dredged Material	Innovative Technologies
	The potential for an increase in habitat diversity for fish species also exists for any in-water placement alternative because placement activities could create bathymetric variations.	Habitat enhancement for wetlands and for upland and coastal wildlife and bird species could be directly incorporated into the final project design.		If nourishment of beach fronts produced additional usable beach area and encouraged recreational usage, public revenues could increase from associated visitation fees.	
	Upland areas created as part of CDFs can become port sites, or created land for infrastructure projects.				

Table ES-5. Cumulative Impacts and Mitigation.

<table>
<tr><th>Open-Water Placement of Dredged Material (Confined and Unconfined)</th><th>Confined Nearshore Placement of Dredged Material</th><th>Upland Placement of Dredged Material</th><th>Landfill Placement of Dredged Material</th><th>Beneficial Use of Dredged Material</th></tr>
<tr><td colspan="5">Action Alternatives</td></tr>
<tr><td colspan="5">• Any cumulative adverse impact to Long Island Sound's physical, environmental, infrastructure, cultural, or socioeconomic resources could diminish its value for commercial and recreational uses. Short-term impacts observed to date under the alternatives considered have been shown to be temporary and have not resulted in significant unacceptable adverse impacts to Long Island Sound.
• Non-dredging events (vessel-related contamination) and watershed-wide contaminant loading from agricultural, urban, and industrial sources would continue to dominate the inventory of stressors, particularly in the Western Basin.
• Climate change resulting in sea level rise and increased storm activity could have a greater impact on beach loss, erosion, and changes to habitat (which could lead to increased damage to shoreline and nearshore alternative sites), increased sediment transport, and impacts to benthic, pelagic, and terrestrial organisms.</td></tr>
<tr><td colspan="5">No Action Alternative</td></tr>
<tr><td colspan="5">• Under the No Action Alternative, the option of dredged material placement at a designated open-water placement site would no longer be available.
• Under the scenarios which result in continued in-water placement and/or increase nearshore, upland and beneficial use alternatives, cumulative impacts would be similar to impacts from the action alternatives.
• If dredging were limited or did not occur, the accumulation of naturally deposited sediment could cause shoaling in rivers and harbors, resulting in decreased water depths and potential changes in nearshore hydrodynamics.
• Regional impacts from climate change and sea level rise have caused significant damage to many existing structures and have affected much of the coastal infrastructure within Long Island Sound. These impacts are much larger in magnitude than anticipated impacts from dredging-related activities.
• Decreased dredging, in combination with increased runoff and sedimentation as a result of climate change and sea level rise, could result in increases in shoaling, which would have negative impacts to recreational and commercial vessels.
• Delayed or abandoned dredging of Long Island Sound’s waterways would likely affect regional economic enterprises (and the associated employment) that depend on Long Island Sound for reliable access to water resources and transportation.
• In the absence of a DMMP, local ports would compete for limited dredging funds at a higher unit cost while attempting to maintain economic viability.</td></tr>
<tr><td colspan="5">Mitigation</td></tr>
<tr><td colspan="5">When specific dredging projects are developed, specific mitigation strategies and practices will be addressed as part of the permitting process.</td></tr>
</table>

ALTERNATIVE SELECTION

As recommended by the Long Island Sound DMMP Working Group, the USACE developed a formal, quantitative screening process using Multi-Criteria Decision Analysis to evaluate and rank placement alternatives for each USACE Navigation Project in Long Island Sound. In addition to the physical, logistical, and economic factors that were used to score and rank placement alternatives, the evaluation hierarchy and relative priorities expressed by the Working Group were used to guide the development of the impacts/benefits portion of the screening process. One of the tasks given to the Working Group was collaborative participation in developing a multi-criteria decision model for weighing placement alternatives. The resulting model included general alternatives, criteria, and metrics relevant to stakeholder interests. With the exception of a few outliers, there was some consensus that all of the criteria—economic, environmental, and social—were important to the stakeholders and the region.

The screening process used to evaluate and rank potential wide range of dredged material placement alternatives within the Long Island Sound study area incorporated input from the Working Group, the results of the Multi-Criteria Decision Analysis, and information from three sources: the Long Island Sound DMMP study efforts, the EIS for the designation of open-water dredged material disposal sites in central and western Long Island Sound, and the USACE. The information gathered was used to describe and characterize each of the USACE Navigation Projects and potential placement alternatives.

Alternative sites that were identified in the DMMP background studies were screened against each USACE Navigation Project using a series of evaluation factors to identify those alternatives that would most likely be feasible for each project. Screening was conducted using four evaluation factors:

- **Suitability/Compatibility:** Suitability of material was determined based on the most recent sediment testing results and/or most recent placement site used for each USACE and other Federal agency project. In some cases, the most recent testing occurred decades ago and may not reflect current conditions. All project material would be tested to determine suitability for placement before dredging occurred.
- **Capacity:** Alternative site capacity was calculated using either the 30-year projected dredging volume or the average per-event volume (for beaches and feeder berms) for each project, and did not consider that multiple placements of smaller volumes could occur over the project lifetime. Therefore, the available capacity used to score each alternative site assumes that all project material would be placed at that one alternative site. The scoring also did not take into consideration that an alternative site could be used by multiple projects over the 30-year period of the DMMP, or that a single project could use multiple alternative sites during a dredging event.
- **Distances:** Distances between project–alternative pairs are straight-line distances and do not reflect actual haul distances that equipment would use to transport material from dredging projects to alternative sites.

- **Impacts:** Impacts are based on resource data (where available) and reflect potential or anticipated impacts. Project-specific NEPA documents would need to be prepared that describe in greater detail the current conditions and anticipated impacts associated with placement of dredged material at each alternative site considered for each dredging project.

Metrics were developed for these evaluation factors to quantitatively score each alternative site by project. In addition, estimated dredging and placement costs were included with the screening results for comparison purposes but were not included in the quantitative screening scores.

This process was used to identify the overall top 10 scoring placement alternatives for each USACE Navigation Project based on the total score of the four evaluation factors. This screening does not identify or select the “preferred” alternative for any of the projects; rather, it is a guide to assist the USACE in identifying the most feasible and cost-effective alternatives within the universe of potential alternatives. Screening was also performed for other Federal agency (non-USACE) projects, which are presented with the USACE Navigation Projects by dredging center. This ranking of alternatives, combined with the procedures and standards recommended in the DMMP (Section 7 of the DMMP), support the identification and use of practicable alternatives to open-water disposal

Actual decisions on the final plan for dredged material placement for Federal projects would be made as projects are funded and investigated in the future. These projects would each need to conduct investigations on sediment suitability and placement site acceptability, prepare any NEPA and decision documents, provide for adequate public involvement and review, secure any necessary Federal and state agency regulatory approvals, and secure Federal and sponsor funds for implementation.

CONCLUSION

The assessment conducted for this PEIS serves as a guide to assist the USACE and other Federal agencies in identifying the most feasible, environmentally acceptable, and cost-effective alternatives for dredged material placement within the Long Island Sound study area. It can also serve as a guide and resource for other non-Federal dredging proponents in their future development of project-specific NEPA documents. The PEIS 1) describes the universe of potential alternatives identified within the Long Island Sound study area, 2) describes the existing conditions within the study area and at the alternative sites identified, and 3) assesses the potential impacts associated with placement of dredged material at a variety of alternatives within the study area. The analysis and evaluations included in the PEIS assist the LIS DMMP in development of procedures and standards for evaluating and recommending dredged material placement options that support the goal of reducing or eliminating the need for open-water placement of dredged material in Long Island Sound. The preparation of this PEIS is also compliant with the NEPA and provides opportunities for public participation.

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ACRONYMS

ADCP	acoustic doppler current profiler
APEG	alkaline polyethylene glycol
AVS	acid-volatile sulfide
BCDP	base-catalyzed decomposition process
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
Btu	British thermal unit
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAD	confined aquatic disposal
CBG	Census Block Group
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
COC	community of concern
CSDS	Cornfield Shoals Disposal Site
CSO	combined sewer overflow
CT DEP	Connecticut Department of Environmental Protection (now CTDEEP)
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
dCO_2	dissolved carbon dioxide
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenylchloroethylene
DDT	dichlorodiphenyltrichloroethane
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DMMP	Dredged Material Management Plan
DMSO	dimethyl sulfoxide
DO	dissolved oxygen
DSP	diarrhetic shellfish poisoning
dw	dry weight
ECL	Environmental Conservation Law
EDTA	ethylenediamine-tetraacetic acid
EEV	Ecological Effects Value
EF	enrichment factor

EFH	essential fish habitat
EJ	environmental justice
EMAP	Environmental Monitoring and Assessment Program
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
FRA	Federal Railroad Administration
FVP	Field Verification Program
FY	fiscal year
g	gram
$g/m^2/yr$	grams per square meter per year
GC	General Conformity
GDP	gross domestic product
GHG	greenhouse gas
GIS	Geographic Information System
GSP	gross state product
GWP	global warming potential
H_2S	hydrogen sulfide
HAB	harmful algal bloom
HAP	hazardous air pollutant
HARS	Historic Area Remediation Site
HEPA	high-efficiency particulate air
HTTD	high temperature thermal desorption
L_{10}	noise level exceeded for 10% of a period of time
L_{eq}	equivalent continuous sound level
L_{dn}	day-night average sound level
lb	pound
LC	lethal concentration
LTTD	low temperature thermal desorption
LWA	light-weight aggregate
µg/g	micrograms per gram
µg/L	micrograms per liter
µm	micrometer
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
MPO	Metropolitan Planning Organization
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NAD	North Atlantic Division
NAE	New England District (USACE)
NAICS	North American Industry Classification System
NAN	New York District (USACE)
NAP	Philadelphia District (USACE)
NBSP	National Benthic Surveillance Program
NCA	National Coastal Assessment
NDC	Navigation Data Cente
NEPA	National Environmental Policy Act
ng/g	nanograms per gram
NJDOT	New Jersey Department of Transportation
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
NYC DOT	New York City Department of Transportation
NYCEDC	New York City Economic Development Corporation
NYCRR	New York Codes, Rules, and Regulations
NYNJLICT	New York, New Jersey, Long Island, Connecticut
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSOA	New York State Ornithological Association
OBS	optical backscatter
OCDD	octachlorodibenzodioxin
OLISP	Office of Long Island Sound Programs
Pa	pascal
PA	Preliminary Assessment
PA DEP	Pennsylvania Department of Environmental Protection
PAHs	polycylic aromatic hydrocarbons
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PEG	polyethylene glycol
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter

PM_{10}	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 trillion
psi	pounds per square inch
PSD	Prevention of Significant Deterioration
PSP	paralytic shellfish poisoning
psu	practical salinity unit
QC	quality control
RAT	Regional Air Team
RCRA	Resource Conservation and Recovery Act
REMOTS®	Remote Ecological Monitoring of the Seafloor
RI CRMS	Rhode Island Coastal Resources Management Council
RIDEM	Rhode Island Department of Environmental Management
RISDS	Rhode Island Sound Disposal Site
RPD	redox potential discontinuity
SAV	submerged aquatic vegetation
SCC	secondary combustion chamber
SEM	simultaneously extracted metal
SFLN	sulfolane
SHPO	State Historic Preservation Office
SIP	state implementation plan
SLCL	straight line carapace length
SO_2	sulfur dioxide
SPI	sediment profile imagery
SQG	sediment quality guideline
SQT	Sediment Quality Triad
SQUID	Sediment Quality Information Database
SVOC	semi-volatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TBT	tributyltin
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
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

Programmatic Environmental Impact Statement for the Long Island Sound Dredged Material Management Plan

1 INTRODUCTION

To facilitate safe navigation and marine commerce in Connecticut, New York, and Rhode Island rivers, harbors, and coastal areas throughout the Long Island Sound region, dredging activities and subsequent management of the dredged material must be conducted to maintain and periodically improve Federally authorized channel depths and widths. Records of dredging activities in the Long Island Sound area extend back to the 1870s, with most of the material being transported to open-water dredged material placement sites in Long Island Sound. Navigation projects led by the U.S. Army Corps of Engineers (USACE) (referred to as USACE Navigation Projects) produce most of the dredged material generated in Long Island Sound every year. Other Federal agencies, including the U.S. Navy and U.S. Coast Guard, also periodically generate dredged materials from the maintenance and improvement of their facilities in this region.

This Programmatic Environmental Impact Statement (PEIS) describes the existing environment and assesses the impacts of available or potentially developable dredged material management alternatives for the USACE's Dredged Material Management Plan (DMMP) for Long Island Sound.

The Long Island Sound Dredged Material Management Plan

Under USACE Engineer Regulation (ER) 1105-2-100 (USACE, 2000), the USACE is responsible for developing a DMMP for USACE Navigation Projects where there is an indication of existing insufficient placement capacity to accommodate maintenance dredging for at least the next 20 years. The USACE conducted a Preliminary Assessment (PA) to document the need for a comprehensive DMMP for the Long Island Sound region. The PA was completed and approved by the USACE in June 2006 (USACE, 2006). In addition, because of the extensive area covered, and because of the funds and time needed to develop a comprehensive DMMP, it was determined that it would be more appropriate to extend the planning period to 30 years.

The Project Management Plan (PMP) (Appendix I), which serves as the initial work plan for the Long Island Sound DMMP, was completed and approved by the USACE, in consultation with the Project Delivery Team, which was comprised of all of the Federal and State agencies involved in the DMMP, in October 2007. Since 2007, the USACE's New England District (NAE) has conducted several studies to collect information necessary to prepare the DMMP, including information on:

- available literature and environmental data for Long Island Sound (USACE, 2009a); (USACE, 2010a);
- dredging needs (USACE, 2009b);
- Federal and state regulations (USACE, 2011a);
- nearshore berm placement sites (USACE, 2012a);

- upland, beneficial use, and dewatering sites (USACE, 2009c); (USACE, 2011b); (USACE, 2010b);
- containment sites (USACE, 2012b);
- cultural resources (USACE and PAL, 2010);
- baseline economic data (USACE, 2010c);
- Multi-Criteria Decision Analysis (MCDA) ((Linkov, et al., 2013); and
- air quality impact analysis and estimating tool (USACE, 2014).

These studies provided background information that was used in the preparation of the Long Island Sound DMMP and the PEIS to identify, describe, and evaluate potential alternatives, as well as assess the potential overall impacts of using these alternative sites for the management of dredged material from Long Island Sound projects.

The Long Island Sound DMMP is an important milestone in the ongoing regional effort to develop a comprehensive plan for dredged material management in Long Island Sound. The purpose of the DMMP is to ensure that dredging needs for USACE Navigation Projects are met and that proper planning may, over time and where practicable, reduce or eliminate the need for open-water placement in the Sound. The Long Island Sound DMMP will identify, evaluate, and recommend, where possible, practicable dredged material management alternatives through a broad-based public process that protects the environment based on best scientific data and analysis, while meeting society's need for safe and economically viable navigation for water-based commerce, transportation, national security, and other public purposes. USACE DMMPs are usually for a single navigation project or for USACE Navigation Projects that are interrelated (e.g., projects in close proximity or common placement areas used) or are economically complementary. However, at the request of the States of New York and Connecticut, a single DMMP encompassing the entire group of dredging projects within Long Island Sound is being prepared to meet the management needs of USACE Navigation Projects, as well as other Federal navigation projects, in the Sound.

The USACE NAE is managing the development of the Long Island Sound DMMP in coordination with the following agencies and entities:

- USACE New York District (NAN)
- U.S. Environmental Protection Agency (EPA) Regions 1 and 2
- National Oceanic and Atmospheric Administration (NOAA)
- New York State Department of State (NYSDOS)
- New York State Department of Environmental Conservation (NYSDEC)
- Connecticut Department of Energy and Environmental Protection (CTDEEP) (formerly the Connecticut Department of Environmental Protection [CT DEP])
- Connecticut Department of Transportation (CT DOT)
- Rhode Island Coastal Resources Management Council (RI CRMC)

Programmatic Environmental Impact Statement for the Long Island Sound Dredged Material Management Plan

To comply with the National Environmental Policy Act (NEPA), the USACE prepared this PEIS in conjunction with the Long Island Sound DMMP. The USACE published the Notice of Intent to develop this PEIS in the Federal Register on August 31, 2007 (72 FR 50332). The specific objective of this PEIS was to evaluate the environmental, economic, socioeconomic, and cumulative impacts of the alternative sites identified in the DMMP with respect to the environment of Long Island Sound region and its tributaries, and provide suggestions for mitigation of the impacts.

Potential placement alternatives evaluated in the PEIS include the following:

- Open-Water Placement
- Confined Placement
    - In-harbor confined aquatic disposal (CAD) cells
    - Landfill placement
- Confined Placement/Beneficial Use
    - Island contained disposal facilities (CDFs)
    - Shoreline CDFs
    - Upland CDFs
- Beneficial Use
    - Nearshore bar/nearshore berm placement sites
    - Beach nourishment
    - Landfill cover/capping
    - Brownfields and other redevelopment
    - Mine and quarry restoration
    - Agriculture/aquaculture
    - Habitat restoration/enhancement or creation (including marsh, island, and shoreline restoration)
    - Non-structural and structural fill
    - Road bed and berm material
    - Asphalt/cement and other
    - Manufactured soil
- Innovative Treatment
    - Aggregates

By following a programmatic approach to assessing these impacts, decision makers will be able to evaluate different dredged material placement options with full knowledge of potential environmental consequences. The PEIS is an umbrella document that considers generic impacts of options. In the future, as specific alternatives are put in place to implement a given management option, specific project- and alternative-focused NEPA documents and permits, utilizing information presented in this PEIS, will be prepared to address implementation of a given option at a specific location.

This PEIS was prepared concurrently with the preparation of the DMMP. It was prepared in accordance with NEPA, Council on Environmental Quality (CEQ) regulations (40 CFR 1500 et seq.), and USACE regulations for implementing NEPA (33 CFR Part 230).

1.1 PURPOSE AND NEED FOR THE DMMP

The need for a comprehensive DMMP for the Long Island Sound region was recommended in the PA (USACE, 2006) based on the anticipated volume of dredged material to be generated in Long Island Sound, the lack of existing placement sites to manage those volumes, the request by the Governors of New York and Connecticut for the development of a Long Island Sound DMMP, and the use restrictions placed on the designation of two of the open water placement sites (Western Long Island Sound Disposal Site [WLDS] and Central Long Island Sound Disposal Site [CLDS]) (40 C.F. R. 228.15(b)(4)(vi)(D)[1]). The PA concluded that successful completion of a Long Island Sound DMMP is critical to the USACE's ability to maintain the region's Civil Works navigation projects and provide future navigation improvements to the system of Federal waterways in the Long Island Sound region. Analysis of the economic contribution of navigation-dependent facilities indicated that future maintenance of most of Long Island Sound's USACE Navigation Projects is likely warranted, and that such maintenance is in the Federal interest when examined on a project-by-project basis. Appropriate future cost-effective management methods and capacities must be identified to serve both Federal and non-Federal project needs in this region for the long-term health of the region's economy and environment.

A dredging needs study conducted by the USACE in 2009 (USACE, 2009b) for the Long Island Sound and its tributaries examined past dredging activities, quantities, and dredging cycles. Future dredging/placement needs were estimated based on the review of historic information and on information collected as part of a questionnaire sent to navigation-dependent facilities identified within the study area. During preparation of the draft DMMP in 2014-2015, it was recognized that (1) a significant volume of dredging work had occurred in the Long Island Sound region since 2009 including the work done in the wake of Hurricane Sandy, (2) that the 2009 report had not differentiated the types of dredged material in developing its dredging needs timeline, (3) that a number of USACE Navigation Projects, including many from NAN, and up-river/up-harbor segments of larger projects, did not have specific data on historical or projected dredging, and (4) that some USACE Navigation Projects with maintenance frequencies of less than 30 years did not have future projections that included recurring dredging actions. For these reasons the information gathered from the analysis of USACE Navigation Projects and the non-Corps facility survey was updated. Information for the USACE Navigation Projects was revised to reflect recent activities and currently proposed efforts. This mainly involved eliminating

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[1] "Except as provided in paragraphs (b)(4)(vi)(D) and (E) of this section, the disposal of dredged material at the CLIS [also known as CLDS] and WLIS [also known as WLDS] sites pursuant to this designation shall not be allowed beginning eight (8) years after July 5, 2005, unless a regional dredged material management plan (DMMP) for Long Island Sound has been completed by the North Atlantic Division of the USACE, in consultation with the State of New York, State of Connecticut and EPA, with a goal of reducing or eliminating the disposal of dredged material in Long Island Sound, and the EPA thereafter amends this site designation to incorporate procedures and standards that are consistent with those recommended in the DMMP. 1. Completion of the DMMP means finishing the items listed in the work plan (except for any ongoing long-term studies), including the identification of alternatives to open-water disposal, and the development of procedures and standards for the use of practicable alternatives to open-water disposal. If the completion of the DMMP does not occur within eight years of July 5, 2005 (plus any extensions under paragraphs (b)(4)(vi)(D) and (E) of this section), use of the sites shall be prohibited. However, if the DMMP is thereafter completed within one year, disposal of dredged material at the sites may resume."

dredging completed from the projections, adding newly projected work to later years of the extended DMMP timeframe, and adjusting volume estimates as described below. For the non-Corps dredging work, large projects completed since 2009 were removed from the projections, and dredging center-wide projections of demand were shifted over the revised 30-year period, as was recurring maintenance at those facilities reporting such needs in 2009.

The 2015 dredging needs evaluation estimated that nearly 52.7 million cubic yards (CY) of dredged material will be generated over the 30-year interval studied (Table 1-1) from maintenance and improvement projects. Figure 1-1 shows the projected 30-year volumes of dredged material from Long Island Sound by dredging center.

Table 1-1. Summary of Long Island Sound Dredging Needs by Project/Facility Type.

Project/Facility Type	2015-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	30-Year Total
Maintenance Dredging Needs (cubic yards)							
USACE Projects	4,929,900	5,151,900	3,202,700	3,535,600	3,273,000	5,941,400	26,034,500
Other Federal Facilities	163,000	43,200	84,000	50,000	33,200	28,000	401,400
Non-Federal Facilities	2,939,300	2,503,900	1,682,600	1,631,900	1,467,800	1,551,300	11,776,800
TOTALS	8,023,200	7,699,000	4,969,300	5,217,500	4,774,000	7,520,700	38,212,700
Improvement Dredging Needs (cubic yards)							
USACE Projects	1,657,100	5,100,000	450,000	0	0	0	7,207,100
Other Federal Facilities	200,000	150,000	0	0	0	0	350,000
Non-Federal Facilities	4,563,000	1,703,400	426,100	70,700	95,600	91,700	6,950,500
TOTALS	6,420,100	6,953,400	876,100	70,700	95,600	91,700	14,507,600
GRAND TOTALS	14,452,300	14,652,400	5,845,400	5,288,200	4,869,600	7,612,400	52,720,300

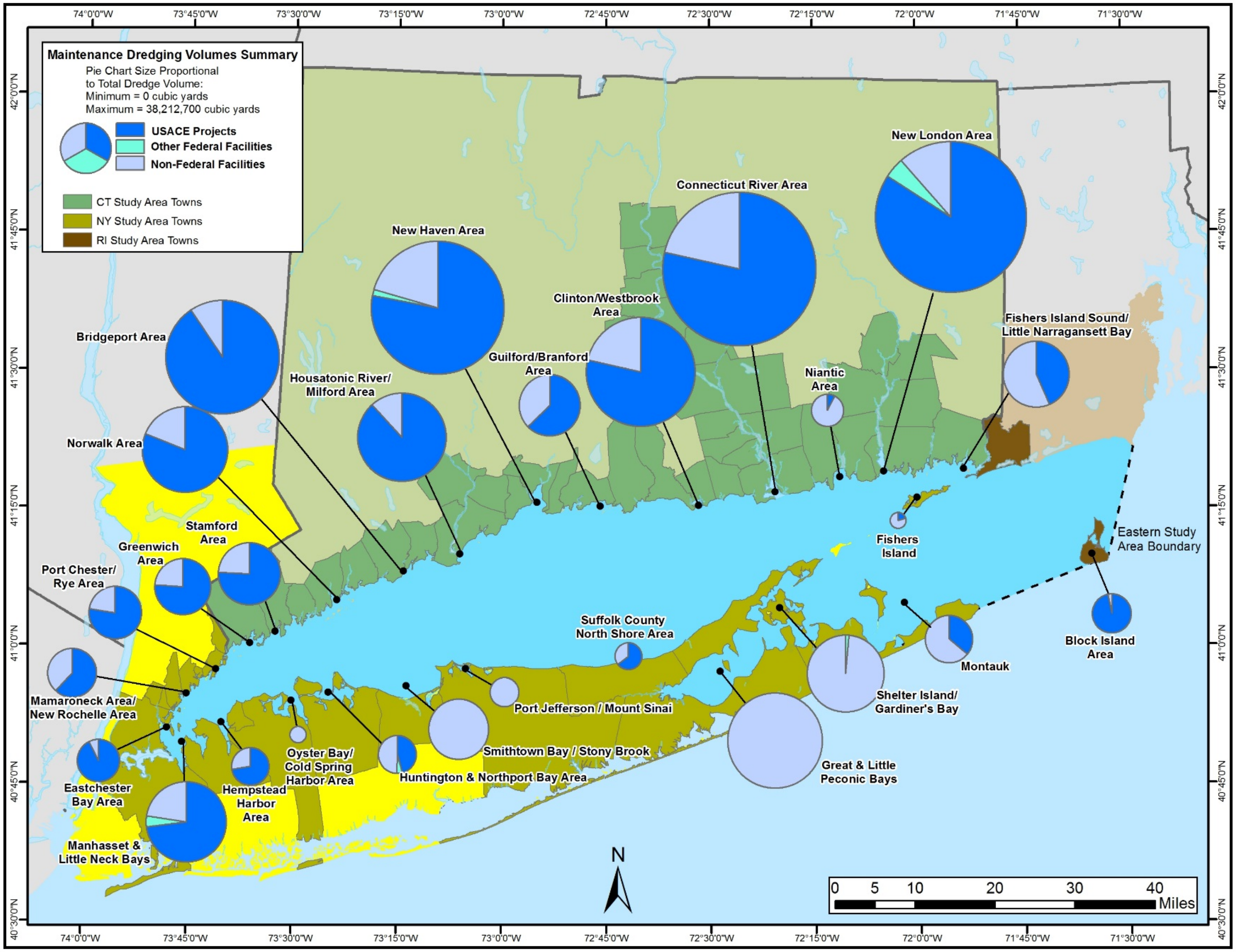

Figure 1-1. Long Island Sound DMMP Maintenance Dredging Needs - Dredging Center Distribution by Category.

1.2 STUDY AUTHORITY

In 2004, the EPA, in coordination with the USACE NAE, prepared an environmental impact statement (EIS) on the designation of ocean-based dredged material placement sites in Central and Western Long Island Sound (EPA, 2004). In the preamble to the EPA site designation rule, EPA addressed the issue of procedures and standards for evaluating placement alternatives for Marine Protection, Research, and Sanctuaries Act (MPRSA) projects in Long Island Sound as follows:

> "Consistent with [New York's and Connecticut's] requests, today's rule contemplates that the DMMP for Long Island Sound will include the identification of alternatives to open-water disposal and the development of procedures and standards for the use of practicable alternatives to open-water disposal, so as to reduce wherever practicable the open-water disposal of dredged material. The DMMP also may contain recommendations regarding the use of the sites themselves" (40 CFR Part 228).

In February 2005, the Governors of New York and Connecticut sent a joint letter to the USACE requesting its assistance with the development of the DMMP and, in separate letters, asked members of their respective congressional delegations to seek appropriation of Federal funds to initiate the DMMP. Under ER 1105-2-100, the role of the USACE with respect to navigation is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for movement of commerce, national security needs, and recreation (USACE, 2000). In this capacity, the USACE is responsible for dredged material management planning for all USACE harbor projects and therefore agreed to work with the states on the DMMP. Requests for funds were included in the President's budget for Federal fiscal years (FY) 2007 and 2008. Federal funding for the Long Island Sound DMMP began in FY08 and continued through FY14 at varying levels.

To address the 2004 Designation Rule provision with respect to "standards", and the request of the Governors of New York and Connecticut, the Long Island Sound DMMP has attempted to identify all the dredging needs, both USACE and non-USACE, for all of the harbors in Long Island Sound and vicinity following the approach detailed in USACE ER 1105-2-100. The Long Island Sound DMMP identified environmentally acceptable, practicable management plans that can be utilized by various dredging proponents in their analysis of options to manage their projects. Although it is not the intention of the Long Island Sound DMMP to identify an alternative for every potential project in the study area, the DMMP provides non-USACE navigational interests with an array of suitable/feasible options that could be used in their alternatives analysis to meet or exceed their needs. In addition, the states may use the DMMP findings to take whatever actions are necessary to establish or expand state programs to to assist in implementing reductions in open-water placement.. To be compliant with NEPA, the USACE developed this PEIS to assess the impacts of implementing the DMMP and provided opportunities for public participation.

1.3 STUDY AREA

The Long Island Sound study area encompasses the State of Connecticut; Washington County, Rhode Island; and Suffolk, Nassau, Queens, Kings (Brooklyn), New York (Manhattan), Bronx, and Westchester Counties in New York (Figure 1-2). The study area also includes all of the coastal and navigable tributary waters from Montauk Point, New York, west across northern Long Island to the East River at Throgs Neck, and then east through New York and Connecticut to the southern coast of Rhode Island, and southwest across to Montauk Point, New York. All navigable rivers, harbors, and coastal waters on Long Island Sound proper in Connecticut and New York east of Throgs Neck to a line drawn from Westerly, Rhode Island, south to Montauk Point are encompassed, including the waters of the Peconic Bay and Gardiners Bay shorelines in New York; the Fishers Island Sound shores of Connecticut, New York, and Rhode Island; and the Block Island Sound shores of New York and Rhode Island to the area's eastern boundary. The study area does not include New York Harbor itself, but it does include USACE NAN projects east of Throgs Neck to Montauk Point. The Connecticut River below the Hartford navigation project is included, as is the Thames River to Norwich, Housatonic River to Derby, and the Peconic River to Riverhead, New York. The waters of Block Island Sound east of Montauk Point to Block Island and Point Judith are included to the extent that they produce dredged material that may be managed in the region, or provide opportunities to beneficially use dredged material.

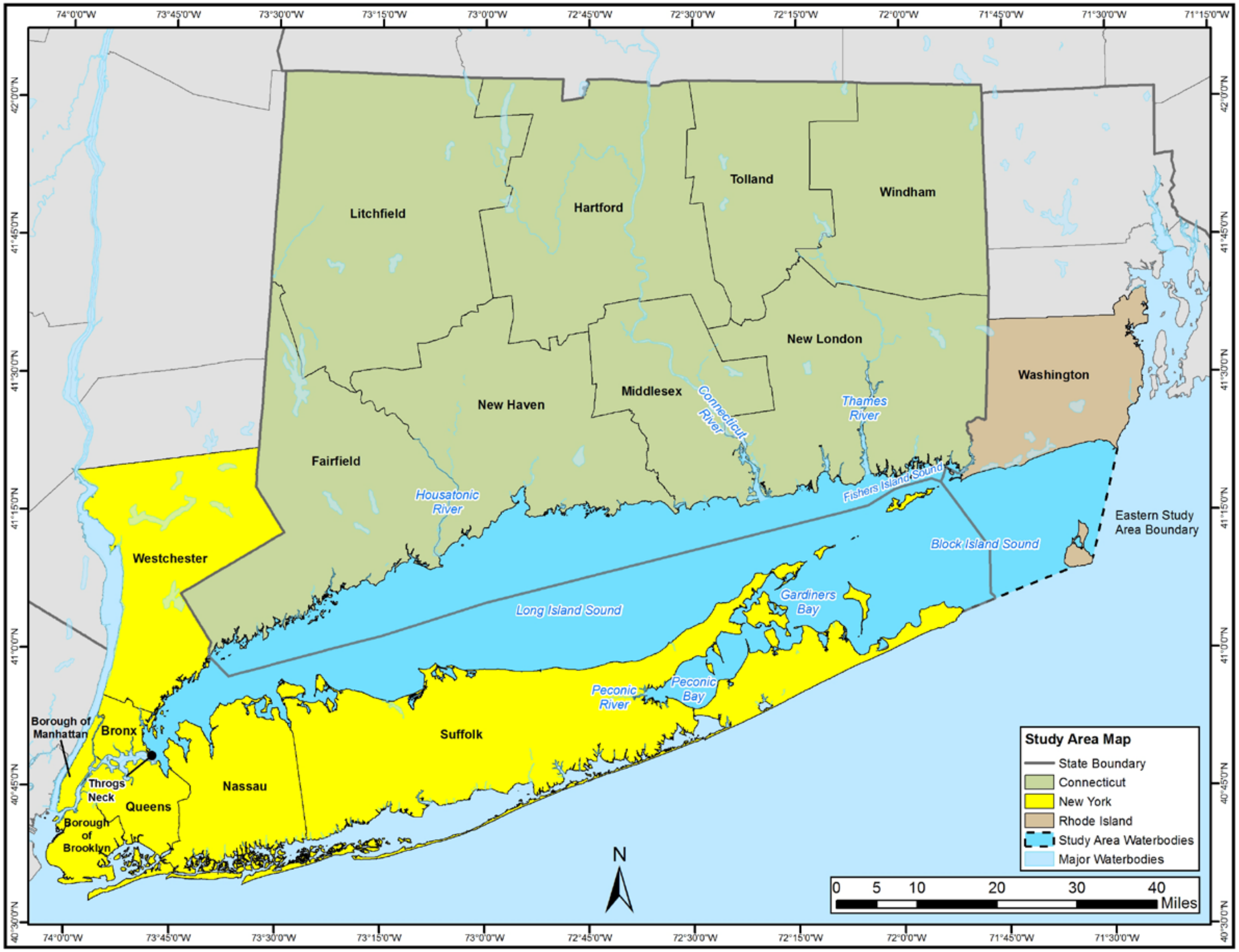

Figure 1-2. Long Island Sound Study Area.

1.4 REFERENCES

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2 DREDGING AND DREDGED MATERIAL CHARACTERISTICS – AN OVERVIEW

Dredged material has been generated from the harbors and rivers of the Long Island Sound study area for nearly 150 years to develop and keep navigation channels open for commerce and recreation. The characteristics of the material vary, dredging operations have evolved, and numerous placement options and locations have been established over these years. This chapter summarizes the regulations and programs currently used to manage dredging and dredged material placement to include a range of open-water, nearshore, upland, beneficial use, and treatment technology options. The range of dredged material characteristics found in the study area is also summarized as placement or treatment options may require different sediment characteristics to meet use requirements.

Periodic dredging ensures safe navigation and marine commerce in Connecticut and New York rivers, harbors, and coastal areas. The material removed from the navigation channels and harbors has been placed at open-water sites in Long Island Sound since at least the 1870s. While records of dredging activities extend back to this time, placement methods and sites for projects were not systematically recorded until the 1950s; however, there is evidence of continuous use of some sites since 1941 (Fredette, et al., 1992). From the 1950s through the early 1970s, about 19 open-water placement sites were active in Long Island Sound (Dames and Moore, 1981). Since the early 1980s, dredged material has been placed predominantly at four placement sites: WLDS [also known as WLIS]), CLDS [also known as CLIS]), Cornfield Shoals Disposal Site (CSDS), and New London Disposal Site (NLDS). These sites were evaluated and chosen to receive dredged material pursuant to programmatic and site-specific EISs prepared by the USACE and/or EPA in 1982, 1991, and 2004 ((USACE, 1982a), (USACE, 1982b), (USACE, 1991), (EPA and USACE, 2004a). Based on information collected through the USACE’s Disposal Area Monitoring System (DAMOS) program, it is estimated that about 17 million CY of material may have been placed at these open-water sites in Long Island Sound from 1982 to 2013.

Since 1977, the USACE, EPA, and the states have evaluated and regulated placement of dredged material in Long Island Sound under the provisions of the Clean Water Act (CWA) amendments to the Federal Water Pollution Control Act and MPRSA. Since 1972, Federal activities and activities of others carried out under Federal permit are subject to review by the states under their Coastal Zone Management programs. In the late 1970s, in response to concerns over the quality of dredged sediment and a lack of information on suspected impacts of placement, the number of actively used placement sites in the Sound was reduced, leading to the current system of four open-water sites by the mid-1980s.

This PEIS presents and evaluates the options for placement of dredged material from the Long Island Sound study area. Each option is subject to a set of laws and regulations that guide the selection process for dredged material placement.

2.1 REGULATORY ENVIRONMENT

The primary authorities that govern the placement of dredged material in the United States are the CWA and MPRSA. All dredged material placement activities in Long Island Sound, whether from Federal or non-Federal projects of any size, are subject to the requirements of the CWA. In addition, all Federal projects of any size and all non-Federal projects placing more than 25,000 CY of dredged material into the Sound must comply with the requirements of MPRSA. However, 40 CFR Part 228 supports the goal of eliminating or reducing open-water placement into Long Island Sound; therefore, a wide range of dredged material management options were identified under this PEIS. Moreover, a number of regulations and programs beyond the CWA and MPRSA must be considered for effective management of dredging (Table 2-1). Detailed summaries of each statute, as well as the state regulatory processes in New York, Connecticut, and Rhode Island for the placement of dredged material, can be found in *Federal, State, and Local Regulations and Programs Applicable to Dredged Material Management* (USACE, 2011).

Provisions of the CWA, MPRSA, and the Coastal Zone Management Act (CZMA) considered key to dredged material management in the study area are described in the following sections. Results of assessments conducted in response to other regulations (e.g., Magnuson Stevens Fishery Conservation and Management Act, Endangered Species Act, Fish and Wildlife Coordination Act) are discussed throughout the Affected Environment and Environmental Consequences, Cumulative Impacts, and Benefits chapters.

2.1.1 Clean Water Act, Section 404

CWA § 404, 33 U.S.C. § 1344, governs the placement of dredged or fill material into waters landward of the baseline from which the territorial sea is measured (the “Baseline”). The Baseline generally follows the coastline, but may cut from a point of land across the mouth of bays, and other similar bodies of water, to another point of land, thus leaving potentially significant areas of coastal waters landward of the Baseline. Indeed, all of the waters of Long Island Sound lie landward of the Baseline. Under the CWA, any lawful placement of dredged material into waters landward of the Baseline must first be authorized by the USACE and must be conducted in compliance with the conditions of such authorization.

It should be noted that when Federal dredged material placement projects are undertaken by the USACE, the USACE does not actually issue itself a permit; rather, it applies the same standards and general procedures under the CWA to determine whether the placement should be authorized.

In making its permit decisions and recommendations under its Civil Works program, the USACE applies the standards and criteria set forth in EPA regulations commonly referred to as the “CWA § 404(b)(1) Guidelines,” which are promulgated at 40 CFR Part 230 (33 U.S.C. § 1344(b)). The USACE also applies its own regulations promulgated at 33 CFR Parts 320 to 338. In addition, other provisions of applicable law must be satisfied (e.g., applicable state water quality standards, applicable requirements of state coastal zone management plans, the Endangered Species Act). USACE permits and Civil Works decisions under CWA Section 404 are subject to review, and potential veto, by EPA.

Table 2-1. Summary of Applicability of Federal and State Regulations and Programs on Placement Options.

	Open-Water Placement		**Confined Placement**		**Confined Placement/ Beneficial Use**			**Beneficial Use**										
Regulations	**Unconfined**	**Confined**	**In-Harbor CAD Cell**	**Landfill Placement**	**Island CDF**	**Shoreline CDF**	**Upland CDF**	**Nearshore Bar/Berm Placement Sites**	**Beach Renourishment**	**Landfill Cover/ Capping**	**Brownfield & Other Redevelopment**	**Mines & Quarries**	**Agriculture/ Aquaculture**	**Habitat Restoration/ Enhancement or Creation**	**Road Bed & Berm Material**	**Asphalt/Cement & Other**	**Aggregates**	**Notes**
Federal Regulations																		
Clean Water Act	1,3	1,3	X	2,3	X	X	2,3	X	X	2,3	2,3	X	2,3	X	2,3			[1]additional open-water regulations apply under MPRSA [2]related to dewatering discharge or fill placement in waters of the United States [3]applicable if there is a discharge to the waters of the State
Marine Protection Research and Sanctuaries Act	1	1																[1]only if the material has been deemed suitable for placement under the criteria of MPRSA
Coastal Zone Management Act	1	1	X	1	X	X	1	X	X		1			X	1			[1]applicable for projects located within the defined State coastal zone, activities listed under interstate consistency, and those which may affect the coastal area of the state (CT, NY, RI)
Rivers and Harbors Act	X	X	X		1	1		X	X					X				[1]applicable for the initial creation of the CDF

Table 2-1. Summary of Applicability of Federal and State Regulations and Programs on Placement Options (continued).

	Open-Water Placement		**Confined Placement**		**Confined Placement/ Beneficial Use**			**Beneficial Use**										
Regulations	**Unconfined**	**Confined**	**In-Harbor CAD Cell**	**Landfill Placement**	**Island CDF**	**Shoreline CDF**	**Upland CDF**	**Nearshore Bar/Berm Placement Sites**	**Beach Renourishment**	**Landfill Cover/ Capping**	**Brownfield & Other Redevelopment**	**Mines & Quarries**	**Agriculture/ Aquaculture**	**Habitat Restoration/ Enhancement or Creation**	**Road Bed & Berm Material**	**Asphalt/Cement & Other**	**Aggregates**	**Notes**
National Environmental Policy Act	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	none
Magnuson-Stevens Fishery Conservation and Management Act	X	X	X		1	1	2	X	X					X				[1]applicable for the initial creation of the CDF [2]related to dewatering discharge
Fish and Wildlife Coordination Act	X	X	X	X	X	X	X	X	X	X	X		X	X	X			none
Endangered Species Act	X	X	X	X	X	X	X	X	X	X	X		X	X	X			none
Marine Mammal Protection Act	X	X	X		X	X		X	X					X				none
Clean Air Act	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	Applicable to each state involved and surrounding states if downwind and close enough to impact
Environmental Justice (Federal and State)				1		X	1			1	1		1		1	1	1	[1]applicable to projects requiring construction of an "applicable" facility
Migratory Bird Treaty Act	X	X	X	X	X	X	X	X	X	X			X	X				none
National Historic Preservation Act	1	1	1	X	1	1	X	1	X				X	X				[1]e.g. placement over submerged structure, shipwreck, or intact paleosol which contains pre-

Table 2-1. Summary of Applicability of Federal and State Regulations and Programs on Placement Options (continued).

	Open-Water Placement		Confined Placement		Confined Placement/ Beneficial Use			Beneficial Use										
Regulations	**Unconfined**	**Confined**	**In-Harbor CAD Cell**	**Landfill Placement**	**Island CDF**	**Shoreline CDF**	**Upland CDF**	**Nearshore Bar/Berm Placement Sites**	**Beach Renourishment**	**Landfill Cover/ Capping**	**Brownfield & Other Redevelopment**	**Mines & Quarries**	**Agriculture/ Aquaculture**	**Habitat Restoration/ Enhancement or Creation**	**Road Bed & Berm Material**	**Asphalt/Cement & Other**	**Aggregates**	**Notes**
																		contact sites
Federal-Aid Highway Act				X							X				X	X	X	none
Federal Railroad Administration				X							X				X	X	X	none
State Regulations																		
CT and NY Solid Waste Rules				X			X			X	X	X			X	X	X	none
CT and NY Brownfield Sites											X							none
CT and NY Department of Transportation				X						X	X	X	X		X	X	X	none
CT, NY and RI Coastal Management	1	1	X		X	X		X	X	1	1		1	1	1	1		[1]applicable for projects located within the defined State coastal zone, activities listed under interstate consistency, and those which may affect the coastal area
CT and NY Grants/ Beneficial Reuse Programs								X	X		X			X				none

Table 2-1. Summary of Applicability of Federal and State Regulations and Programs on Placement Options (continued).

Regulations	**Open-Water Placement**		**Confined Placement**		**Confined Placement/ Beneficial Use**			**Beneficial Use**										**Notes**
	Unconfined	**Confined**	**In-Harbor CAD Cell**	**Landfill Placement**	**Island CDF**	**Shoreline CDF**	**Upland CDF**	**Nearshore Bar/Berm Placement Sites**	**Beach Renourishment**	**Landfill Cover/ Capping**	**Brownfield & Other Redevelopment**	**Mines & Quarries**	**Agriculture/ Aquaculture**	**Habitat Restoration/ Enhancement or Creation**	**Road Bed & Berm Material**	**Asphalt/Cement & Other**	**Aggregates**	
CT and NY Environmental Justice						X				1					1	1	1	[1]applicable to projects requiring construction of an "applicable facility"
CT Royalty Statute	1	1	1	1	1	1	1			1	1	1	1		1	1	1	[1]applicable only if material provides an economic benefit (sold for profit)
CT Regional Planning Organizations			1	1		1	1	1	1	1	1	1	1	1	1	1	1	[1]greater applicability for projects that include multiple towns
CT Municipal Regulations			1	X		X	X	1	X	X	X	X	X	1	X	X	X	[1]although these types of management options would not take place directly within municipal boundaries, their direct proximity warrants coordination
CT Proposed Beneficial Use General Permit				X			X				X				X	X	X	none
NY Counties	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	[1]applicable if the in-water, near shore, or upland location was determined to directly affect properties owned or operated by the county

Table 2-1. Summary of Applicability of Federal and State Regulations and Programs on Placement Options (continued).

Regulations	Open-Water Placement		Confined Placement		Confined Placement/ Beneficial Use			Beneficial Use										Notes
	Unconfined	Confined	In-Harbor CAD Cell	Landfill Placement	Island CDF	Shoreline CDF	Upland CDF	Nearshore Bar/Berm Placement Sites	Beach Renourishment	Landfill Cover/ Capping	Brownfield & Other Redevelopment	Mines & Quarries	Agriculture/ Aquaculture	Habitat Restoration/ Enhancement or Creation	Road Bed & Berm Material	Asphalt/Cement & Other	Aggregates	
NY Municipalities, Boroughs, and Villages	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	[1] applicable if the in-water, near shore, or upland location was determined to directly affect properties owned or operated by the municipality
NY Possible Future Regulations				X			X			X	X	X	X		X	X	X	none
RI CRMC **RI Department of Environmental Management**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	RI has a statutory provision for all dredged material to be disposed of beneficially (if suitable) at 46-23-6 et. seq.
RI Department of Revenue/ Division of Motor Vehicles				X						X	X	X			X	X	X	none
RI Washington County Planning Council			1	1		1	1	1	1	1	1	1	1	1	1	1	1	[1] greater applicable for projects that include multiple towns

X = regulation is applicable to this alternative type. Unpopulated cells = regulation is not applicable to this alternative type.

Note: Connecticut Coastal Zone Consistency determinations are handled by the CTDEEP; New York Coastal Zone Consistency determinations are handled by the NYSDOS; and Rhode Island requires a formal Federal Coastal Zone Consistency determination from the RI CRMC.

Under CWA Section 401, an applicant proposing any activity requiring a Federal permit that will result in a discharge to water or wetlands subject to Federal jurisdiction is required to obtain a state water quality certification (WQC) to ensure that the project will comply with state water quality standards. Examples of Federal licenses and permits subject to Section 401 WQC include CWA Section 404 permits for discharge of dredged or fill material issued by the USACE and Rivers and Harbors Act Section 9 and 10 permits issued by the USACE for activities that have a potential discharge in navigable waters.

The following paragraphs discuss the Section 401 WQC process for each state within the Long Island Sound study area.

Connecticut

Placement of dredged material directly within waters of the state or within an area that may affect those waters triggers a requirement for a WQC. The Office of Long Island Sound Programs administers WQCs for open water and coastal areas, and the Inland Water Resources Division administers WQCs for all other state waters (Table 2-1). The discharge must be consistent with the Federal CWA and the Connecticut water quality standards. In making a decision on a request, CTDEEP must consider the effects of proposed discharges on both surface water and groundwater quality and existing designated uses of waters of the state.

New York

NYSDEC regulates any applicant for a Federal license or permit who seeks to conduct an activity that may result in a discharge to the waters of the state, including all navigable waters, all wetlands, watercourses, and natural and man-made ponds (Table 2-1). The applicant must obtain a WQC from NYSDEC that the discharge is consistent with the Federal CWA and New York water quality standards. In making a decision on a request, NYSDEC must consider the effects of proposed discharges on both surface water and groundwater quality and existing designated uses of waters of the state. Activities for which the USACE has issued a Nationwide 404 Permit and for which NYSDEC has correspondingly issued a generic statewide WQC are exempt from the requirement to obtain an individual WQC.

Rhode Island

The Rhode Island Department of Environmental Management (RIDEM) WQC program is responsible for ensuring compliance with state water quality regulations for projects that impact inland and coastal waters such as dredging, filling, water withdrawals, and site disturbances. Updated *Rules and Regulations for Dredging and Management of Dredged Material* (Regulation # DEM-OWR-DR-02-03) ensure that dredging and management of the associated dredged material are conducted in such a way as to protect groundwater quality, surface water quality, fish and wildlife, and habitat resources. In-water placement of dredged material is prohibited unless:

- There is no practicable alternative that would have less adverse impact on the aquatic ecosystem and that would not itself have significant adverse environmental consequences;
- Placement will not cause or contribute to violations of applicable water quality standards;
- Placement will not cause or contribute to significant degradation of waters of the state; or

- Appropriate and practicable steps to minimize the potential adverse impacts of the placement on the aquatic environment have been taken.

2.1.2 Marine Protection, Research, and Sanctuaries Act

MPRSA regulates the ocean placement of waste, provides for a research program on ocean placement, and provides for the designation and regulation of marine sanctuaries. Specifically, MPRSA regulates dredged material placement in waters seaward of the official U.S. Baseline, which are referred to as "ocean waters" under the statute (33 U.S.C. § 1402(b)). The Baseline is recognized as the low-water line along the coast. These waters include the "territorial sea," a 3-mile (mi) band extending seaward of the Baseline. While CWA Section 404 jurisdiction extends to the seaward edge of the territorial sea, thus overlapping with MPRSA jurisdiction within the territorial sea, EPA regulations direct that only the MPRSA program will be applied to regulate dredged material placement in the territorial sea, while the CWA program will be applied to discharges of fill material (40 CFR § 230.2(b)).

MPRSA Section 102 authorizes EPA to issue ocean permits for the transport to and placement of materials into the oceans, excluding wastes regulated by the USACE (primarily dredged material). Section 102 also directs the EPA Administrator to set criteria for the review of ocean placement permits. To protect critical ocean areas, EPA may designate the sites and time periods at which ocean placement can occur. Federal agencies must obtain EPA approval to conduct ocean placement under MPRSA.

MPRSA Section 103 authorizes the USACE to issue permits for the ocean placement of dredged material (i.e., material excavated from navigable U.S. waters). Section 103(e) specifically gives the Secretary of the Army the option of issuing regulations instead of permits for material dredged from Federal projects. Under Section 103 (33 U.S.C. § 1413), the USACE may issue authorizations for ocean placement for specific projects at specific selected sites if the placement "*will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities*" (33 U.S.C. § 1413(a)). In making that determination, the USACE must apply the site designation evaluation criteria described in MPRSA Section 102 and must determine whether there are other possible methods of placement or other appropriate locations for the placement (33 U.S.C. § 1413(b)). In considering appropriate locations, the USACE must, to the maximum extent feasible, use the sites designated under MPRSA Section 102 and obtain EPA concurrence on the selected site. Placement at a selected site is limited to 5 years, unless the site is subsequently designated as a placement site by EPA or circumstances (set forth in the statute) require an additional 5-year placement period.

The waters of Long Island Sound lie landward of the Baseline and, thus, would be expected to be subject to regulation under CWA Section 404 and *not* MPRSA. However, in 1980, MPRSA was amended to add Section 106(f) to the statute (33 U.S.C. § 1416(f)). This provision is commonly referred to as the "Ambro Amendment," named after Congressman Jerome Ambro who is said to have championed the provision. MPRSA § 106(f) (33 U.S.C. § 1416(f)) was itself amended in 1990; as currently enacted, it reads as follows:

> "In addition to other provisions of law and notwithstanding the specific exclusion relating to dredged material in the first sentence of this title, the dumping of dredged material in Long Island Sound from any Federal Project (or pursuant to Federal authorization) or from a dredging project by a non-Federal applicant exceeding 25,000 cubic yards shall comply with the requirements of this subchapter."

As a result of this provision, the placement in Long Island Sound of dredged material from Federal projects (both projects carried out under the USACE Civil Works program and the actions of other Federal agencies), or from non-Federal projects involving more than 25,000 CY of material, must satisfy the requirements of both CWA Section 404 and MPRSA. Placement from non-Federal projects involving less than 25,000 CY of material, however, is subject only to CWA Section 404.

Regulations implementing MPRSA were promulgated by EPA and are codified pursuant to MPRSA § 102(a) (33 U.S.C. § 1412(a)), at 40 CFR Parts 220 to 229 (referred to as the Ocean Dumping Regulations). Title I of MPRSA authorized EPA and the USACE to regulate placement in U.S. ocean waters. EPA and the USACE share responsibility for managing dredged material. EPA is also responsible for reviewing and permitting any proposals to place anything other than dredged material into ocean waters (33 U.S.C. Section 1412(a) and (b)). In 1992, Congress amended MPRSA to permit states to adopt ocean placement standards more stringent than Federal standards and to require that permits conform to long-term management plans for designated placement sites, to ensure that permitted activities are consistent with expected uses of the site.

Like the CWA, MPRSA prohibits the placement of dredged materials into water under its jurisdiction unless placement is conducted in compliance with a permit issued by the USACE or approval under the USACE Civil Works program (33 U.S.C. §§ 1411(a) and 1413(a)). USACE dredged material placement permits and authorizations are issued under MPRSA Section 103 and may include conditions deemed necessary by the USACE related to the type of material to be placed, time of placement, and other matters (U.S.C. §§ 1413 and 1414(a)). The USACE issues a permit, or approves a project under its Civil Works authority, only if it has determined that dredged material placement "will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities" (33 U.S.C. § 1413(a)). Similar to the CWA Section 404 program, however, the USACE makes MPRSA Section 103 determinations by the standards set forth in EPA regulations (33 U.S.C. § 1413(b)).

USACE permit determinations and Civil Works approvals are also subject to any applicable requirements of other laws (e.g., the Endangered Species Act, CZMA). In addition, USACE authorizations under MPRSA Section 103 are subject to EPA review and concurrence, including the potential for EPA to either veto or add conditions to the permit or to the Civil Works approval (33 U.S.C. §§ 1413(c) and 1414(a)). As with the CWA Section 404 program, the USACE does not issue permits under MPRSA for USACE dredged material placement projects under its Civil Works authority; rather, it authorizes its own placement projects by applying the same substantive and procedural requirements “in lieu of” the permit procedures (33 U.S.C. § 1413(e)). Such USACE authorizations for USACE projects are subject to EPA review.

The USACE and EPA are required to review and evaluate authorizations for placement using criteria that include the following:

- The need for the proposed placement;
- The effect of the placement on human health and welfare; fisheries resources, plankton, fish, shellfish, wildlife, shorelines, and beaches; and marine ecosystems;
- The persistence and permanence of the effects of the placement;
- The effect of placing particular volumes and concentrations of such materials;
- Appropriate locations and methods of placement or recycling, including land-based alternatives; and
- The effect on alternate uses of oceans, such as scientific research and utilization of living and non-living resources.

2.1.3 Coastal Zone Management Act

In 1972, CZMA established a national program to encourage coastal states to develop and implement coastal zone management plans. Connecticut, New York, and Rhode Island have developed coastal zone management plans and programs that were Federally approved under CZMA. Section 307 of CZMA 1972, as amended, requires that if Federal agencies propose activities within or outside the coastal zone that may have a reasonably foreseeable effect on land or water use or natural resource of the coastal zone, the agencies must ensure that those activities are conducted in a manner which is consistent, to the maximum extent practicable, with the enforceable policies of approved state coastal management programs.

CZMA has particular relevance to any nearshore, beach, or inland placement activity within each state’s defined coastal zone boundary and adjacent states if the activity has a reasonably foreseeable effect, including those activities listed in each state’s coastal management plan under interstate consistency. CZMA is applicable to Federal, state, and local projects that will need a Federal license or permit or that receive Federal financial assistance.

Under CZMA, states can request interstate consistency, which allows a state to review Federal actions occurring in another state’s coastal zone when the Federal action will affect uses or resources in the state’s coastal zone. In the case of Long Island Sound, the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management has approved interstate reviews for Connecticut and New York with regard to actions pursuant to Section 404 of the CWA and Section 103 of MPRSA in Long Island Sound and Fishers Island Sound. Connecticut’s interstate activities list for actions pursuant to Section 404 of the CWA and Section 103 of MPRSA items also includes the Byram River, Little Narragansett Bay, and/or the Pawcatuck River in Rhode Island. Based on this authority, Connecticut and New York will review all CWA and MPRSA permitted actions that occur in the Long Island Sound study area.

2.1.4 USACE Permitting Authority

A USACE permit is required for any discharge of dredged material in waters of the United States by a party other than the USACE. The USACE has jurisdiction for this permitting under Section 10 of the Rivers and Harbors Act (33 U.S.C. § 403) and, depending on where the placement occurs, under either CWA Section 404 or MPRSA Section 103.

The USACE is the lead Federal agency for all permit actions dealing with open-water placement of dredged material. To ensure that this placement will not unduly degrade or endanger the marine environment and will not adversely affect human health, the marine environment, or other ocean uses, the USACE works cooperatively with Federal and state regulatory and resource agencies throughout the permitting process. Material placed within the coastal zone must receive state coastal consistency, and state statutes and local zoning laws control where and how dredged material is placed in the upland outside of the coastal zone.

Under Section 404 of CWA, with the exception of EPA, the role of these regulatory and resource agencies is advisory; but the USACE rarely, if ever, issues a permit if any of these agencies advise against it. Under Section 103 of MPRSA, however, the USACE cannot issue a permit until EPA determines that the placement will comply with the criteria in 40 CFR 227.4. Thus, for projects placing more than 25,000 CY of dredged material in Long Island Sound and for all dredged-material placements from Federal projects, it is the EPA and not the USACE that has final decision-making authority.

2.2 DREDGED MATERIAL TESTING AND CLASSIFICATION

One of the first steps in the permit application review process for both CWA and MPRSA projects is for the USACE, working with the state and Federal resource agencies and the applicant, to develop sampling and testing plans to determine the suitability of the material placement. The USACE solicits comments from the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), EPA, the CTDEEP Office of Long Island Sound Programs, the state of New York, and the RI CRMC as described in the State of Rhode Island Coastal Resources Management Program, as appropriate, in preparing the sampling and testing plans that initiate the permit process.

Any proposal for the placement of dredged material from a particular project must begin with an examination of the nature of the material. Federal and non-Federal projects evaluated under MPRSA or CWA are subjected to the same qualitative analysis. Applicants perform sampling and analysis based on these plans, and the USACE and Federal agencies review the results according to several testing protocols designed for regional and national use. In this way, they determine the suitability of the material for placement at a given site.

National guidance for determining whether dredged material is acceptable for open-water placement is provided in the Ocean Testing Manual (also known as the Green Book) (EPA and USACE, 1991). The Inland Testing Manual (EPA and USACE, 1998) provides guidance for CWA Section 404 projects. A Regional Implementation Manual, consistent with the Green Book and the Inland Testing Manual, provides specific testing and evaluation methods for dredged material projects at specific sites or groups of sites. The testing guidance manuals use a tiered approach that was developed with reference to the requirements of CWA, MPRSA and the Ocean Dumping regulations, and the 2004 Regional Implementation Manual (EPA and USACE, 2004b) for dredged material testing and evaluation in the Long Island Study Area.

Guidance for testing materials proposed for dredging and placement at an island, nearshore, or upland CDF can be found in USACE (2003). The guidance provides methods for the assessment, where appropriate, of potential effects of the proposed placement of dredged material in upland, nearshore, and island CDFs. It uses physical, chemical, and biological analyses as necessary to provide effects-based conclusions within a tiered framework regarding potential contaminant-related impacts outside the CDF associated with the five potential pathways: effluent, precipitation runoff, leachate and seepage, volatilization, and direct uptake by wetland and terrestrial plants and animals (USACE and EPA, 1992).

Whether or not any particular material from a dredging project is suitable for open-water placement, beneficial use (such as beach nourishment, marsh creation, or other aquatic habitat development), use as structural fill, or any other commercial application first depends on an evaluation of its physical properties. Material found, through physical testing, to consist of clean sand, gravel, rock, or geological parent material (such as glacial tills and marine clays) may in certain circumstances be excluded from further testing (40 CFR § 227.13). This material is often made available for consideration in beneficial uses as described in further detail in subsequent chapters.

Material that includes silts, material with high organic content, and other shoal material from harbors and areas with a history of contamination and industrial use are subjected to additional chemical testing to determine the relative likelihood of suitability. For materials exhibiting higher concentrations of contaminants in comparison to reference site values, project proponents may elect not to incur the cost of further testing and may investigate non-open-water options such as containment and treatment. For materials with chemical test results that do not exhibit high concentrations of contaminants, or where the project proponents wish to maintain the option of open-water placement and other uses, the sediment is subjected to further tests aimed at predicting the biological response to exposure to the material during different phases of the placement process. These tests are generally described as bioassay (toxicity) tests, and bioaccumulation (tissue uptake of contaminants) tests.

Toxicity tests consist of exposing test organisms to the proposed dredged material and comparing survivability rates to selected organisms exposed to both reference and control materials. A reference material is whole sediment collected from a site that is near, but is not under the influence of, a placement site. A control material is a whole sediment that is essentially free of contaminants and is used routinely to assess the acceptability of a toxicity test.

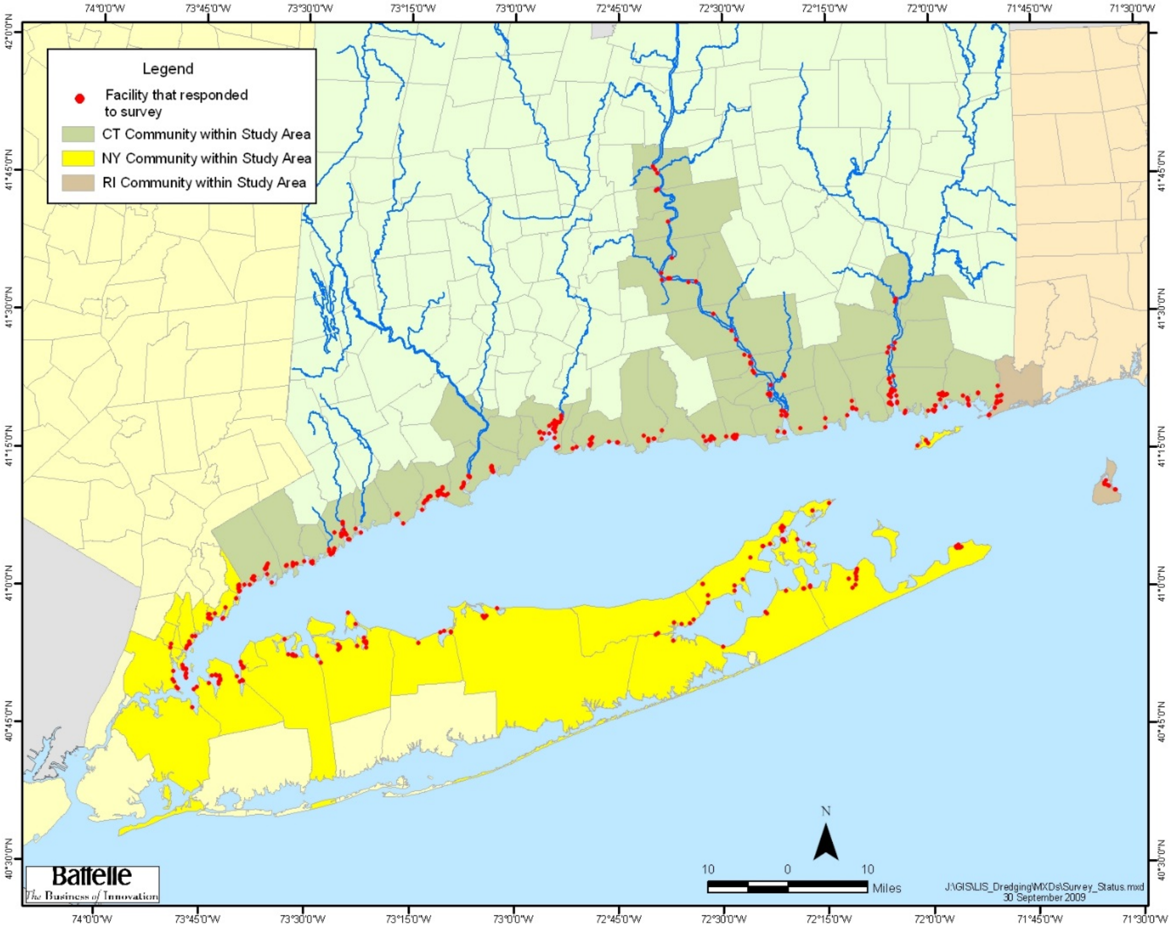
Where the dredged material exhibits greater toxicity to test species than the reference sediments (using statistical tests and nationally developed interpretation guidance), project proponents may elect to forgo any further cost of testing for suitability for open-water placement and seek alternative placement methods. Material that exhibits toxicity comparable to the reference sediments may also be required to undergo bioaccumulation testing before any determination on suitability for open-water placement can be made. In general terms, bioaccumulation involves a long exposure of test organisms to representative sediment proposed for dredging, followed by analysis of their tissues to determine the potential for uptake of contaminants from the proposed dredged material. The test results are evaluated to determine the risk of exposure to ecological and human health. Dredged material that is determined through these testing protocols to pose no unacceptable risk to the human or ecological health is deemed suitable for ocean placement. These findings may be accompanied by placement management requirements.

The unique nature of the regulatory requirements in Long Island Sound, specifically the dual application of MPRSA and CWA, results in differing regulatory approaches for dredged materials, depending on the proponent and the size of the proposed dredging project (see the discussion in Section 2.1.2 on the Ambro Amendment). Non-Federal projects seeking to place 25,000 CY of dredged material or less are not subject to the requirements of MPRSA. Materials from these smaller dredging projects that exhibit potential for adverse impacts may sometimes still be placed in open water under CWA with proper placement management.

2.3 AUTHORIZED FEDERAL PROJECTS AND AMOUNTS

The dredging needs in the study area were updated in 2009 (USACE, 2009) and again in 2015 (as described in Section 1.1 of this PEIS). The dredging needs study area includes all navigable rivers, harbors, and coastal waters in Long Island Sound in Connecticut and New York east of Throgs Neck to a line drawn from Westerly, Rhode Island, south to Montauk Point, including the waters of the Peconic Bay and Gardiners Bay shorelines in New York; the Fishers Island Sound shores of Connecticut, New York, and Rhode Island; and the Block Island Sound shores of New York and Rhode Island (Figure 2-1). The Connecticut River below Hartford is included, as is the Thames River to Norwich, the Housatonic River to Derby, and the Peconic River to Riverhead, New York. All harbors and all port- or navigation-dependent facilities in this area, whether Federal or not, are included in the study area. Of the 731 facilities surveyed, 451 facilities (61.7%) provided responses. The locations of the facilities that responded to the 2009 dredging needs study questionnaire are shown in Figure 2-1.

Dredging centers were used to determine where the largest quantities of dredged material would originate, as determined from information returned on a dredging needs questionnaire. The centers are based on geographic location and logical points of origin for dredged material placement. The study area was divided into 27 dredging centers; their locations are shown in Figure 2-2. Table 2-2 lists the dredging centers and the communities under the purview of each center.



Source: (USACE, 2009).

Figure 2-1. Location of Navigation Dependent Facilities that Responded to the 2009 Long Island Sound Dredging Needs Study.

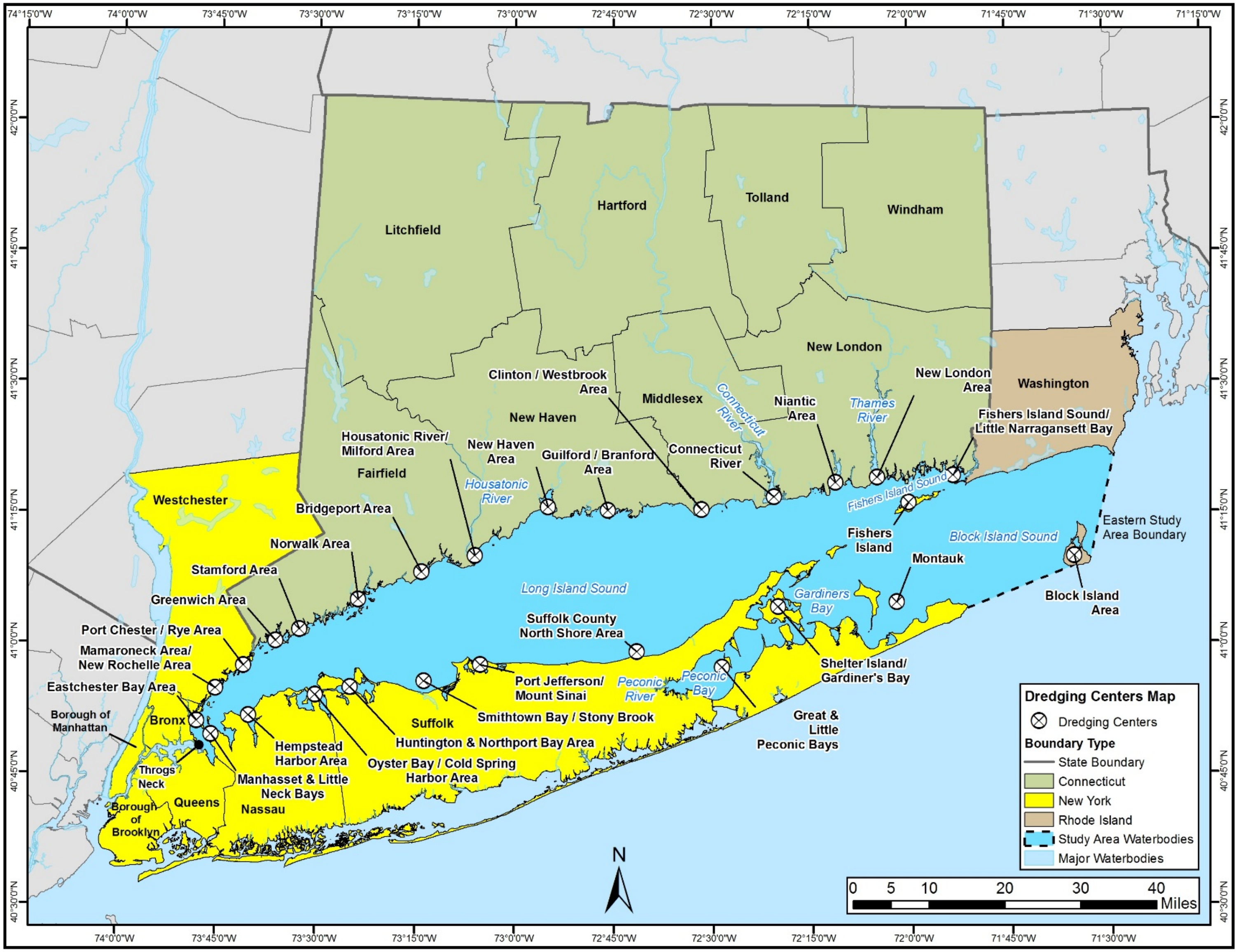


Figure 2-2. Dredging Centers within Long Island Sound.

Table 2-2. Long Island Sound Dredging Centers.

Dredging Center	City/Town	County	State
Block Island Area	Block Island (New Shoreham)	Washington	RI
Fishers Island	Fishers Island	Suffolk	NY
Fishers Island Sound-Little Narragansett Bay Area	Mystic	New London	CT
	Noank	New London	CT
	Pawcatuck	New London	CT
	Stonington	New London	CT
	Westerly	Washington	RI
New London Area	Groton	New London	CT
	Montville	New London	CT
	New London	New London	CT
	Norwich	New London	CT
	Ledyard	New London	CT
	Preston	New London	CT
Niantic Area	Waterford	New London	CT
	Niantic (East Lyme)	New London	CT
Connecticut River	Chester	Middlesex	CT
	Cromwell	Hartford	CT
	Deep River	Middlesex	CT
	East Haddam	Hartford	CT
	East Hampton	Middlesex	CT
	East Hartford	Hartford	CT
	Essex	Middlesex	CT
	Glastonbury	Hartford	CT
	Haddam	New London	CT
	Hartford	Hartford	CT
	Lyme	New London	CT
	Middletown	Middlesex	CT
	Old Lyme	New London	CT
	Old Saybrook	Middlesex	CT
	Portland	Middlesex	CT
	Rocky Hill	Hartford	CT
	Wethersfield	Hartford	CT
Clinton-Westbrook Area	Clinton	Middlesex	CT
	Westbrook	Middlesex	CT
Guilford-Branford Area	Branford	New Haven	CT
	Guilford	New Haven	CT
	Madison	New Haven	CT
New Haven Area	East Haven	New Haven	CT
	New Haven	New Haven	CT
	West Haven	New Haven	CT
Housatonic River-Milford Area	Derby	Fairfield	CT
	Milford	New Haven	CT
	Orange	Fairfield	CT
	Shelton	Fairfield	CT
	Stratford	Fairfield	CT

Table 2-2. Long Island Sound Dredging Centers (continued).

Dredging Center	City/Town	County	State
Bridgeport Area	Bridgeport	Fairfield	CT
	Fairfield	Fairfield	CT
Norwalk Area	Darien	Fairfield	CT
	Norwalk	Fairfield	CT
	Southport	Fairfield	CT
	Westport	Fairfield	CT
Stamford Area	Stamford	Fairfield	CT
Greenwich Area	Greenwich	Fairfield	CT
Port Chester-Rye Area	Rye	Westchester	NY
Mamaroneck Area-New Rochelle Area	Mamaroneck	Westchester	NY
	New Rochelle	Westchester	NY
Eastchester Bay Area	Bronx	Bronx	NY
	Mount Vernon	Westchester	NY
	Pelham	Westchester	NY
Manhasset and Little Neck Bays Area	Great Neck	Nassau	NY
	Kings Point	Nassau	NY
	Manhasset	Nassau	NY
	Port Washington	Nassau	NY
	Queens	Queens	NY
Hempstead Harbor Area	North Hempstead	Nassau	NY
	Oyster Bay	Nassau	NY
Oyster Bay-Cold Spring Harbor Area	Huntington	Suffolk	NY
	Oyster Bay	Nassau	NY
Huntington and Northport Bay Area	Huntington	Suffolk	NY
Smithtown Bay-Stony Brook Area	Brookhaven	Suffolk	NY
	Huntington	Suffolk	NY
	Smithtown	Suffolk	NY
Port Jefferson-Mount Sinai Area	Brookhaven	Suffolk	NY
Suffolk County North Shore Area	Brookhaven	Suffolk	NY
	Riverhead	Suffolk	NY
	Southold	Suffolk	NY
Great and Little Peconic Bays Area	Riverhead	Suffolk	NY
	Southampton	Suffolk	NY
	Southold	Suffolk	NY
Shelter Island-Gardiner's Bay Area	East Hampton	Suffolk	NY
	Shelter Island	Suffolk	NY
	Southampton	Suffolk	NY
	Southold	Suffolk	NY
Montauk Area	East Hampton	Suffolk	NY

2.3.1 USACE and Other Federal Projects

The locations of USACE Navigation Projects and other Federal agency projects in the study area identified in the Dredging Needs Study (USACE, 2009) are shown in Figure 2-3. Projected dredged material volumes are shown in Table 2-3. The 30-year projected dredging volumes for USACE Navigation Projects presented in the table were updated in 2014 by the USACE.

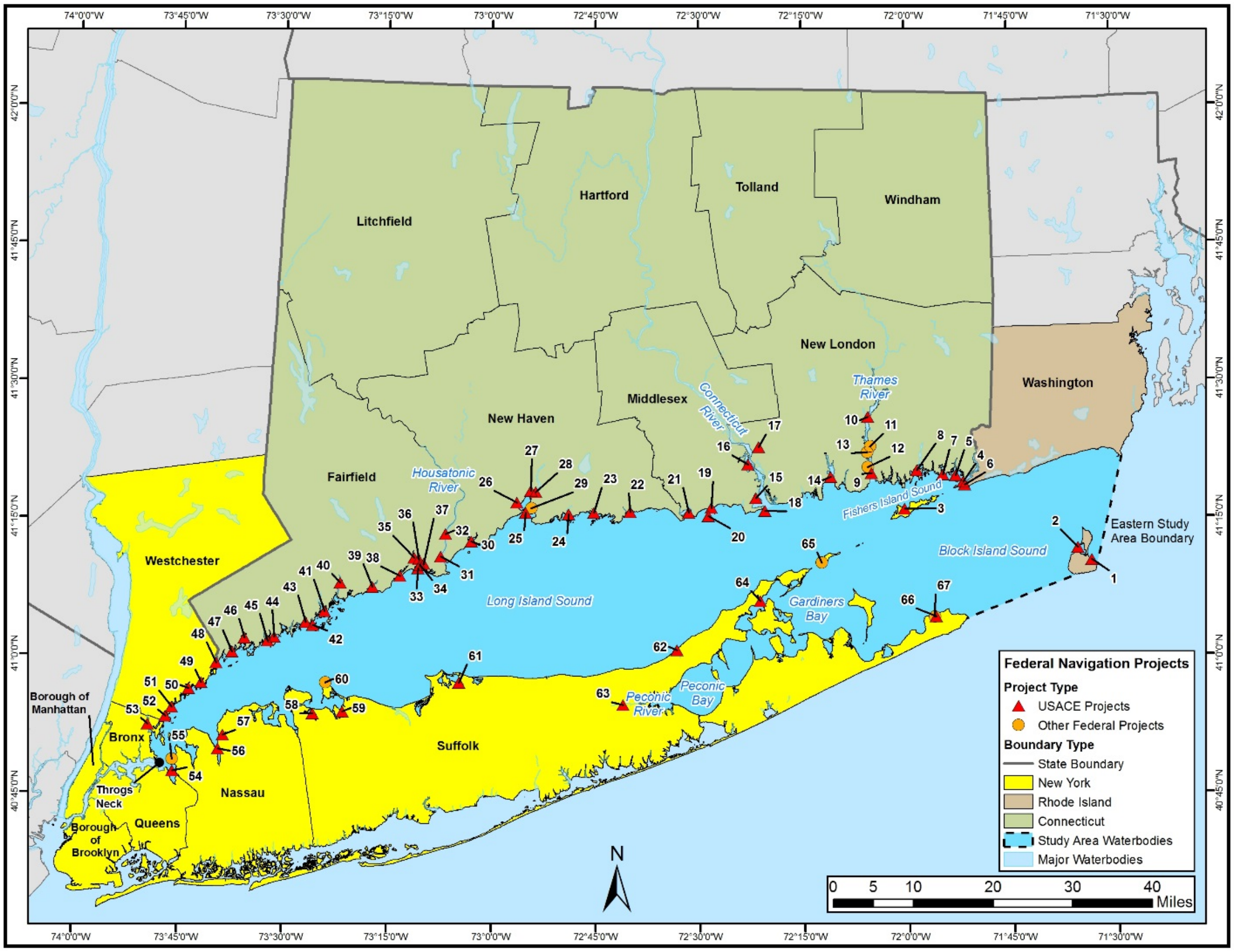


Figure 2-3. Map of Federal Dredging Projects in Long Island Sound.

Table 2-3. Projected Dredging Volumes of USACE and other Federal Navigation Projects Within Long Island Sound.

Label	Project Type	Project Name	Town	State	Volume (CY)[1]
1	USACE	Block Island Harbor of Refuge	New Shoreham	RI	210,200
2	USACE	Great Salt Pond	New Shoreham	RI	140,000
3	USACE	Hay (West) Harbor	Fishers Island	NY	12,000
4	USACE	Pawcatuck River	Stonington	CT	173,000
5	USACE	Little Narragansett Bay	Stonington	CT	153,100
6	USACE	Watch Hill Cove	Stonington	CT	12,200
7	USACE	Stonington Harbor	Stonington	CT	6,600
8	USACE	Mystic Harbor	Groton & Stonington	CT	555,100
9	USACE	New London Harbor	New London	CT	816,200
10	USACE	Thames River	New London & Groton	CT	3,734,50
11	Other	Naval Submarine Base, New London	Groton	CT	475,000
12	Other	U.S. Coast Guard Station, New London	New London	CT	4,000
13	Other	U.S. Coast Guard Academy	New London	CT	110,000
14	USACE	Niantic Bay and Harbor	East Lyme & Waterford	CT	18,000
15	USACE	North Cove	Old Saybrook	CT	872,700
16	USACE	Essex Cove	Essex	CT	25,000
17	USACE	Eightmile River	Lyme	CT	45,200
18	USACE	Connecticut River Below Hartford	Various	CT	3,448,40
19	USACE	Patchogue River	Westbrook	CT	120,000
20	USACE	Duck Island Harbor of Refuge	Westbrook	CT	1,948,00
21	USACE	Clinton Harbor	Clinton	CT	164,900
22	USACE	Guilford Harbor	Guilford	CT	135,800
23	USACE	Stony Creek Harbor	Branford	CT	132,700
24	USACE	Branford Harbor	Branford	CT	289,200
25	USACE	New Haven Harbor	New Haven	CT	7,740,00
26	USACE	West River	New Haven	CT	227,300
27	USACE	Mill River	New Haven	CT	201,500
28	USACE	Quinnipiac River	New Haven	CT	217,100
29	Other	U.S. Coast Guard Sector Long Island Sound	New Haven	CT	60,000
30	USACE	Milford Harbor	Milford	CT	199,500
31	USACE	Housatonic River downstream of	Stratford to Ansonia	CT	1,237,00
32	USACE	Housatonic River upstream of	Stratford to Ansonia	CT	203,900
33	USACE	Bridgeport Harbor - Outer Harbor[2]	Bridgeport	CT	665,600
34	USACE	Bridgeport Harbor - Inner Harbor[2]	Bridgeport	CT	1,034,40
35	USACE	Pequonnock River[2]	Bridgeport	CT	164,700
36	USACE	Yellow Mill Channel[2]	Bridgeport	CT	126,900
37	USACE	Johnsons Creek	Bridgeport	CT	88,000
38	USACE	Black Rock Harbor	Bridgeport	CT	619,500

Table 2-3. Projected Dredging Volumes of USACE and other Federal Navigation Projects Within Long Island Sound (continued).

Label	Project Type	Project Name	Town	State	Volume (CY)[1]
39	USACE	Southport Harbor	Fairfield	CT	78,600
40	USACE	Westport Harbor	Westport	CT	50,700
41	USACE	Norwalk Harbor	Norwalk	CT	687,000
42	USACE	Wilsons Point	Norwalk	CT	618,900
43	USACE	Fivemile River	Darien & Norwalk	CT	55,400
44	USACE	Westcott Cove	Stamford	CT	68,700
45	USACE	Stamford Harbor	Stamford	CT	630,600
46	USACE	Mianus River	Greenwich	CT	137,700
47	USACE	Greenwich Harbor	Greenwich	CT	427,700
48	USACE	Port Chester Harbor	Rye	NY	366,000
49	USACE	Milton Harbor	Rye	NY	140,400
50	USACE	Mamaroneck Harbor	Mamaroneck	NY	210,100
51	USACE	Echo Bay	New Rochelle	NY	59,200
52	USACE	New Rochelle Harbor	New Rochelle	NY	82,600
53	USACE	Eastchester Creek	Bronx	NY	397,800
54	USACE	Little Neck Bay	Bayside & Douglaston	NY	1,114,40
55	Other	Yocum Sailing Center, U.S. Merchant Marine Academy	Great Neck	NY	66,400
56	USACE	Hempstead Harbor	Roslyn	NY	186,900
57	USACE	Glen Cove Creek	Glen Cove	NY	53,500
58	USACE	Huntington Harbor	Huntington	NY	55,600
59	USACE	Northport Harbor	Huntington	NY	101,600
60	Other	U.S. Coast Guard Station, Eatons	Northport	NY	16,000
61	USACE	Port Jefferson Harbor	Brookhaven	NY	0
62	USACE	Mattituck Harbor and Inlet	Mattituck	NY	113,200
63	USACE	Peconic River	Riverhead	NY	13,300
64	USACE	Greenport Harbor	Greenport	NY	3,200
65	Other	U.S. Department of Homeland	Orient Point/Plum Island	NY	20,000
66	USACE	Lake Montauk Harbor	Montauk	NY	193,200
67	Other	U.S. Coast Guard Station	Montauk	NY	0

[1] Volumes are totals for both maintenance and improvement dredging.

[2] The Bridgeport Harbor Federal Navigation Project and associated sub-projects of Pequonnock River and Yellow Mill Channel are the subject of a separate DMMP currently being finalized by the USACE, which will be summarized in the regional DMMP (USACE, 2012). The base plan for these projects has already been defined, and they were not included as part of the alternative site screening for the Long Island Sound PEIS.

2.3.2 Non-Federal Projects

Dredging needs for non-Federal navigation projects in Rhode Island, Connecticut, and New York in and around Long Island Sound were assessed by dredging center only (see Figure 2-2), not by individual dredging project (Table 2-4). Note: data for non-Federal projects are included for informational purposes only; this PEIS analyzes USACE Navigation Projects and other Federal agency projects only.

Table 2-4. Projected Dredging Volumes from the Dredging Centers (Non-Federal Projects).

Dredging Center	Projected Volume[1] (CY)
Block Island Area	36,000
Fishers Island	53,200
Fishers Island Sound-Little Narragansett Bay Area	730,800
New London Area	794,700
Niantic Area	482,400
Connecticut River	1,428,400
Clinton-Westbrook Area	809,300
Guilford-Branford Area	481,800
New Haven Area	2,410,100
Housatonic River-Milford Area	220,400
Bridgeport Area	657,000
Norwalk Area	358,900
Stamford Area	324,600
Greenwich Area	227,000
Port Chester-Rye Area	148,000
Mamaroneck Area-New Rochelle Area	283,800
Eastchester Bay Area	31,700
Manhasset and Little Neck Bays Area	363,200
Hempstead Harbor Area	90,700
Oyster Bay-Cold Spring Harbor Area	65,000
Huntington and Northport Bay Area	3,177,500
Smithtown Bay-Stony Brook Area	1,062,600
Port Jefferson-Mount Sinai Area	200,600
Suffolk County North Shore Area	61,400
Great & Little Peconic Bays Area	2,122,000
Shelter Island-Gardiner's Bay Area	1,689,600
Montauk Area	416,600

[1] Projected volumes are totals for both maintenance and improvement dredging.

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2.4 DREDGED MATERIAL CHARACTERISTICS OF THE STUDY AREA

General characteristics of the material previously tested and dredged from locations throughout the study area have been compiled in two places. The first is a narrative compilation of dredging projects permitted by the USACE since the late 1940s (USACE, 2014). The second is a sediment quality database developed by the State of Connecticut (CTDEEP, 2007), known as SQUID (Sediment Quality Information Database).

2.4.1 USACE Long Island Sound Harbor Characterization Data

Selected details of the Harbor Characterization of USACE Navigation Projects (USACE, 2014) and the Long Island Sound DMMP were used to support the dredged material suitability screening for this PEIS (Chapter 6). These reports include project-specific information such as date of last dredging, placement location, and volume of material dredged. Summaries of sediment characteristics from placement decision-making testing were also recorded, including factors such as the year of testing for open-water placement suitability, physical characteristics of the sediments (i.e., grain size), pollutant chemicals, and (when available) toxicological and bioaccumulation characteristics (Table 2-5). Table 2-6 provides sediment grain size information for each dredging center (i.e., non-USACE dredging projects).

Sediments deposited in regional estuaries, harbors, navigational channels and coastal waters are composed of materials of both upland and littoral origins. Since an appreciable fraction of the sediment discharged from upland areas has the potential to be contaminated, reduction and containment of sediment and contaminant sources within the watersheds are, therefore, a potentially effective option for the management of sediment within the Long Island Sound study area (Appendix E).

In general, dredged material generated from projects on the north shore of Long Island Sound in Rhode Island, Connecticut, and Westchester and Bronx Counties (New York) is predominantly fine-grained (USACE, 2014) (Table 2-5 and Table 2-6). Predominantly sandy material is generated from dredging sources on the north shore of Long Island, except for inner harbor basin areas and more westerly harbors in Nassau and Queens Counties that generate typically silty materials.

The historical data demonstrate that chemical testing of sediments increased in the 1970s and 1980s, with moderate to elevated contaminants found in association with the finer-grained, organic-rich sediments. However, available toxicity test results noted in the Harbor Characterization Report (USACE, 2014) indicate that most sediments were not acutely toxic. Although initial screening based on sediment grain size and distance from the dredging center will indicate which alternatives are most suitable, additional chemical and toxicity characterization will need to be conducted on a project-by-project basis.

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects.

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
Block Island Area	Block Island Harbor of Refuge – Entrance Channel, Inner Basin, and Anchorage	RI	2014	Nearshore off Crescent Beach	2013	Sand (0.1 – 12% fines)	N/A
	Block Island Harbor of Refuge –Anchorage SW Area and Inner Basin Corners	RI	N/A	N/A	N/A	Silt (24 – 69% fines)	N/A
	Great Salt Pond	RI	2013	Nearshore off Beach West of Sachem Pond	2012	Fine to Medium Sand	N/A
Fishers Island	Hay (West) Harbor	NY	1931	Unknown	N/A	Mixed Sand and Fine-Grained	N/A
Fishers Island Sound-Little Narragansett Bay Area	Pawcatuck River	CT	1948	Stonington Disposal Site in FIS	1948	Mud and sand	N/A
	Little Narragansett Bay – Entrance Channel	CT	2014 - 2015	Misquamicut Beach (nearshore) and Sandy Point Beach	2003	Sand (<2% fines)	N/A
	Little Narragansett Bay – Inner Bay Channel	CT	1948	NLDS or RISDS	2003	Silt (6 to 75% fines)	
	Watch Hill Cove	CT	1949	Napatree Beach	N/A	Sand	N/A
	Stonington Harbor	CT	1956	Stonington Disposal Site	N/A	Fine-Grained	N/A
	Mystic Harbor - Maintenance	CT	2014 - 2015	NLDS or RISDS	2006	Fine-Grained	Metals and polycyclic aromatic hydrocarbons (PAHs); sediments not acutely toxic

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Mystic Harbor - Improvement	CT	2014 - 2015	NLDS or RISDS	2006	Fine-Grained	Metals and PAHs; sediments not acutely toxic
New London Area	New London Harbor – Main Channel and Anchorage, 23-Foot Channel	CT	1984	NLDS	1984	Fine-Grained (66 – 100% fines)	Contamination low
	New London Harbor – 15-foot Shaws Cove	CT	1934	Unknown	1978	Sandy silt (68 – 86% fines)	Elevated chemistry
	Thames River – Lower Channels, Navy Base to Harbor	CT	1995-1996	NLDS	2000	Olive black or gray silty sand	Polychlorinated biphenyls (PCBs), PAHs and perylene
	Thames River – Upper Channel, to Norwich	CT	1966	NLDS or In-River	1973	Silt (up to 95% fines)	N/A
	Naval Submarine Base, New London - Suitable	CT	2009	NLDS and CLDS	2009	Fine-grained	Suitable
	Naval Submarine Base, New London - Unsuitable	CT	2009	CAD cells	2009	Fine-grained	Contaminated
	Naval Submarine Base, New London - Improvement	CT	N/A	N/A	N/A	Fine-grained	Suitable
	U.S. Coast Guard Station, New London	CT	N/A	N/A	N/A	Fine-grained	Suitable
	U.S. Coast Guard Academy	CT	N/A	N/A	N/A	N/A	N/A
Niantic Area	Niantic Bay and Harbor – Entrance Channel	CT	1970	Niantic DS	1977	Sand (4 – 10% fines)	N/A
	Niantic Bay and Harbor – Upper Channel	CT	1970	Niantic DS	1977	Sandy Silt (16 – 71% fines)	N/A

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
Connecticut River	North Cove	CT	2008-2009	CSDS and CLDS	1999	Fine-Grained (76 – 100% fines)	Sediments not acutely toxic
	Essex Cove	CT	1976	Notts Island	1974	Mixed sand and fine-grained (37 – 91% fines)	N/A
	Eightmile River	CT	1911	N/A	1977	Mixed sand and fine-grained (28 – 78% fines)	N/A
	Connecticut River Below Hartford – Entrance Bars	CT	2001	CSDS	2001	Fine-grained (33 – 66% fines)	Contamination low; sediments not acutely toxic
	Connecticut River Below Hartford – Lower Bars	CT	1991	CSDS; Notts Island	1977	Sand (<1% fines)	N/A
Clinton-Westbrook Area	Patchogue River – Entrance Channel	CT	2012	Nearshore off Hammonasset Beach or CSDS	2004	Sand to silty sand (0 – 38% fines)	Sediments not acutely toxic
	Patchogue River – Inner Harbor	CT	2012	CSDS	2004	Silt and clay (68 – 94% fines)	Sediments not acutely toxic
	Duck Island Harbor of Refuge	CT	1949	N/A	N/A	Sand	N/A
	Clinton Harbor – Entrance Channel	CT	2013	Nearshore off Hammonasset Beach	2003	Sand (12 – 16% fines)	Not contaminated
	Clinton Harbor – Inner Harbor	CT	1984	N/A	1975	Fine-grained (43 – 97% fines)	N/A
Guilford-Branford Area	Guilford Harbor – Entrance and Inner	CT	2014	CLDS	2013	Fine-Grained, Organic Sandy Silt	Contamination low

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Guilford Harbor – Middle	CT	2014	Nearshore	2013	Sand	Contamination low
	Stony Creek Harbor	CT	1995	CLDS	1992	Silt and Clay	Low concentrations of metals and PCBs
	Branford Harbor	CT	1989-1990	CLDS	1986	Fine-Grained	Moderately high concentrations of cadmium, copper, chromium, lead, arsenic and zinc
New Haven Area	New Haven Harbor	CT	2013-2014	CLDS	2010	Suitable Fine-Grained to Suitable Sand and Silt	PCBs and metals; sediments not acutely toxic
	West River	CT	1989	CLDS, Upland	1986	Silt and clay (89% fines)	Lead and copper
	Mill River	CT	1982	CLDS	1986	Organic Sandy Silt	Copper
	Quinnipiac River	CT	1982	CLDS	1986	Organic Sandy Silt	Copper
	U.S. Coast Guard Sector Long Island Sound	CT	N/A	NLDS & CAD cells	1998	Sand to Sandy Silt (5 to 62% fines)	N/A
Housatonic River-Milford Area	Milford Harbor – Entrance Channel and Outer Anchorage	CT	1988	Gulf Beach	1985 (chemistry); 2003 (grain size	Medium to fine sand	Low contaminants
	Milford Harbor – Inner Channels and Anchorages	CT	1988	CLDS	1985	Sandy to silty clay	Cadmium, Moderate to low contaminants

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Housatonic River downstream of I-95	CT	2013	Nearshore off Point No Point, Stratford	1999	Sand	Contamination low
	Housatonic River upstream of I-95	CT	1944-1945	Unknown	N/A	Expected to be sand and silty sand	N/A
Bridgeport Area	Bridgeport Harbor - Outer Harbor[1]	CT	1962-1963	Adjacent Beaches	2001	Coarse Grained	Sediment not acutely toxic
	Bridgeport Harbor – Inner Harbor[1]	CT	1961-1962	Bridgeport Disposal Site	1982	Fine-Grained Organic Silt	Moderately highly to highly contaminated
	Pequonnock River[1]	CT	1944	Bridgeport Disposal Site	2013 (chemistry); 1973 (grain size)	Gray or black organic silt	Relatively high levels of contaminants relative to reference material
	Yellow Mill Channel[1]	CT	1952	Bridgeport Disposal Site	2013 (chemistry); 1973 (grain size)	Gray or black organic silt	Relatively high levels of contaminants relative to reference material
	Johnsons Creek	CT	1963	Bridgeport Disposal Site	1973	Gray or black organic silt	Moderately high concentrations of metals and volatile solids
	Black Rock Harbor	CT	1982-1983	CLDS	1973 (chemistry); 1980 (grain size)	Fine-Grained (34 to 90% fines)	Moderate to high concentrations of metals, oil and grease, volatile solids, and other potential pollutants

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Southport Harbor – Entrance Channel	CT	2004	CLDS, Southport Disposal Site	1998	Sand (2 to 14% fines)	Contamination low
	Southport Harbor – Inner Harbor	CT	2004	CLDS, Southport Disposal Site	1998	Fine-grained (4 to 95% fines)	Contamination low
Norwalk Area	Westport Harbor	CT	1970	Historic WLIS-I site	2003-2004	Fine-Grained Silt and Clay	Metals, PAHS, pesticides, DDD and PCBs; sediments not acutely toxic
	Norwalk Harbor – Suitable	CT	2013	CLDS, WLDS or CAD cells	2000	Fine-Grained Clayey Silt	Suitable
	Norwalk Harbor – West Branch I-95 Area	CT	2013	CAD	2000	Fine-Grained Clayey Silt	Sediments acutely toxic
	Wilsons Point	CT	1892	Unknown	N/A	Mud and sand	N/A
	Fivemile River	CT	1999	CLDS, WLDS	1995 - 1998	Fine-Grained Silt and Clay	High levels of total organic carbon, a few metals, and volatile solids
Stamford Area	Westcott Cove - Sand	CT	1978	West Beach	1977	Coarse and Fine Sand	Low Contaminants
	Westcott Cove - Fines	CT	1978	City Park (Upland)	1977	Fine Sandy Organic Silt	Low Contaminants
	Stamford Harbor - Outer 18-Foot Channel & Anchorage	CT	1941-1944	Unknown	1976	Fine-grained	Low Contaminants
	Stamford Harbor - 15-Foot Upper Main & West Channel	CT	1963	Stamford Disposal Site	1976	Fine-Grained	Zinc, cadmium and lead
	Stamford Harbor - 12-Foot East Branch Channel	CT	1980	CLDS (capped)	1979	Fine-Grained	High to moderately high levels of contaminants

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
Greenwich Area	Mianus River	CT	1985	WLIS-III	2005	Black, Organic, Fine-Grained Silts	Low contaminants
	Greenwich Harbor – Entrance Channel – Suitable	CT	1968	Stamford Dumping Ground	2012	Silt and clay overlain by fine to medium sand	Suitable based on bioassay/bioaccumulation testing
	Greenwich Harbor – Entrance Channel, Inner Channel and Anchorages	CT	1951	Stamford Dumping Ground	2012	Silt and clay overlain by fine to medium sand	Unsuitable based on bioassay/bioaccumulation testing
Port Chester-Rye Area	Port Chester Harbor	NY	1990	WLIS-III, HARS	1994	Sand and gravel to silt	Elevated lead, zinc and nickel
	Milton Harbor	NY	1993	HARS	1992	Silt with some Clay	High levels of ammonia, phenols, arsenic, chromium, copper, mercury, nickel, lead, vanadium, and zinc
Mamaroneck-New Rochelle Area	Mamaroneck Harbor	NY	1999	CLDS	1998	Silt and clay	Low to moderate heavy metals and low PAHs
	Echo Bay	NY	1949	Unknown	2008	Silty sand and clay	Suitable
	New Rochelle Harbor	NY	1971	Stamford Dumping Ground	1991	Silty Sand	Sediments not acutely toxic
Eastchester Bay Area	Eastchester Creek - Suitable	NY	2010	Upland – NJ Brownfields	2009	Silt and Clay	N/A
	Eastchester Creek - Unsuitable		2010	Upland – NJ Brownfields	2009	Silt and Clay	Unsuitable
Manhasset and Little Neck Bays Area	Little Neck Bay	NY	1966-1968	Unknown	N/A	Expected to be mixed sandy and fine-Grained	N/A

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Yocum Sailing Center, U.S. Merchant Marine Academy	NY	2005-2006	Upland, WLIS	N/A	N/A	N/A
Hempstead Harbor Area	Hempstead Harbor	NY	1950	Unknown	1982 (grain size); 1976 (chemistry)	Sand with some silt and clay	Metals low or undetected
	Glen Cove Creek	NY	2007	Upland	1996	Silt and clay with some sand	Radiological contamination
Oyster Bay-Cold Spring Harbor Area	None	---	---	---	---	---	---
Huntington and Northport Bay Area	Huntington Harbor - Sand	NY	1941	Unknown	1971 (chemistry)	N/A	Elevated oil, grease, metals (mercury, lead, zinc)
	Huntington Harbor – Silt	NY	1941	Unknown	1971 (chemistry)	N/A	Elevated oil, grease, metals (mercury, lead, zinc)
	Northport Harbor - Sand	NY	1956	Unknown	1971 (chemistry)	N/A	Elevated oil, grease, metals (mercury, lead, zinc)
	Northport Harbor - Silt	NY	1956	Unknown	1971 (chemistry)	N/A	Elevated oil, grease, metals (mercury, lead, zinc)
	U.S. Coast Guard, Station Eatons Neck	NY	N/A	N/A	N/A	N/A	N/A
Smithtown Bay-Stony Brook Area	None	---	---	---	---	---	---
Port Jefferson-Mount Sinai Area	Port Jefferson Harbor - Sand	NY	1906	Unknown	1971 (chemistry)	N/A	Zinc and oil and metals (mercury, lead, and zinc)

Table 2-5. Sediment Characteristics and Past Dredging Activity by Dredging Center for USACE and Other Federal Agency Navigation Projects (continued).

Dredging Center	USACE/Federal Navigation Project	State	Year Last Dredged	Most Recent Placement Site Used	Year of Last Testing Results	Currently Anticipated Material Type(s)	Potential Chemical Characteristics
	Port Jefferson Harbor - Silt	NY	1906	Unknown	1971 (chemistry)	N/A	Zinc and oil and metals (mercury, lead, and zinc)
Suffolk County Northeast Shore Area	Mattituck Harbor and Inlet	NY	2014	Bailie's Beach (On-beach)	2003	Sand and Gravel or Silt and Clay	N/A
Great and Little Peconic Bays Area	Peconic River	NY	1948	Unknown	1971	N/A	Contamination low
Shelter Island-Gardiner's Bay Area	Greenport Harbor	NY	1939	Unknown	1971	N/A	Contamination low
	U.S. Department of Homeland Security-Plum Gut Harbor and Orient Point	NY	2007; 1993	Beach; Upland	N/A	N/A	N/A
Montauk Area	Lake Montauk Harbor	NY	2014	West Beach	2005	Sand to Gravel	N/A
	U.S. Coast Guard Station	NY	N/A	N/A	N/A	N/A	N/A

N/A = not available; PAHs = polycyclic aromatic hydrocarbons; PCB = polychlorinated biphenyls; DDD = dichlorodiphenyldichloroethane.

[1] The Bridgeport Harbor Federal Navigation Project, and associated sub-projects of Pequonnock River and Yellow Mill Channel, are the subject of a separate DMMP currently being finalized by the USACE, which will be summarized in the regional DMMP (USACE, 2012). The base plan for these projects has already been defined, and they were not included as part of the alternative site screening for the Long Island Sound PEIS.

Table 2-6. Sediment Grain Size Characteristics by Dredging Center for Non-Federal Projects.

Dredging Center	State	Year Last Dredged	Placement Sites Used	Currently Anticipated Material Types
Block Island Area	RI	N/A	N/A	N/A
Fishers Island Sound/Little Narragansett Bay Area	CT	2009	NLDS, CSDS, CLDS	Fine-Grained to Sand and Silt
Fishers Island	NY	2009	NLDS, WLDS, CLDS	Fine-grained
New London Area	CT	2006	N/A	Sand and silt
Niantic Area	CT	2002	NLDS	Sand and silt
Connecticut River	CT	2011	Gildersleeve Island, Upland, CSDS, CLDS	Silt and Clay to Sand and Gravel
Clinton/Westbrook Area	CT	2012	CSDS, CLDS	Fine-Grained Silt to Sand and Silt
Guilford/Branford Area	CT	2010	CLDS, WLDS	Silt and Clay to Sand and Silt
New Haven Area	CT	2010	CLDS, WLDS	Fine-Grained Silt to Sand and Silt
Housatonic River/Milford Area	CT	2011	CLDS	Fine-Grained to Sand and Silt
Bridgeport Area	CT	2011	CLDS, WLDS	Silt to Sand
Norwalk Area	CT	2011	CLDS, WLDS	Fine-Grained Silt to Fine Sand
Stamford Area	CT	2008	N/A	Sand and silt
Greenwich Area	CT	2012	CLDS, WLDS	Fine-grained
Port Chester/Rye Area	NY	2013	WLDS	Fine-grained
Mamaroneck/New Rochelle Area	NY	2012	N/A	Fine-grained
Eastchester Bay Area	NY	N/A	N/A	N/A
Manhasset & Little Neck Bays	NY	N/A	N/A	N/A
Hempstead Harbor Area	NY	N/A	N/A	N/A
Oyster Bay/Cold Spring Harbor Area	NY	2013	N/A	Sand
Huntington & Northport Bay Area	NY	2012	WLDS	Fine-grained
Smithtown Bay/Stony Brook	NY	N/A	N/A	N/A
Port Jefferson/Mount Sinai	NY	N/A	N/A	N/A
Suffolk County North Shore Area	NY	N/A	N/A	N/A
Great & Little Peconic Bays	NY	N/A	N/A	N/A
Shelter Island/Gardiner’s Bay	NY	N/A	N/A	N/A
Montauk	NY	N/A	N/A	N/A

N/A = not available; CLDS = Central Long Island Sound Disposal Site; CSDS = Cornfield Shoals Disposal Site; NLDS = New London Disposal Site; WLDS = Western Long Island Sound Disposal Site

2.4.2 Sediment Quality Information Database

The primary goal of the Sediment Quality Information Database (SQUID) is to provide information that enhances dredging management decisions, such as developing sediment testing plans, selecting priority pollutants for testing, or evaluating the suitability of sediments for open-water placement (CTDEEP, 2007). SQUID is one of the data sources used by Mitch and Anisfeld (2010) in their compilations of sediment quality information for Long Island Sound.

The database includes localities (Figure 2-4) that have been proposed for dredging in Connecticut and New York along the coast of Long Island Sound. It includes heavy metals, polychlorinated biphenyls (PCBs), pesticides, and polycyclic aromatic hydrocarbons (PAHs) in sediments from 1990 to 2001. It also includes data from 2001 to 2010 collected from Greenwich to New Haven, Connecticut. Samples are from cores of variable depths that reflect sediment to be dredged. Some of the samples are composite samples of multiple cores; compositing is generally done only when grain size distributions are similar. Some caution is needed with the dataset due to the lack of quality control (QC) data, testing conducted by different laboratories, and high detection limits combined with data below these levels (Mitch & Anisfeld, 2010). The database is not available online at this time; but can be obtained from Connecticut database managers.

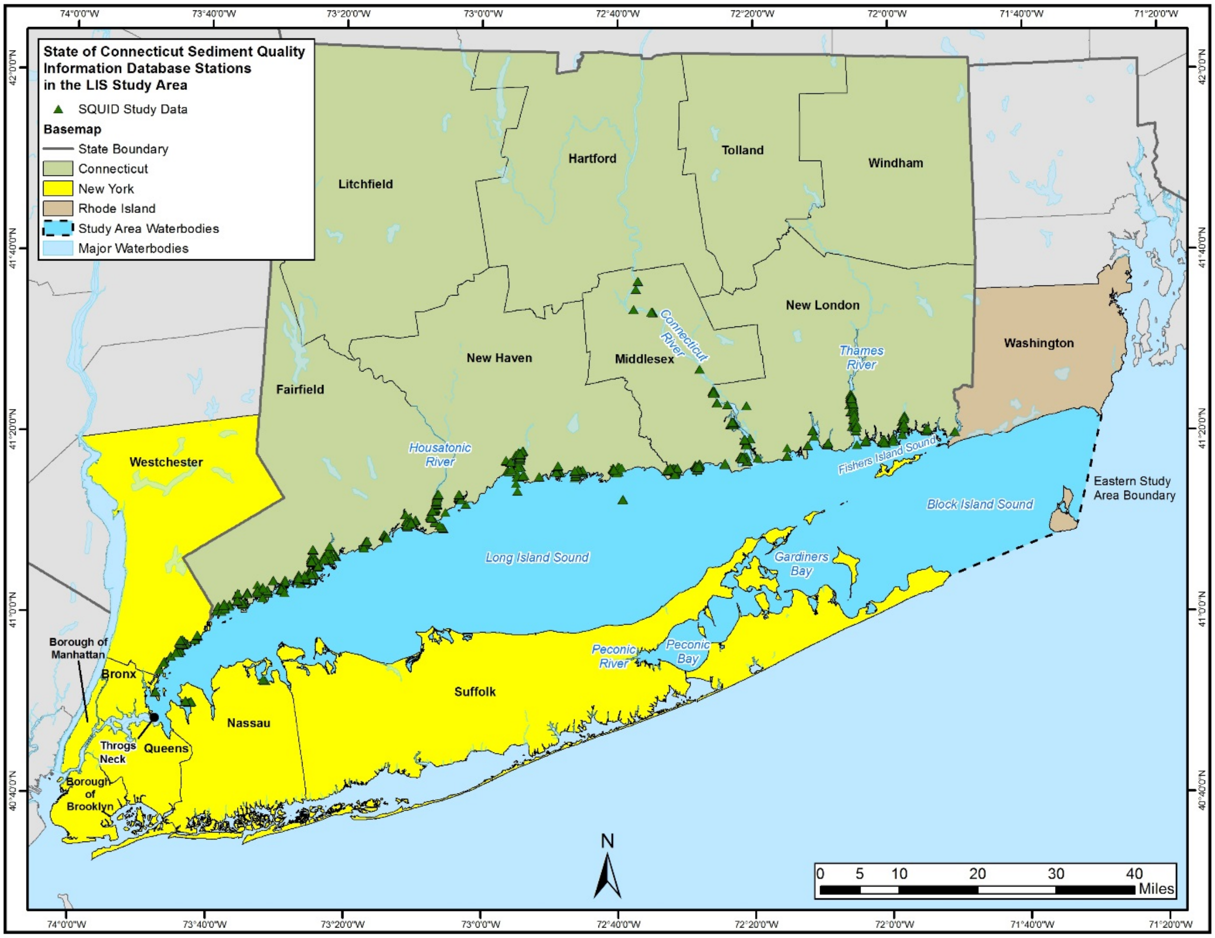

Figure 2-4. Location of SQUID Study Data Points in Connecticut and New York.

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3 ALTERNATIVES

The purpose of this PEIS is to identify one or more potential environmentally sound and feasible dredged material management plans for future long-term use for each of the USACE Navigation Projects and other Federal agency projects in Long Island Sound. This chapter describes the process used to identify the universe of potential alternatives and provides a general overview of the alternative sites evaluated throughout the PEIS process. In accordance with NEPA, and to support of goals of the DMMP, a variety of alternatives to open-water placement were considered during the overall EIS process: containment, beneficial uses, upland alternatives, treatment technologies, and the No Action Alternative. The resources present at each of these alternative sites (physical, environmental, cultural, and socioeconomic) are described in Chapter 4, and potential impacts to these resources through placement of dredged material at these sites are evaluated in Chapter 5. This information was then combined with practicability considerations to evaluate and rank the various potential dredged material placement alternatives for each of the USACE and other Federal agency projects in Chapter 6.

3.1 NO ACTION ALTERNATIVE

NEPA requires that an EIS evaluate the “No Action Alternative” (40 CFR 1502.14(d)). In cases involving a Federal decision on proposals for projects, “no action” means the proposed activity would not take place. This provides a baseline against which the proposed action and other alternatives can be evaluated. Evaluation of the No Action Alternative involves assessing the environmental and socioeconomic impacts that would result if the action did not take place. These impacts can then be compared with the impacts of the proposed action and other “action” alternatives. In this case, the No Action Alternative is defined as the absence of a comprehensive plan for dredged material management in Long Island Sound (i.e., no DMMP would be in effect). Without a DMMP, the current process of dredging and dredged material placement would continue to take place on a project-by-project basis. Furthermore, the conditions under which the long-term use of the CLDS and WLDS were designated (40 C.F. R. 228.15(b)(4)(vi)(D)) would not be met, and use of the sites would expire for MPRSA-regulated projects as scheduled on April 30, 2016. Expiration of the WLDS and CLDS placement sites would mean that open-water placement in Long Island Sound of MPRSA-regulated projects could occur only at the two USACE-selected sites (CSDS and NLDS) until they expire on December 23, 2016 (as per §116 of the Consolidated Appropriations Act for Fiscal Year 2012 (2012 CAA), Public Law 112-74).

It is impossible to know with certainty how dredging needs of Long Island Sound harbors and waterways would be met if there were no designated open-water placement sites for MPRSA-regulated projects within Long Island Sound. However, several scenarios might reasonably be considered. First, placement site authorization for private projects involving less than 25,000 CY of material would simply continue to be evaluated on a project-specific basis under CWA Section 404. Second, for projects subject to MPRSA §106(f) (i.e., either Federal projects of any size or private projects involving greater than 25,000 CY of material), project proponents would need to pursue one or more of the following courses of action:

(1) Use an alternative open-water site, either inside or outside of Long Island Sound, that has been "selected" by the USACE under MPRSA §103. Such a site would need to be one that has not been in use since the 1992 amendments to MPRSA, or has not had its second five-year period of use expire. EPA would need to concur with the Selection.
(2) Use an existing EPA-designated (MPRSA §102) open-water site outside of the Long Island Sound study area (e.g., RISDS, HARS). EPA would need to concur with any placement at such sites.
(3) Delay dredging until EPA designation (MPRSA §102) of a different open-water placement site within Long Island Sound
(4) Cancel the proposed dredging projects
(5) Study, design, authorize, construct, and use practicable and cost-effective land-based, in-harbor, nearshore, beneficial use, or CDF placement/use alternatives. The type of alternative would vary depending on the size of the project, nature of the material to be dredged, any additional non-navigation benefits of the alternative, non-Federal sponsorship and funding, and the level of Federal participation warranted.

The environmental consequences associated with the No Action Alternative are evaluated in detail in Chapter 5.

3.2 IDENTIFICATION OF ALTERNATIVES

During the process of identifying potential alternative sites, the USACE and EPA, in coordination with the states and with input from the public, reviewed all potential upland, shoreline, and in-water locations where dredged material could be placed in the Long Island Sound area. The study area under consideration (see Figure 2-2) during the review of potential alternatives includes all of Connecticut; Westchester, Bronx, Queens, Suffolk, and Nassau counties of New York, as well as the Boroughs of Brooklyn (Kings County) and Manhattan (New York County), New York; and Washington County in Rhode Island (Section 1.3). The Long Island Sound PEIS evaluates only those alternatives located within the study area. Additional alternatives located outside of the study area may provide feasible, environmentally acceptable, and cost-effective options for specific projects within Long Island Sound. These alternatives are discussed briefly in this chapter and on a project-specific basis in the Long Island Sound DMMP but are not included in the analysis or screening of alternatives in this PEIS.

Several USACE-sponsored studies were conducted to identify potential containment, beneficial use, and upland alternative sites within the study area (USACE, 2009); (USACE, 2010); (USACE, 2011); (USACE, 2012a); (USACE, 2012b). These studies identified, characterized, and evaluated the feasibility of the sites for potential use for dredged material management from USACE Navigation Projects, as well as smaller, non-USACE projects.

- The Upland, Beneficial Use, and Sediment Dewatering Site Inventory was completed in two phases. Phase 1 of the study (USACE, 2009) described, in preliminary fashion, the universe of sites potentially available for upland placement, beneficial use, or dewatering of dredged material for use by the Long Island Sound region's navigational facilities. The initial report screened the sites to identify the ones that were considered potentially viable for use by USACE in management of dredged material from USACE Navigation Projects. The Phase 1 inventory consisted of 157 potential sites that could potentially accept dredged material and 22 potential dewatering sites. The 157 sites with capacity for material consisted of 104 beaches, 5 habitat restoration sites, 6 landfills, 10 redevelopment-construction sites, 1 mine reclamation site, 1 Brownfield site, and 30 concrete/asphalt plants.

- The Phase 2 study (USACE, 2010) built on the 2009 work to more fully describe and characterize those upland and beneficial use sites that may be available for processing or placement of dredged material from USACE Navigation Projects. This was achieved through site visits, site operator/owner interviews, and communications among USACE, the states, and interested stakeholders. The final site inventory consisted of 102 sites at 99 different locations: 67 beaches, 1 mine reclamation site, 6 landfills, 3 redevelopment/construction sites, 4 habitat restoration areas, and 21 potential dewatering sites.
- A separate study (USACE, 2011)involved further screening and investigation of the smaller upland, beneficial use, and dewatering sites that were not investigated under Phase 2 described above. These sites were evaluated for use by smaller, mainly non-Federal navigational interests, to meet one of the stated goals of the Long Island Sound DMMP—namely, to identify alternatives that could be used by non-Federal navigation interests in their alternative analysis for management of their dredged material. The list of potential alternative sites for smaller, non-Federal projects included 75 beaches, 30 concrete and asphalt plants, and 16 potential dewatering sites. These alternatives are not being evaluated in this PEIS.
- The containment site report (USACE, 2012a) evaluated both in-harbor and open-water CAD cells, shoreline CDFs, and island CDFs. The report includes a general description of dredged material containment methods, a summary of previously developed or proposed containment projects in Long Island Sound and elsewhere, a site-by-site assessment of candidate sites in the Long Island Sound study area, and an estimated capacity for dredged material at each site. Preliminary engineering designs are also discussed, and potential impacts are summarized. The final list of 18 containment sites consists of 4 CAD cells, 8 shoreline CDFs, and 6 island CDFs.
- The nearshore berm report (USACE, 2012b) includes a general description of nearshore berm placement methods, a site-by-site assessment of candidate sites in the Long Island Sound study area, and an estimate of the available capacity for dredged material placement at each site. Preliminary engineering designs are also discussed and potential impacts are summarized.

In addition to these studies, the USACE provided information on specific alternative sites within the study area that have been used in the past for placement of dredged material from USACE and other Federal agency projects. The locations of the alternative sites identified for potential use by USACE and other Federal agency projects in the Long Island Sound area are shown in Figure 3-1. These sites are described in the following sections.

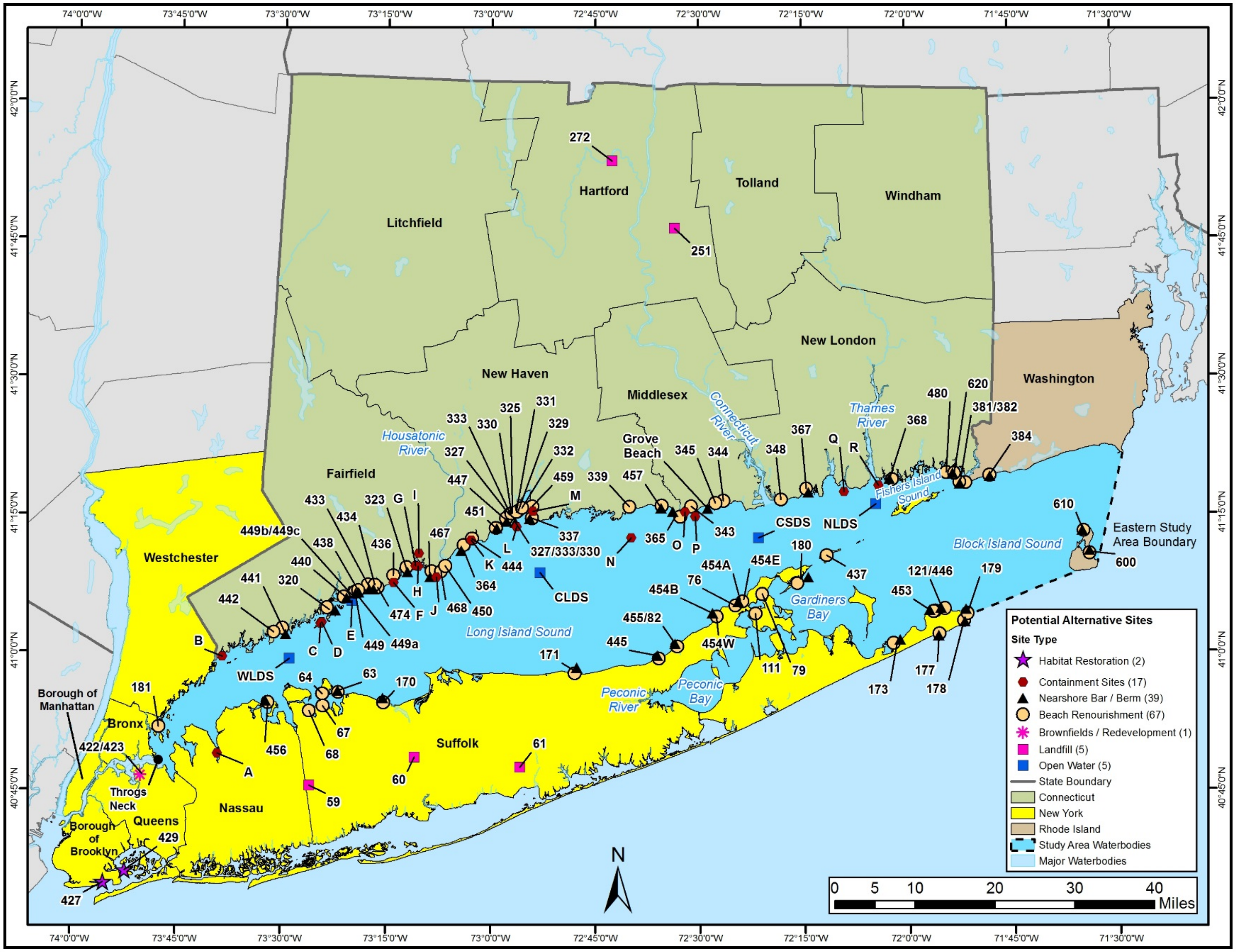
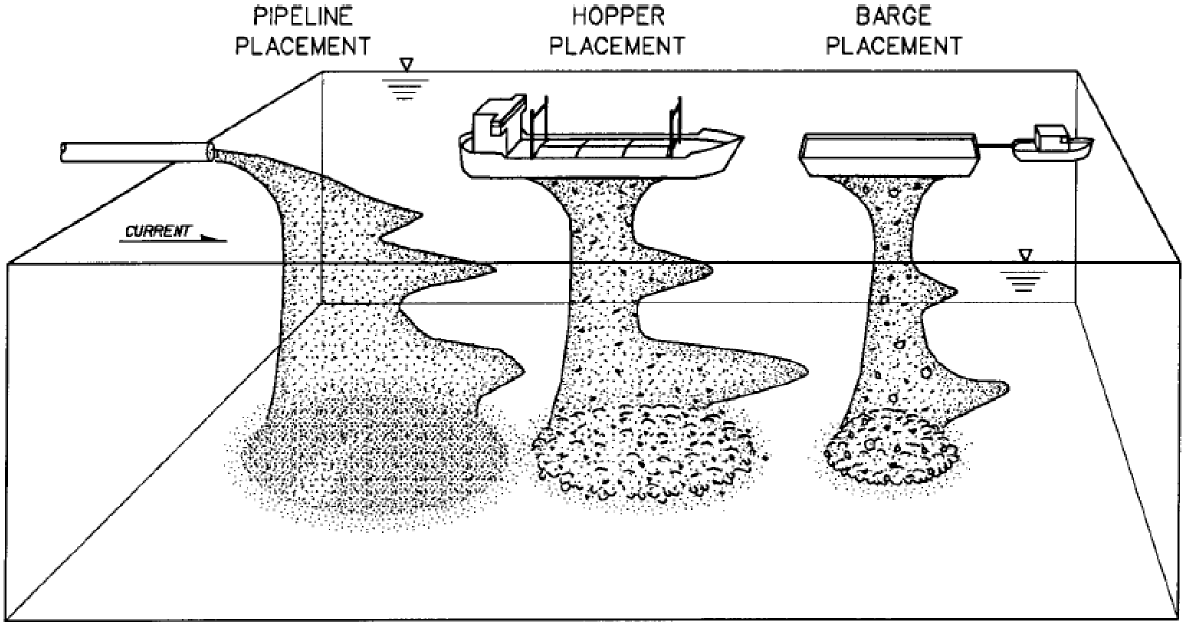


Figure 3-1. Potential Alternative Sites for the Placement of Dredged Material from Long Island Sound.

3.3 OPEN-WATER ALTERNATIVES

The open-water alternative would involve the placement of dredged material in the aquatic environment, such as in rivers, lakes, estuaries, or oceans. A variety of equipment can be used to place dredged material in open water, depending upon the location of the placement site in relation to the dredging location (Figure 3-2). For open-water placement adjacent to channels, pipelines or hydraulic dredges are commonly used to pump a slurry of site water and dredged material directly from the dredging site to the placement location. Hopper dredges store and transport a mixture of water and solids to the placement site, where the hopper doors on the bottom of the hull are opened and the contents are emptied onto the placement location. Bottom-release barges and scows may also be used to transport and place dredged sediment at the open-water placement location, with the possibility of multiple barges being used for frequent placement. Each release of dredged material would occur as a discrete discharge of material.



Source: (EPA and USACE, 2004).

Figure 3-2. Open-Water Placement Operations.

3.3.1 Physical Processes

During placement activities at open-water sites, dredged material is released, physically passes through the water column, and then impacts the seafloor in a limited area. Both individual placement events and multiple placement events have been monitored and well-studied. Throughout the extensive monitoring activities, only near-field and short-term physical impacts from dredged material disposal have been discerned (Fredette, et al., 1993); (Fredette & French, 2004).

The process of how dredged material descends through the water column to settle on the seafloor is well understood (Scorer, 1957); (Woodward, 1959); (Csanady, 1973); (Brandsma & Divoky, 1976); (Tsai & Proni, 1985); (Ecker & Downing, 1987); (Kraus, 1991); (Torresan & Gardner, 2000); (SAIC, 2003a); (SAIC, 2003b); (SAIC, 2005a); (SAIC, 2005b); (ENSR, 2008). The results of the process vary depending on barge type and position, sediment volume and properties (e.g., density, cohesion), and water depth and properties. Generally, dredged material released from a barge into open waters follows a three-phased pattern (convective descent, dynamic collapse, and long-term consolidation).

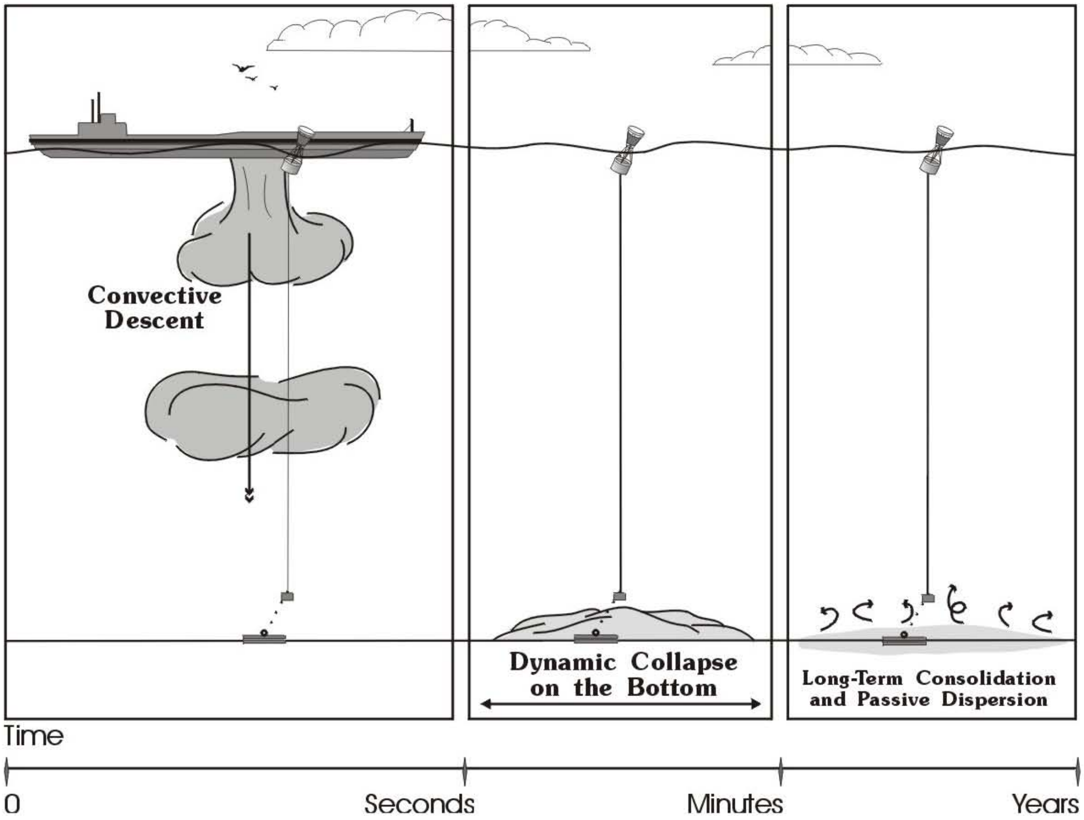
Convective Descent

Initially, a barge releases sediment into the water, resulting in convective descent. The dredged material descends rapidly through the water column under the influence of gravity, generally maintaining its form as a single bolus of sediment and water (SAIC, 2003b) (Figure 3-3). As the sediment falls through the water, the dense sediment-water mixture entrains some of the water that is not displaced and may expand horizontally to a limited extent and leave a plume of suspended sediment. At the Rhode Island Sound Disposal Site (RISDS), an active open water site outside of the study area boundary, six different disposal events of fine-grained dredged material were studied; each of the resulting plumes was characterized as a discrete column "with the size and suspended sediment concentrations dependent upon the dimensions of the disposal barge and volume of dredged material disposed (ENSR, 2008)." The duration of convective descent lasts only seconds to minutes in relatively shallow waters, such as in Long Island Sound (EPA, 2004a). Field and laboratory studies indicate that most of the sediment reaches the seafloor, with approximately 1 to 5% of the discharged sediment remaining in the water column after the convective descent phase (Ruggaber & Adams, 2000); (Tavolaro, 1984); (USACE, 1986); (Gordon, 1974); (Bokuniewicz & Gordon, 1980).

Dynamic Collapse

The dynamic collapse phase occurs when the sediment-water mixture impacts the seafloor and most of it comes to rest. Some of the sediment diffuses horizontally due to its momentum, which may also displace and resuspend ambient sediment (SAIC, 2003b) (Figure 3-3). Circular ring structures and pits have been evident at multiple dredged material sites and indicate individual disposal event impacts (Lopez, et al., 2014). The size and form of these ring-like features are a function of disposal operation (e.g., barge type, barge volume), dredged material characteristics (e.g., sand, silty sand, soft mud), and seafloor characteristics (SAIC, 2003b). For example, rings from dredged material placement at CLDS have been 33 to 164 feet (ft) in diameter (ENSR, 2007).

As the energy from the disposal activity dissipates, the remaining small amount of sediment entrained in the water column undergoes passive diffusion. During this phase, the ambient oceanographic conditions affect the transport and settling of the suspended sediments, which may last for several hours depending on the specific gravity and particle size of the sediment and physical dynamics of the area (Tramontano & Bohlen, 1982); (Arimoto & Feng, 1983). The suspended sediment concentration is reduced due to eventual settling and dilution (Gordon, 1974).



Source: SAIC (2003b).

Figure 3-3. Schematic Diagram of the Three Phases of Descent Encountered During a Dredged Material Disposal Event.

Numerous field studies have confirmed that these plumes are transient, short-term (i.e., hours in duration) features of dredged material disposal (Dragos & Lewis, 1993); (Dragos & Peven, 1994); (SAIC, 1988); (SAIC, 2004); (ENSR, 2008). The investigations at the RISDS site are informative because fine-grained material was disposed and the site's water depths are comparable to or deeper than WLDS, CLDS, and NLDS in Long Island Sound. At RISDS, within an hour, the suspended particulate matter demonstrated dramatic declines. The plumes were detectable at low levels, both optically and acoustically, for three to four hours within the water column and then fell to background levels (ENSR, 2008).

Open-water placement sites are characterized as either being non-dispersive or dispersive, depending on the physical dynamics present at the location (currents, waves, etc.) and the intended purpose of the site. Material placed at non-dispersive sites is intended to remain at the site following placement and may be placed to form mounds that assist in the containment of material at the site (EPA and USACE, 2004). At dispersive sites, material may be dispersed either during placement or transported from the site over time by currents and/or wave action. Additional details of open-water placement processes can be found in EPA and USACE (2004).

At predominantly non-dispersive sites, including WLDS, CLDS, and NLDS, most of the material remains on the bottom within the site following placement and may be placed to form mounds that are stable over decades (Carey, et al., 2006). In contrast, at predominantly dispersive sites, such as CSDS, material may be dispersed either during placement or eroded from the bottom over time and transported away from the disposal site by currents and/or wave action (EPA and USACE, 2004).

Long-term Consolidation

The final process occurring after disposal is reconsolidation of the sediment and consolidation of the ambient sediments due to the weight of the overlying material in the mound (SAIC, 2003b) (Figure 3-3). As a result of this settling process, pore water in the dredged material and ambient sediments is expelled laterally, reducing the total volume and height of the mound. The volume of water released and rate of this process depend on the properties of the sediment, including grain size and water content. The top layer of the mound consolidates rapidly, creating a dense 'filter cake' that is less permeable than side slopes and underlying sediment (Poindexter-Rollings, 1990). This is particularly true when sandy dredged material is placed on the top of mounds. The underlying ambient sediment may build up excess pore pressure and take up to 10 years to equilibrate. Most dredged material consolidation has been found to occur within the first 3 years after disposal, and in Long Island Sound the ambient sediments may represent as much as a fifth of the total consolidation (Poindexter-Rollings, 1990); (Brandes & Silva, 1997).

3.3.2 Unconfined Open-Water Placement

Unconfined placement refers to areas where dredged material is placed directly on the seafloor through release from a bottom-release hopper or barge at the surface as described above (Lopez, et al., 2014). Four potential unconfined open-water placement alternatives have been identified for potential use by USACE Navigation Projects within the Long Island Sound study area (Table 3-1). All of these sites are currently active placement sites within Long Island Sound, but are scheduled to expire for use by MPRSA-regulated projects in 2016. WLDS, CLDS, and NLDS are non-dispersive sites, where dredged material placed at the site remains at the site. CSDS is the only dredged material placement site managed as a dispersive site, where dredged material placed at the site is expected to be transported out of the area by bedload transport from strong tidal currents and sediment resuspension during storm events.

Table 3-1. Active Open-Water Disposal Sites Within Long Island Sound.

Site ID	Type	Site Name	Authority	Available Capacity (CY)	Site Expiration Date
WLDS	Unconfined Open Water	Western Long Island Sound Disposal Site	EPA-designated	20,000,000	April 30, 2016
CLDS	Unconfined Open Water	Central Long Island Sound Disposal Site	EPA-designated	20,000,000	April 30, 2016
CSDS	Unconfined Open Water	Cornfield Shoals Disposal Site	USACE-selected	200,000,000	December 23, 2016
NLDS	Unconfined Open Water	New London Disposal Site	USACE-selected	7,796,450	December 23, 2016

Each of these alternative sites is described below. Their locations are shown in Figure 3-1. In addition, two other open-water disposal sites that lie beyond the study area boundary (and therefore are not evaluated in this PEIS but are addressed on a project-specific basis in the DMMP) are briefly described below: the RISDS and the Historic Area Remediation Site (HARS).

Western Long Island Sound Disposal Site

The WLDS is centered at 40° 59.500’ N, 73° 28.950’W (NAD 83), 2 nautical miles (nmi) north of Lloyd Point, New York, and 2.5 nmi south of Long Neck Point near Noroton, Connecticut, in water depths of 79 to118 ft. The site is positioned over an east-to-west depression on the seafloor with a relatively flat bottom. The minimum water depth of 79 ft is found at the northwest corner of the site, and the maximum depth of 118 ft is found over the east-west trending depression before rising to 82 ft at the southern site boundary.

WLDS has been used for dredged material placement since 1982, when the site was established as a regional dredged material placement site to serve the needs of the western area of Long Island Sound. It is the newest of the currently active placement sites in Long Island Sound and is adjacent to three historic placement sites (Eaton’s Neck, Norwalk, and Stamford). Since 1982, approximately 1.9 million CY of dredged material have been deposited at the site. The WLDS site was designated by EPA for long-term use for the placement of dredged material on June 5, 2005.

The sediments at the site are heterogeneous, with clay-silt in the northeast corner and a mixture of sand-silt-clay in the center and southeast corner (Poppe, et al., 2000). These sediments are typical of those found in fine-grained depositional environments of the western basin of Long Island Sound (Knebel & Poppe, 2000). In addition to the ambient silts from this region, there are deposits of material of mixed grain sizes dredged from harbors and navigation channels throughout the Western Basin (Murray & Saffert, 1999).

Central Long Island Sound Disposal Site

The CLDS is a rectangular shape, approximately 2 nmi by 1 nmi, located at a center of 41° 08.950’ N, 72° 52.950’ W (NAD 83), 5.6 nmi south of South End Point near East Haven, Connecticut, and over 10 nmi north of Shoreham Beach, New York, in water depths from 59 to 74 ft. The site occupies a wide, flat area of the seafloor in a depositional area with a gradually sloping bottom from a depth of 59 ft in the northwest corner to 74 ft in the southeast.

CLDS has been one of the most active dredged material placement sites in New England. The CLDS site has the longest known continuous record of use of any placement site in Long Island Sound. There are records of volumes received at the site from 1941 to 1945 and again from 1954 to the present day. Since 1980, 8,339,136 CY of dredged material have been placed at the site. CLDS receives the largest volumes from USACE Navigation Projects in New Haven, Stamford, and Norwalk harbors, with numerous smaller harbors in Connecticut and New York contributing to the total placement volume. The CLDS site was designated by EPA for long-term use for the placement of dredged material on June 5, 2005.

The sediments at the site are predominantly uniform clayey silt with an area of mixed sand, clay, and silt (Poppe, et al., 2000). These sediments are typical of those found in fine-grained depositional environments of the Central Basin of Long Island Sound (Knebel & Poppe, 2000). In addition to the ambient silts, there are deposits of dredged material with mixed grain sizes from harbors and navigation channels throughout the Western and Central Basins (SAIC, 2002).

Cornfield Shoals Disposal Site

The CSDS is located 3.3 nmi south of Cornfield Point in Old Saybrook, Connecticut. This 1-nmi^2 site is centered at 41° 12.6858' N, 72° 21.4914' W (NAD 83). The CSDS site is recognized by regulators as a dispersal site. Since 1982, 1,337,058 CY of dredged material have been placed at the site. The site is located at a sandy shoal seaward of the mouth of the Connecticut River, where strong bottom currents tend to disperse material deposited there. The predominant topographic features are a smooth, sandy bottom and bedforms oriented in an east-west direction. The southeastern portion of CSDS is bisected by the New York-Connecticut state boundary.

New London Disposal Site

The NLDS is an active open-water dredged material placement site located 3.1 nmi south of Eastern Point in Groton, Connecticut. Centered at 41°16.306' N, 72°04.571' W (NAD 83), the 1-nmi^2 NLDS has water depths ranging from 46 ft to 79 ft at the southern placement site boundary. Since 1981, approximately 2,811,000 CY of dredged material have been placed at the site. Two important management boundaries bisect the NLDS: a 330-yard (yd) submarine transit corridor and the New York-Connecticut state boundary. The submarine corridor was established to minimize conflict between placement buoy positions and submarine traffic to and from the U.S. Navy Base in Groton, Connecticut.

Rhode Island Sound Disposal Site

The RISDS is an active open-water dredged material placement site centered at 41° 13.850' N, 71° 22.817' W (NAD 83), and located approximately 25 mi east of the Long Island Sound PEIS study area. Because it is located outside of the study area, RISDS is not evaluated in this PEIS. However, it may be a feasible and cost-effective option for the placement of dredged material from USACE Navigation Projects located on Block Island, which lies about 10 mi to the west of RISDS. Since 2003, a total of 5,311,963 CY has been disposed of at this site. This alternative site is discussed on a project-specific basis in the DMMP.

Historic Area Remediation Site

Another open-water site located outside of the Long Island Sound PEIS study area that has historically received dredged material from USACE and other Federal agency projects within Long Island Sound is the HARS. HARS is a 15.7-nmi^2 area located off the coast of Sandy Hook, New Jersey, and lies 7.7 nmi south of Rockaway, New York. It is located approximately 140 mi from the eastern boundary of the PEIS study area and 35 mi from the western boundary. HARS is only available for placement of material that meets the definition of remediation material for this ocean site. Material for Remediation is defined in the HARS final rule preamble as "uncontaminated dredged material (i.e., dredged material that meets current Category I Standards and will not cause significant undesirable effects including through bioaccumulation)." This alternative site is discussed on a project-specific basis in the DMMP.

3.3.3 Confined Open-Water Placement

One of the alternative sites identified during the containment site study (USACE, 2012a) is a confined open-water placement site (Site E) (Table 3-2). Confined placement refers to areas where a low mound of dredged material on the seafloor is covered with additional layers of dredged material to 'cap' or confine the initial placement (Fredette, et al., 1992). This alternative site occupies a former borrow pit approximately ½-mi offshore of Sherwood Island State Park near Westport, Connecticut (Figure 3-1). However, since this site is located outside of a harbor within the waters of Long Island Sound, placement of dredged material at this location is subject to MPRSA and is considered open-water placement. Therefore, this site can accept only suitable material for base fill material. Development of this containment site alternative would be contingent on three conditions: being "selected" by the USACE, meeting the criteria for determining that the material poses no unacceptable risk to human health or the environment, and obtaining concurrence from EPA. It could also be designated by EPA.

Table 3-2. Confined Open-Water Alternatives.

Site ID	Type	Site Name	Footprint (acres)	Capacity (CY)
E	Confined Open Water	Sherwood Island Borrow Pit	100	750,000

3.4 IN-HARBOR CAD CELLS

CAD cells are existing sea floor depressions and borrow pits or newly excavated pits that can be filled with dredged materials. There are generally three categories of such pits (USACE, 1999):

- Existing pits such as sand/gravel mined borrow pits whose capacity is limited by their existing size;
- Newly excavated pits which require the excavation of a volume of material usually slightly greater than the intended capacity of the pit; and,
- In-channel pits/cells which are excavated within the confines of a channel or berthing area below its authorized depth. This option minimizes impacts to undisturbed areas by utilizing previously disturbed sites. It also has the potential to optimize dredging operations and lessen costs by reducing the transport distances of dredged material. The disadvantage of in-channel cells is that placement can limit or eliminate future deepening of those navigation channels.

These CAD cells are typically sized and designed to accommodate specific volumes of material from individual projects, but they can also be developed to meet regional needs of multiple projects as was done in Providence River, Rhode Island (USACE, 2001). Cells may also need to be sized to accommodate both the bulked ("dredged") volume of placed material and a cap of clean material to isolate the dredged material underneath. If cells are constructed beneath navigation channels, their finished elevation must also account for future dredging depths, including long-range plans for future port improvement, as the finished elevation of the cell will restrict navigation depths or require rehandling of that material. While CAD cells could be constructed to accommodate material deemed suitable for open-water placement, construction of the cells themselves generates dredged material requiring placement, so use of these features is typically confined to the management of materials unsuitable for open-water placement. Another issue with CAD cells constructed within harbors is the suitability of materials excavated to form the cell, particularly the surface material which may be similar in terms of contaminant levels to the harbor shoal materials that would be placed into the excavated cell. Temporary storage of these surface materials, often in combination with construction of one or more smaller 'starter' cells, is one method of dealing with this problem. Placement or beneficial use of the remaining excavated CAD cell material from deeper elevations may also pose challenges. This material is often parent material (mainly of glacial or marine origin in New England) that is relatively uncontaminated, and itself suitable for open water placement, or beneficial use according to its sediment classification (fine or coarse). Evaluation of CAD cells and design of these features are project-specific. Their higher cost relative to other aquatic placement options makes them practicable only for dredged material that is unsuitable for other means of placement. Regional CAD cells are large, capital-intensive projects that take a great deal of time and resources to construct and manage. Development requires Federal, state, and port authority partnerships and cost sharing. A significant revenue stream is necessary for sponsoring port authorities and agencies to participate in such projects.

Three potential in-harbor CAD cell alternative sites (Sites G, H, and M) were identified in the containment alternative site study (USACE, 2012a) (Table 3-3). The locations of these alternative sites are shown in Figure 3-1. Site G (Bridgeport Outer Harbor West) is a potential CAD cell west of the Bridgeport Harbor Channel and north (harbor side) of the western jetty in Bridgeport, Connecticut. Site H (Bridgeport Outer Harbor Southeast) is a potential CAD cell east of the Bridgeport Harbor Channel and north (harbor side) of the eastern jetty in Bridgeport, Connecticut. Site M (Morris Cove) is a potential CAD facility occupying a former borrow pit offshore of Fort Nathan Hale Park and Pardee Parkway in outer New Haven Harbor. Unlike other CAD cells, which typically accept only unsuitable material as base fill, Morris Cove could accept both suitable and unsuitable material as base material. All three of these facilities would be filled with dredged material from Bridgeport Harbor and capped. Sites G and H are not located at an existing depression or borrow pit; therefore, they would need to be excavated as part of facility construction. Further details on the design plans for these sites are available in the Bridgeport Harbor DMMP (USACE, 2009).

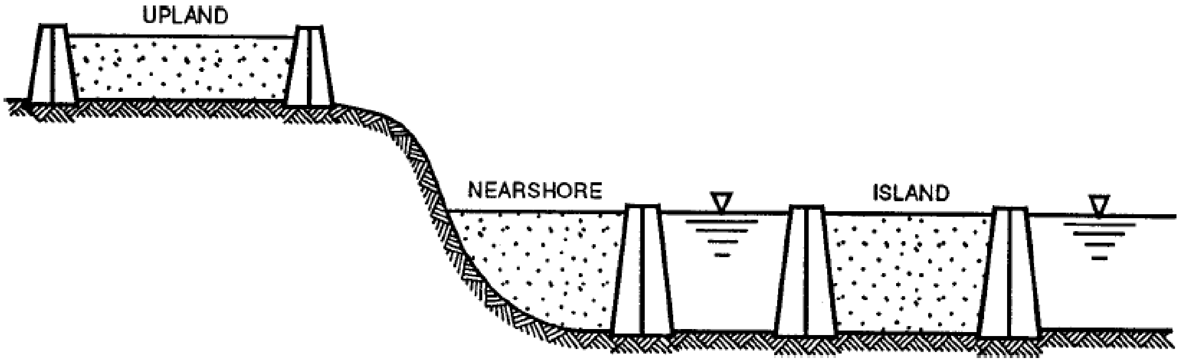
Table 3-3. In-Harbor CAD Cell Alternatives.

Site ID	Type	Site Name	Footprint (acres)	Capacity (CY)
G	CAD	Bridgeport Outer Harbor West[1]	14	469,000
H	CAD	Bridgeport Outer Harbor Southeast[1]	16	1,065,000
M	CAD	Morris Cove	30	610,000

[1] The Bridgeport Outer Harbor West and Southeast CAD cells, if constructed, would be part of the Bridgeport Harbor project, and the cells would not be available for use by other USACE Navigation Projects in Long Island Sound. Therefore, CAD G and CAD H are not included in the Long Island Sound PEIS alternative screening (Chapter 6).

3.5 CONFINED DISPOSAL FACILITIES

Dredged material CDFs are one type of contained placement that consists of a diked containment facility covering sufficient area to provide either a limited fill capacity for a single port or project or a regional placement capacity for multiple ports. CDFs can be constructed on land, in water, or along the shoreline. In the latter cases, intertidal and/or shallow subtidal lands are diked and filled over a period of years or decades to form an island (an island CDF) or an extension of the shoreline seaward (a shoreline CDF) (Figure 3-4). After filling and years of drying and consolidation, the created land is then adapted for its intended end use. These facilities are typically constructed either as port fill for industrial development or to create parkland or habitat as the finished end use. For example, port fill facilities have been constructed in other regions, such as Craney Island in the Port of Norfolk, Virginia, which is still in use and is being expanded. These sites are large-capacity placement areas for dredged material. They are large, capital-intensive projects that take a great deal of time and resources to construct and manage. Development requires Federal, state, and port authority partnerships and cost sharing. A significant revenue stream is necessary for sponsoring port authorities and agencies to participate in such projects.



Source: (EPA and USACE, 2004).

Figure 3-4. Upland, Nearshore (Shoreline), and Island CDFs.

3.5.1 Island CDFs

Island CDFs are constructed in open water (bays, harbors, etc.) and thus present unique site, design, construction, and operation challenges. Similar to other types of CDFs, the principal design and operation objectives of island CDFs are to (1) provide adequate storage capacity for meeting dredging requirements, (2) maximize efficiency in retaining the solids and isolating them from the aquatic environment, and (3) control releases during filling and over the long term.

Six potential island CDF alternative sites (Sites B, L, N, P, Q, and R) were identified as described in the containment alternative site study (USACE, 2012a) (Table 3-4). The locations of these alternative sites are shown in Figure 3-1. Brief summaries of each identified island CDF alternative site are presented below. Details on the potential CDF site designs, including construction methods and engineering considerations, are described in the containment site study report (USACE, 2012a), the Long Island Sound Studies Dredged Material Containment Facilities Feasibility Report (USACE, 1985a), and the Long Island Sound Studies Dredged Material Containment Supplemental Data (USACE, 1985b).

Table 3-4. Island CDF Alternatives.

Site ID	Type	Site Name	Footprint (acres)	Capacity (CY)
B	Island CDF	Greenwich Captain Harbor	49	830,000*
L	Island CDF	New Haven Breakwaters	1150	58,250,000*
N	Island CDF	Falkner Island	240	17,180,000*
P	Island CDF	Duck Island Roads	48	1,610,000 *
Q	Island CDF	Twotree Island	80	3,400,000
R	Island CDF	Groton Black Ledge	125	7,500,000

* estimated using specifications from the containment documents

Site B (Greenwich Captain Harbor) is a potential island CDF occupying either the area between the Calf Islands or between the southern Calf Island and Bowers Island in Captain Harbor near Greenwich, Connecticut, approximately 1 mi northeast of Byram Point at the mouth of Byram Harbor (Figure 3-1). The project area connects either the existing Calf Islands or the southern Calf Islands with Bowers Island. This site would potentially receive dredged material from regional dredging projects (Port Chester, Greenwich, and Cos Cob harbors).

Site L (New Haven Breakwaters) is a potential island CDF occupying the area behind the west and middle breakwaters in the southwestern portion of New Haven Harbor adjacent to the entrance channel to the harbor in New Haven, Connecticut, and anchored to the two breakwaters west of the channel (Figure 3-1). This site would potentially receive dredged material from New Haven and other regional harbors.

Site N (Falkner Island) is a potential island CDF approximately 4 mi south of Guilford Harbor, Connecticut, connecting Falkner Island to Goose Island (Figure 3-1). This site would potentially receive dredged material from regional dredging projects (New Haven, Branford, Stony Creek, Guilford, and/or Clinton harbors).

Site P (Duck Island Roads) is a potential island CDF approximately 0.25 mi south of Kelsey Point in Clinton, Connecticut, and bounded by the southern tip of Stone Island, East Ledge, and the Kelsey Point Breakwater (Figure 3-1). The project is a triangle-shaped area approximately 700 yd on each side. This site would potentially receive dredged material from regional dredging projects (Clinton, Guilford, Westbrook, and/or Old Saybrook harbors).

Site Q (Twotree Island) is a potential island CDF approximately 0.75 mi southeast of Millstone Power Plant in Waterford, Connecticut, surrounding the existing Twotree Island (Figure 3-1). This site would potentially receive dredged material from unspecified harbors.

Site R (Groton Black Ledge) is a potential island CDF adjacent to the New London Harbor navigation channel approximately 1 mi seaward of the entrance to New London Harbor and south of Avery Point in Groton, Connecticut (Figure 3-1). Black Ledge is an existing rocky shoal primarily occupying the area within the 18-ft isobath, with depths ranging from 10 to 30 ft mean low water and a small portion (20 square yards [yd^2]) exposed over most of the tidal cycle. This site would potentially receive dredged material from regional dredging projects (primarily Thames River, but also Niantic Bay/Harbor, Mystic River, Stonington Harbor, or Pawcatuck River).

3.5.2 Nearshore/Shoreline CDFs

Nearshore/shoreline CDFs are constructed in shallow coastal water adjacent to land (e.g., peninsulas) and use confinement, retention dikes, or other structures to isolate the dredged material from the surrounding water. One or more dikes are constructed to enclose a Shoreline CDF. In many cases, one of the sides is land. The dikes are constructed to an elevation above mean high water to allow ponding of water and retention of dredged material. Direct interchange between CDF water and surrounding water is restricted. However, clarified effluent is released from CDFs following settling of solids via a system of weirs or pipes. Upon closure of the CDF, a clean cap of sediment is typically placed on the surface of the dredged materials. The land created from this process can then be used for a variety of purposes, including wetland and upland habitat creation, commercial development (typically port-related), or recreational uses (USACE, 1999).

Eight potential shoreline CDF alternative sites (Sites A, C, D, F, I, J, K, and O) were identified as described in the containment alternative site study (USACE, 2012a) (Table 3-5). The locations of these alternative sites are shown in Figure 3-1. Brief summaries of each identified shoreline CDF alternative site are presented below. Details on the potential CDF site designs, including construction methods and engineering considerations, are described in the containment site study report (USACE, 2012a), the Long Island Sound Studies Dredged Material Containment Facilities Feasibility Report (USACE, 1985a), and the Long Island Sound Studies Dredged Material Containment Supplemental Data (USACE, 1985b).

Table 3-5. Shoreline CDF Alternatives.

Site ID	Type	Site Name	Footprint (acres)	Capacity (CY)
A	Shoreline CDF	Hempstead Harbor	116	3,500,000
C	Shoreline CDF	Norwalk Outer Harbor Islands – Marsh	78	930,000*
D	Shoreline CDF	Norwalk Outer Harbor Islands – Shore	33	400,000*
F	Shoreline CDF	Penfield Reef	1035	38,550,000*
I	Shoreline CDF	Bridgeport Yellow Mill Channel	16	300,000
J	Shoreline CDF	Stratford Point	1090	38,950,000*
K	Shoreline CDF	Milford Harbor	11	270,000
O	Shoreline CDF	Clinton Harbor	100	700,000

* estimated using specifications from the containment documents

Site A (Hempstead Harbor) is a potential shoreline CDF occupying the southwestern shoreline of Hempstead Harbor near Port Washington, New York, and Glenwood Landing, New York (Figure 3-1). It would extend along the western shoreline of Hempstead Harbor (south of

Hempstead Harbor Park) approximately 333 yd. The project area overlaps the former operating area of the Colonial Sand and Stone mining company.

Site C (Norwalk Outer Harbor Islands Marsh) is a potential shoreline CDF approximately 1 mi south of Manresa Island in Norwalk, Connecticut (Figure 3-1). It is designed to create salt marsh habitat in Ram Bay between Shea Island and Sheffield Island. This site would potentially receive dredged material from regional dredging projects (Greenwich, Stamford, Norwalk, Bridgeport, and/or Saugatuck). The site would then be planted with *Spartina alterniflora*.

Site D (Norwalk Outer Harbor Islands Shore) is a potential shoreline CDF occupying the area southwest of Shea Island (Figure 3-1). The project extends across the cove on the southwest side of Shea Island, through Wood Island. This site would potentially receive dredged material from regional dredging projects (Greenwich, Stamford, Norwalk, Bridgeport, and/or Saugatuck).

Site F (Penfield Reef) is a potential shoreline CDF extending approximately 1.25 mi southeast around Penfield Reef from Shoal Point in Fairfield, Connecticut (Figure 3-1). Penfield Reef is currently a small island and a submerged ridge with elevations between +0.2 and -10.8 ft mean low water, but historical records indicate it was once a barrier beach providing protection to landward areas. This site would potentially receive dredged material from Black Rock Harbor (via hydraulic dredge) or other regional projects, such as Westport Harbor/Saugatuck River, Southport, Bridgeport, or Housatonic River (using booster pump or mechanical dredging with bucket/scow).

Site I (Bridgeport Yellow Mill Channel) is a potential shoreline CDF filling the northern reach of the Yellow Mill Channel between the railroad corridor and I-95 in the city of Bridgeport, Connecticut (Figure 3-1). The project area is an industrial channel adjacent to Bridgeport Harbor and abutting an elementary school and two parks. The site would potentially receive dredged material from Bridgeport Harbor (likely via hydraulic dredge). The site would be capped for upland development.

Site J (Stratford Point) is a potential shoreline CDF occupying the area south of Stratford Point and Lordship west to Lewis Gut in Stratford, Connecticut (Figure 3-1). The site would potentially receive dredged material from unspecified harbors. Previous investigations of this site were not encountered in the literature.

Site K (Milford Harbor) is a potential shoreline CDF occupying the area outside the eastern jetty of Milford Harbor and adjacent to Gulf Beach adjacent to the entrance channel to Milford Harbor in Milford, Connecticut ,and anchored to the outside of the eastern jetty (Figure 3-1). The Milford Harbor project was originally proposed for the western jetty but was later altered to take advantage of littoral drift to feed Gulf Beach. The site would potentially receive dredged material from Milford Harbor (via hydraulic dredge).

Site O (Clinton Harbor) is a potential shoreline CDF that would create a salt marsh habitat adjacent to the Clinton Harbor Federal navigation channel along the southern shoreline of Cedar Island and the eastern shoreline of Willard Island (Hammonasset Beach State Park) (Figure 3-1).

The site would potentially receive dredged material from Clinton Harbor via hydraulic pumping. The site would then be planted with *Spartina alterniflora*, creating 68 acres of tidal wetlands.

3.5.3 Upland CDFs

No specific upland CDF sites were identified as part of the containment site study report (USACE, 2012a). This does not preclude the requirement for individual port and harbor dredging projects to investigate and evaluate the potential for upland confined placement alternatives for specific project purposes.

3.6 LANDFILL PLACEMENT

Upland placement alternatives were investigated within the Long Island Sound region as part of the Long Island Sound DMMP effort (USACE, 2010). The upland study included a review of existing landfills and identified one privately owned landfill which could potentially accept dredged material as fill material (Site 59) (Table 3-6). This site was originally a sand mine, and now the excavated areas are being filled. This landfill can accept various types of material, including electrical conduit, construction and demolition material, and organic waste. Tipping fees are generally lower than at municipal landfills in the area. The landfill has a great deal of capacity and flexibility to accept dredged material as daily cover or fill. The dredged material would first need to be processed for upland placement as described in Section 3.8.1 before it could be placed at this site. The disadvantages of upland placement are additional costs for dewatering/processing the dredged material, additional material handling, and transportation costs. Additional details regarding this site can be found in the upland study report (USACE, 2010). Landfill cover and capping alternatives were also identified in that report and are discussed below as part of the upland beneficial use alternatives (Section 3.8.3).

Table 3-6. Landfill Placement Alternatives.

Site ID	Type	State	Town	Site Name	Capacity (CY)
59	Landfill	NY	Melville	110 Sand Company Clean Fill Disposal Site	1,000,000

3.7 BENEFICIAL USE IN THE COASTAL ZONE

Beneficial use can be either for an ecological benefit (e.g., beach nourishment, marsh creation) an economic benefit (e.g., port development fill), or a combination of purposes (Brownfield restoration). Beneficial use of dredged materials is encouraged where a need for such use exists, the dredged material is suitable for that use, and any additional cost associated with that placement method is justified by the benefit. It is USACE policy to consider and weigh the beneficial use potential of dredged material prior to pursuing other options. Beneficial uses include beach nourishment through either direct placement or nearshore placement, environmental uses such as marsh creation or bottom habitat development, along-shore fill in support of waterfront development, or some of the upland uses such as landfill and Brownfield capping and remediation. The suitability of dredged material for these uses depends largely on the project-specific evaluation of the dredged material's type and quality. All of these possible options are project-specific, and must be examined for each individual dredging project. In the

Long Island Sound region, the states of CT and NY have participated in beneficial use projects, both through cost-sharing where Federal interest was warranted, and by providing full non-Federal funding in other cases. It is in part through these efforts that the volume of open water placement in Long Island Sound has been reduced in the past several years.

3.7.1 Beach Nourishment

The most common form of beneficial use is beach nourishment using suitable sandy dredged materials on beaches adjacent to the harbor being dredged. Several times each year, projects of this nature are undertaken in New England waters. This method of placement is commonly used to maintain entrance channels and beaches for the harbors of Nassau and Suffolk Counties on Long Island, and to a lesser extent, for Connecticut harbors, using a hydraulic pipeline dredge to pump materials directly onto the receiving beach. For most projects, this requires a receiving beach within about 1 mi of the dredging site. Entrance channels at Connecticut harbors such as Milford, Clinton, Westbrook, Little Narragansett Bay, Southport, and the Housatonic River have all used direct beach placement in past dredging projects.

The upland, beneficial use, and sediment dewatering site study identified 67 beaches that could potentially accept dredged material from USACE Navigation Projects for beach nourishment activities (USACE, 2010). This group of beaches (presented in Table 3-7) consists of municipal/county, state, and Federal Shore Protection beaches. The locations of these beaches are shown in Figure 3-1. Most of the identified beaches are located in Connecticut (37 beaches), with New York having 24 beaches and Rhode Island having 6 beaches. In general, most of the beaches considered in this study have capacity for clean, beach-compatible sand in the medium- to coarse-grained size range. The estimated existing site capacity for beaches in the study area ranges between 4.9 million and 6.0 million CY. Beaches that receive beach nourishment are still subject to loss or accretion of sand by natural coastal actions. Therefore, at any time, the capacity could be lower or higher, depending on natural events. For that reason, the capacity identified above is considered the “typical” capacity. At several sites, beach nourishment designs have been completed by the USACE or the state environmental offices in New York and Connecticut in preparation for shore protection projects. Detailed site summaries for each of these beaches, as well as site capacity methodology, are included in the upland, beneficial use, and sediment dewatering site study report (USACE, 2010).

Table 3-7. Beach Nourishment Alternatives.

Site ID	State	Town	Site Name	Capacity (CY)[a]	Capacity + 35% (CY)[b]
323	CT	Bridgeport	Seaside Beach	130,900	176,700
433	CT	Fairfield	Southport Beach	15,700	21,200
434	CT	Fairfield	Sasco Hill Beach	6,300	8,500
436	CT	Fairfield	Jennings Beach	24,700	33,400
365	CT	Madison	Hammonasset State Park	562,700*	562,700*
457	CT	Madison	East Wharf Beach	4,300	5,700
364	CT	Milford	Silver Sands State Park	21,000	28,400
444	CT	Milford	Gulf Beach	5,300	7,100
451	CT	Milford	Woodmont Shore Beach	500	700
337	CT	New Haven	Lighthouse Point Park Beach	3,400	4,600
320	CT	Norwalk	Calf Pasture Beach	31,900	43,000
441	CT	Stamford	Cove Island Beach	20,100	27,100
442	CT	Stamford	Cummings Park Beaches	38,700	52,200
450	CT	Stratford	Short Beach	54,400	73,500
447	CT	West Haven	Prospect Beach	63,100	85,300
438	CT	Westport	Burial Hill Beach	2,800	3,700
440	CT	Westport	Compo Beach	65,800	88,800
449	CT	Westport	Sherwood Island State Park	71,400	96,300
181	NY	Bronx	Orchard Beach	33,750*	33,750*
453	NY	East Hampton	Lake Montauk Harbor	400,000*	400,000*
63	NY	Huntington	Asharoken Beach	600,000*	600,000*
456	NY	Oyster Bay	Bayville	77,200	104,200
454 East	NY	Southold	Hashamomuck Cove – County Road 48	162,800	219,800
454 West	NY	Southold	Hashamomuck Cove – Kenney’s Beach	50,700	68,500
455/82	NY	Mattituck	Mattituck Harbor 111/Bailie’s Beach	100,000*	100,000*
384	RI	Westerly	Misquamicut State Beach	32,000	43,200
367	CT	East Lyme	Rocky Neck State Park	10,400	14,100
368	CT	Groton	Bluff Point State Park	131,200	177,100
171	NY	Wading River	Wildwood State Park	164,100	221,500
173	NY	East Hampton	Hither Hills State Park	319,600	431,500
177	NY	East Hampton	Shadmoor State Park	20,100	27,100
178	NY	East Hampton	Camp Hero State Park	76,900	103,800
179	NY	East Hampton	Montauk Point State Park	147,300	198,900
170	NY	Kings Park	Sunken Meadow State Park	160,600	216,800
180	NY	Orient	Orient Beach State Park	119,900	161,800
445	NY	Riverhead	Jamesport State Park	120,000	161,900
446	NY	East Hampton	Theodore Roosevelt County Park	427,400	577,000
343	CT	Clinton	Clinton Town Beach	1,200	1,600
474	CT	Fairfield	South Pine Creek Beach	100	100
339	CT	Guilford	Jacobs Beach	6,400	8,600
459	CT	New Haven	Fort Nathan Hale Park	5,300	7,100
348	CT	Old Lyme	White Sands Beach	1,700	2,300
480	CT	Stonington	DuBois Beach	3,300	4,500

Table 3-7. Beach Nourishment Alternatives (continued).

Site ID	State	Town	Site Name	Capacity (CY)[a]	Capacity + 35% (CY)[b]
467	CT	Stratford	Long Beach	23,200	31,300
468	CT	Stratford	Russian Beach	31,700	42,800
325	CT	West Haven	Altschuler Beach	51,200	69,100
327	CT	West Haven	Bradley Point Park	11,600	15,600
329	CT	West Haven	Morse Beach	17,700	23,900
330	CT	West Haven	Oak Street Beach	17,700	23,900
331	CT	West Haven	Peck Beach	29,800	40,200
332	CT	West Haven	Sandy Point	27,700	37,400
333	CT	West Haven	Savin Rock	1,800	2,400
344	CT	Westbrook	Middle Beach	600	900
345	CT	Westbrook	West Beach	42,200	57,000
121	NY	East Hampton	Gin Beach	9,000	12,200
64	NY	Huntington	Hobart Beach	128,800	173,900
67	NY	Huntington	Crescent Beach (Huntington)	3,600	4,800
68	NY	Huntington	Gold Star Battalion Beach	2,400	3,200
111	NY	Shelter Island	Crescent Beach (Shelter Island)	23,900	32,200
76	NY	Southold	Southold Town Beach	23,200	31,300
79	NY	Southold	Gull Pond Beach (Norman E. Klipp Park)	14,400	19,500
381	RI	Westerly	Watch Hill Beach	22,600	30,500
382	RI	Westerly	Napatree Point Beach	68,100	91,900
437	NY	Southold	Plum Island	41,600	56,100
600	RI	New Shoreham	Crescent Beach (Block Island)_	66,667	90,000
610	RI	New Shoreham	Sachem's Pond West Beach	66,667	90,000
620	RI	Westerly	Sandy Point Beach (Westerly)	80,000	108,000

*Nourishment volume obtained from USACE or state environmental engineering design.

[a] The beach nourishment capacity generated using the methodology described in USACE (2010) is a conservative estimate (low-end value). In most cases, the beaches in the study area could hold an additional volume of material on the upper beach face above the berm or in dune areas at the landward edge of the beach. In addition, these volumes reflect the available capacity for a single placement event, not the total capacity over the 30-year planning horizon. Littoral transport of material and sea level rise will create an ongoing need for material for beach nourishment.

[b] A high-end capacity volume was calculated by increasing the conservative estimates by 35%.

3.7.2 Nearshore Bar/Berm Placement

Equally common in much of New England is the practice of depositing clean sandy or silty sand materials from hopper dredges into the nearshore littoral bar system off beaches. This method of dredging and placement allows placement of the material in beach systems at a greater distance from the dredging site than can be achieved with a pipeline dredge, and it also allows natural forces to sort fine materials from the coarser materials. However, this method of beneficial use has not been widely used in Long Island Sound, and most material generated by the region's dredging projects is not suitable for use as beach nourishment.

Nearshore berms are submerged, high-relief mounds, generally built parallel to the shoreline. They are commonly constructed of sediment removed from a nearby dredging project. There are typically two types: feeder berms and stable berms. Feeder berms are transient features that contain predominantly clean sand placed in the nearshore zone directly adjacent to a beach. The physical benefits of feeder berms include the introduction of new sediment to the littoral system, beach nourishment through onshore sediment transport, and a reduction in nearshore wave energy along with reduced shoreline erosion. Stable berms are generally longer-lasting features constructed in deeper water or low-energy environments, where sediment transport is limited. These berms can be constructed with finer-grained material since the environment is not conducive to wave- or current-induced sediment transport. The physical benefits to stable berms include reduced wave energy along the shoreline, lower shoreline erosion, and enhanced habitat for fisheries.

Costs associated with nearshore berm construction are generally lower than hauling the dredged sediment to an offshore placement site or, in the case of clean beach-compatible material, pumping directly to the beach. Additionally, by linking the dredging activity with nearby beach needs through regional sediment management, a least-cost dredging and nearshore placement solution can often result in a beneficial use alternative.

The nearshore berm study (USACE, 2012b) identified and characterized 39 nearshore berms that could potentially receive dredged material from USACE Navigation Projects (Table 3-8). The study report also discusses the construction methods, engineering considerations, and regulatory oversight for these sites. Connecticut contains most of the potential sites (21 sites), followed by New York (15 sites) and Rhode Island (5 sites). The locations of potential nearshore berm sites are shown in Figure 3-1.

Table 3-8. Nearshore Berm Alternatives.

Site ID	Site Name	Site Length (ft)	Capacity (CY)	Sediment Type	Type
177	Shadmoor State Park	1,477	33,700	medium sand	Feeder
178	Camp Hero State Park	3,703	84,332	cobble to coarse sand	Feeder
179	Montauk Point State Park	5,760	131,119	cobble to coarse sand	Stable
121/446	Gin Beach & Theodore Roosevelt City Park	8,892	202,358	medium to fine sand	Stable

Table 3-8. Nearshore Berm Alternatives (continued).

Site ID	Site Name	Site Length (ft)	Capacity (CY)	Sediment Type	Type
453	Lake Montauk Harbor	4,618	105,144	medium to fine sand	Stable
173	Hither Hills State Park	12,132	276,053	coarse sand	Stable
180	Orient Beach State Park	8,968	204,086	medium sand	Stable
454A	Hashamomuck Cove – County Road 48/	6,815	155,115	coarse sand	Stable
454B	Hashamomuck Cove – Kenney's Beach	3,196	72,800	coarse sand	Stable
455/82	Mattituck Harbor 111 / Bailie's Beach	1,540	35,133	medium sand	Stable
445	Jamesport State Park	5,695	129,641	medium to coarse sand	Stable
171	Wildwood State Park	8,693	197,831	coarse to medium sand	Stable
170	Sunken Meadow State Park	10,670	242,799	medium to coarse sand	Stable
63	Asharoken Beach	10,912	248,304	medium to fine sand	Stable
456	Bayville	4,224	96,182	medium sand	Stable
441	Cove Island Beach	1,235	28,196	coarse sand	Stable
320	Calf Pasture Beach	1,325	30,243	medium to coarse sand	Stable
440	Compo Beach	2,561	58,356	coarse sand	Stable
449	Sherwood Island State Park	4,648	105,931	coarse sand	Stable
438	Burial Hill Beach	554	12,706	coarse sand	Stable
433	Southport Beach	1,192	27,218	coarse sand	Stable
434	Sasco Hill Beach	878	20,076	coarse sand	Stable
323	Seaside Beach	6,285	143,060	medium sand	Stable
467	Long Beach	1,989	45,346	medium sand	Stable
364	Silver Sands State Park	1,111	25,375	fine sand	Stable
451	Woodmont Shore Beach	354	8,157	medium to coarse sand	Stable
447	Prospect Beach	2,413	54,990	medium sand	Stable*
327/333 /330	Bradley Point Park/Savin Rock/Oak Street Beach	9,435	214,709	medium sand	Stable
337	Lighthouse Point Park Beach	2,439	55,581	medium sand	Stable*
457	East Wharf Beach	379	8,726	coarse to medium sand	Stable
365	Hammonasset State Park	6,151	140,012	medium sand	Stable
Grove Beach	Grove Beach	2,757	62,814	medium sand	Stable*
367	Rocky Neck State Park	2,131	48,576	medium sand	Stable
368	Bluff Point State Park	3,173	72,277	coarse sand	Stable
381/382	Watch Hill Beach /Napatree Point Beach	6,806	154,911	medium to fine sand	Feeder
384	Misquamicut State Beach	3,093	70,457	medium to fine sand	Feeder
600	Crescent Beach	N/A	192,274	medium sand	Unknown
610	Sachem's Pond West Beach	N/A	194,495	sandy cobble	Unknown
620	Sandy Point Beach (Westerly)	2,168	80,000	sand	Unknown

*Site assumed to be stable due to protection by breakwaters; near-bed velocity not calculated.
N/A = Not available

3.8 UPLAND BENEFICIAL USE

The use of dredged material has been important in the environmental and economic restoration of degraded lands in many areas of the country. Dredged material must be processed prior to upland placement. Up-front processing can include screening to remove debris (including organic detrital material) and rocks, amending the dredged material with Portland cement to reduce moisture and stabilize contaminants, and dewatering (see Section 3.8.1).

There are testing and additional permit requirements and criteria that must be met for upland placement. The Upland Testing Manual (USACE, 2003) provides technical guidance for evaluating potential contaminant migration pathways from CDFs. It describes a tiered testing approach that is faster and less expensive than testing for ocean placement. Once processed, almost all material dredged for navigation can meet the leachability and other chemical criteria for upland placement, though leachability tests need to be performed on representative samples in each case. The type of leachability test and the number of extractions would be decided by the regulatory agency. Geotechnical testing is required for any use where a load is applied.

3.8.1 Processing of Dredged Material for Upland Placement

Pretreatment and Dewatering

Dredged material for upland placement requires additional handling. Transport of the material from the dredging location to the shore can be accomplished by either barge or pipeline. Off-loading of the dredged material from a barge requires that the barge be secured to a pier or seawall along the shore front. Front end loaders or cranes are used to unload the dredged material from the barge and place it either directly adjacent to a staging area on-site or in lined dump trucks, which then move the material to a specific location on or off the site. The materials handling component of this pretreatment phase is critical to ensure that the dredged material is handled properly and to preclude the loss of dredged material back into the waterway. If the dredged material has a high water content, water-tight crane buckets and dump trucks may be required to minimize the uncontrolled discharge of sea water and suspended sediment back into the water. Where hydraulic dredging is used, the slurry may be conveyed directly to the dewatering site or equipment. Dredged material could also be removed by slurry directly from a barge. This slurry would be more applicable to a mechanical dewatering scenario.

Dredged material is screened prior to dewatering to remove large pieces of debris, such as piling fragments, fishing gear, reinforcing bar/wire, rocks, and other debris typically encountered in an urban harbor environment. This material must be removed from the dredged material and disposed of separately. It may require decontamination by washing or steam. Pretreatment may include sand separation by a hydrocyclone or other type of particle classifier system to remove sand for beneficial use. Following removal of debris, oversize material, and sand, the remaining material is treated with flocculants, coagulants, or other chemicals such as lime, ferric chloride, and aluminum sulfate to speed settling and thickening.

The selection of a dewatering technology involves consideration of factors such as dredged material volume, permitting requirements for water treatment discharge, duration of the project, sediment texture and contaminant loads, the land area required for staging and processing, proximity to residential communities, odor control and noise, cost, and the end use of the processed material. The technology selected and its performance may have considerable effect on the overall project costs, particularly when the dewatered material must be transported for further processing or placement.

Passive Dewatering

In passive dewatering, water is separated through gravity drainage and/or evaporation or, alternatively, passed through a fabric filter. This approach requires large land areas and engineered containment.

Settling ponds

Settling ponds are engineered containment areas with impermeable liners. Water is removed from the top by weir boxes and pumped to a treatment facility prior to discharge. Coagulants, flocculants, subsurface drainage, and wick (vertical strip) drains may be used to promote dewatering and consolidation (EPA, 1994). The dewatered sediment can be excavated and transported for treatment or placement or left in place as a CDF. Cells within the containment can be constructed for multiple projects. Odor treatment, such as with lime, may be needed to control the sulfur odor produced by anaerobic decomposition.

Geotextile methods

In this method, sediment is pumped as slurry into bags made of geotextile material on an impermeable liner. The excess water drains through the geotextile and is collected (usually in an engineered settling basin), treated by sand and charcoal filters, and discharged. Once the sediment is dewatered, additional dredged material can be added to the bags until capacity is reached. Various chemical additives and treatments can be added to the slurry during and after pumping. Air lines can be inserted into the bags along with microbes for bioremediation. When desired cake dryness is reached, the bags can be cut open and the dewatered sediment can be transported for placement in a landfill or for further treatment and beneficial use.

Mechanical Dewatering

Mechanical dewatering systems squeeze, press or draw water from sediment. Much less land is required for mechanical systems than for passive systems. To be economically viable, these methods require a consistent flow of dredged material (it is not batched fed).

The principal methods of mechanical dewatering are belt filter presses and plate-and-frame or membrane filter presses. Polymers or inorganic conditioners and flocculants are used to facilitate water separation either before or during pressing. Belt filter presses typically achieve about 50% solids in the processed filter cake, while plate-and-frame or membrane filter presses can achieve up to 70% solids. The excess water is collected, treated, and discharged. The processed filter cake can be transported for placement in a landfill or for further treatment and beneficial use.

Stabilization

Dredged material is commonly amended with Portland cement to dewater and stabilize material unsuitable for ocean disposal in a single process. At the present time, Portland cement is the most common pozzolanic additive and is typically added at 8%, though fly ash, coal dust, and other such materials may be feasible if they are tested and determined to meet land-based criteria. The amending agent and the dredged material may be homogenized in a barge using rakers or by pugmill systems situated on land. The amendment either physically binds (encloses) contaminants within a stabilized mass or causes chemical reactions to reduce their mobility and susceptibility to leaching. Pozzolanic amendments are particularly effective in chemically binding metals but are less effective for organic compounds. Organic compounds are immobilized in the matrix by entrapment or encapsulation of the particles they are adhered to.

Combining dewatering and treatment technologies at a single regional facility is a cost-effective approach used in many areas such as New York/New Jersey Harbor and on Superfund sites such as the Fox River in Wisconsin and the Miami River in Florida.

Potential Dewatering Sites in the Long Island Sound Study Area

Potential locations for regional dewatering facilities were identified during the upland, beneficial use, and dewatering site studies (USACE, 2009); (USACE, 2010). These regional facilities, if developed, would be available to process and dewater dredged material from several USACE and other Federal agency projects within the Long Island Sound study area. Regional dewatering facilities are large, capital-intensive projects that take a great deal of time and resources to construct and manage. Development requires Federal, state, and port authority partnerships and cost sharing. A significant revenue stream is necessary for sponsoring port authorities and agencies to participate in such projects.

Historically, USACE has also used smaller, local dewatering facilities located near the sites of USACE Navigation Projects for dredged sediment rehandling and processing. The regional and local dewatering sites that were identified during the Long Island Sound DMMP effort are listed in Table 3-9 and their locations are shown in Figure 3-5. The relative distances between these dewatering sites and the USACE Navigation Projects and upland alternative sites were used to screen the upland alternatives (Section 3.8.3) in Chapter 6 (Alternative Selection).

3.8.2 Uses of Processed Dredged Material

Non-structural and Structural Fill

As non-structural fill, processed dredged material can be valuable in the conversion of fallow or impacted real estate to productive use. For Brownfield applications, it is used to raise site elevations or, as a low-permeability capping material, to isolate impacted soil below parking lots and other paved areas. One example of this application is the Jersey Gardens Mall (Newark, New Jersey), where approximately 800,000 CY were used. Approximately 5 million CY of sediment were used to construct the Bayonne, New Jersey, Golf Club course. In New Jersey, processed dredged material has been used extensively for landfill daily cover and under the liner applications in landfill closures. The processed dredged material must be cured either before application or during application through the use of small lifts to cure in place. A limitation to some applications is that the high pH, chlorides, and sulfides present in processed dredged material are potentially corrosive to buried concrete and steel, so corrosion protection measures may be required (Maher, et al., 2013).

Table 3-9. Potential Regional and Local Dewatering Sites Identified within the Long Island Sound Study Area.

Site ID	Site Name	Town	State	Approximate Acreage	Capacity (CY)[a]
Currently Feasible					
CT_28	Anastasio Trucking Site	New Haven	CT	15	23,100
CT_54	P&W Railroad Co. Site	Norwich	CT	11	17,500
NY_5_A	Northport Boat Ramp and Fields	Huntington	NY	37	122,000
Potentially Feasible in the Future					
CT_30_A	North Haven Tire Pond Site	Hamden &North Haven	CT	32	99,600
CT_41	Ansonia Target Store	Ansonia	CT	11	1,000
CT_8	Fairfield Public Works Site	Fairfield	CT	12.5	47,800
NY_1	Mattituck Agricultural Fields	Mattituck	NY	450	2,085,000
NY_28	Shoreham Power Station	Brookhaven	NY	10.5	42,600
NY_29	North Hempstead Aerodrome	North Hempstead	NY	75	39,900
NY_3	Northville Agricultural Fields	Northville	NY	72	35,200
NY_5_B	Northport Power Station	Huntington	NY	13	63,000
NY_7_A	Garvies Pt. Remediation Site	Glen Cove	NY	15	27,300
NY_8	Glen Cove Industrial Site	North Hempstead	NY	25	11,000
RI_4_C	Quonset Point South	North Kingstown	RI	15	87,800
RI_5	Quonset Point North	North Kingstown	RI	43	102,200
Local					
Branford Harbor	Branford Harbor	Branford	CT	9.6	N/A
Cedar Island Marina	Cedar Island Marina	Clinton	CT	13.4	N/A
Jacobs Beach	Jacobs Beach	Guilford	CT	6.2	N/A
Manresa Island	Manresa Island	Norwalk	CT	52.3	N/A
Patchogue Marina	Patchogue Marina	Westbrook	CT	7.0	N/A

N/A = not available

[a] Dewatering site capacity calculations were performed to estimate the maximum amount of material that could be dewatered on a given parcel (USACE, 2010). The analysis assumed that the dewatering facility would consist of a single basin made up of retaining dikes to passively dewater the dredged material. In addition, a minimum one-quarter acre was reserved outside the dewatering area, for staging (e.g., storage of trucks, equipment, pipeline) and to support work on constructing and maintaining drainage features.

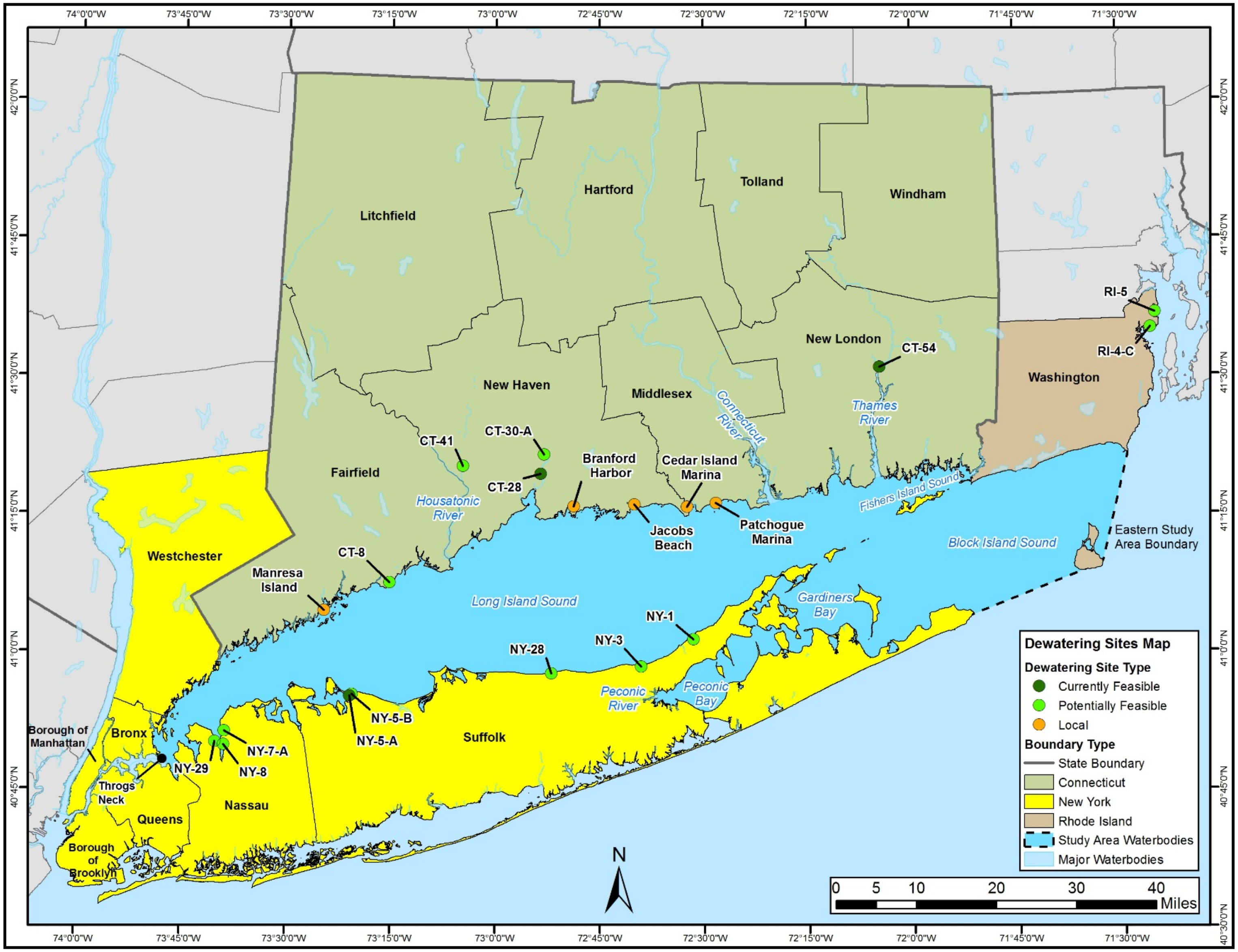


Figure 3-5. Potential Regional and Local Dewatering Sites Identified within the Long Island Sound Study Area.

One potential beneficial use of dredged material is the concept of reclaiming abandoned strip mine sites that are too acidic for standard reclamation practices (EPA and USACE, 2004). Mine reclamation would require large quantities of dewatered dredged material that could be moderately contaminated and still be acceptable, as long a permit requirements were met. This material could be used to provide substrate for vegetative cover, with the ultimate goal of remediating the site for limited recreational use or habitat restoration.

One example of a mine reclamation site is the Hazelton Mine in Pennsylvania. This reclamation site is a 277-acre abandoned mine site southwest of downtown Hazelton that contains deep mine pits and spoil piles. Approximately 50 acres of the site was used previously for placement of industrial and municipal waste. Extensive underground mining occurred throughout the area, and the mines are currently filled with water. Water discharges through a mine tunnel into a stream that feeds the Susquehanna River. The site's reclamation plan seeks to fill mine pits and redevelop the area in order to create the Hazelton Performing Arts Center and shopping facilities at the site. Currently, the project is permitted by the Pennsylvania Department of Environmental Protection (PA DEP) (O-85 and O-96) to receive dredged material, cement kiln dust, and regulated fill (construction waste) and is currently in active operations. The reclamation project has received 700,000 CY of dredged material from the USACE Philadelphia District (Fort Mifflin) in the past. Additional details about the Hazelton Mine site can be found in the Phase 2 upland, beneficial use, and dewatering site study report (USACE, 2010). Because this site is located outside of the Long Island Sound study area, it is not currently being considered as a potential alternative site for USACE and other Federal agency projects in Long Island Sound. In addition, the relative costs associated with placement at this alternative site are much higher than other alternatives located within the study area. For example, for a hypothetical project with 26,000 CY of dredged material, estimated costs for transporting this material via railroad to the Hazelton Mine site in Pennsylvania mine are two to five times more expensive than for other upland placement sites located within the study area.

With appropriate additives, curing, and moisture control verified by geotechnical testing of the final product, processed dredged material can be suitable for structural fill (capable of supporting 2,400 pounds per square inch [psi]) or other uses where the material must meet strength requirements. It is considered suitable, flowable fill (controlled low-strength materials: materials having compressive strength of 1,200 psi or less) for use as backfill for utility and trenches.

Road Bed and Berm Materials

Processed dredged material may be suitable for use in the construction of roadway embankments when engineered to meet geotechnical and slope stability criteria. Typically the material is suitable for embankments with horizontal:vertical slopes between 4:1 and 3:1 (Maher, et al., 2013).

Manufactured soil

Suitable dredged material may be amended with organic material, cellulose, or biosolids to create manufactured soil for use as a growing medium. The blend of additives will depend on the physical and chemical characteristics of the dredged material and the availability of organic materials (Sturgis, et al., 2001). For harbor material, this technique was demonstrated at New York City's Pennsylvania Avenue and Fountain Avenue landfills using dredged sand and fine-grained material. In a study using contaminated sediments, the USACE blended yard waste and biosolids with Newtown Creek (Brooklyn, New York) sediments. The study found that the manufactured topsoil immobilized metals and organic contaminants and resulted in little leaching from the manufactured soil. Because dioxins and polychlorinated biphenyls (PCBs) were not degraded, the manufactured soil in this case was recommended for use only on controlled sites such as landfills (Lee, 2000).

A number of technologies can be used for manufacturing soil. If texturally and chemically suitable, the end products from innovative technologies described in Section 3.9 can be raw material for soil manufacturing.

Residual salinity may be a limitation in selecting suitable placement sites for manufactured soil derived from dredged material as salts may leach from the dredged material and impact groundwater or adjacent surface water quality. However where placement occurs in coastal locations, groundwater and surface water may be naturally brackish or estuarine in salinity and would not be adversely impacted by leached salts.

Blending

Clean material can be simply blended with organic additives, fertilizer, compost, clay, and sand (as needed) using a pugmill. This technique was used by New York City at the Pennsylvania Avenue and Fountain Avenue landfills.

Land tilling

Land tilling is a bioremediation technology in which dredged material is applied to land in a shallow lift (less than 1 ft) and tilled periodically to allow oxygenation and bacterial growth. Organic additives, fertilizer, and sand may be tilled into the dredged material. The technique is suitable for material containing aerobically biodegradable compounds such as petroleum hydrocarbons and non-halogenated semi-volatile organic compounds (SVOCs), pesticides, and coal tar wastes. Petroleum refineries have used land tilling to help dispose of waste sludges. It is not suitable for clayey material; material containing volatile contaminants, halogenated compounds, or metals; or highly contaminated material. Siting requires a large area, and considerations include land use restrictions, climate, soil texture and chemistry, depth to groundwater, proximity to surface water, and slopes (EPA, 2003). A significant limitation is that soil temperatures are favorable to soil bacteria only 7 to 9 months of the year (EPA, 2004b).

Land farming

Land farming is similar to land tilling, but differs in that clean soil is mixed into the contaminated material. Volatile organic compounds (VOCs) may require operations within an enclosure (EPA, 2004b).

Composting

Composting is a bioremediation process that degrades organic contaminants. In composting, bulking agents (e.g., wood chips, bark, sawdust, straw) are added to the solid material to absorb moisture, increase porosity, and provide a source of degradable carbon. Water, oxygen, and nutrients are added to facilitate bacterial growth. Composting techniques include aerated static pile, windrowing, and closed reactor designs (Reis, et al., 2007).

Asphalt Batching

Tests have proven asphalt's effectiveness in immobilizing total petroleum hydrocarbon (TPH) compounds, VOCs, and polycyclic aromatic hydrocarbon (PAH) compounds (Office of Coastal Zone Management, et al., 2012). Sandy material containing petroleum contaminants (especially No. 2 and No. 6 fuel oils and lubricating oils) or non-hazardous concentrations of metals are particularly suitable for reuse in asphalt (NAVFAC, 2014a). Lighter hydrocarbon compounds or solvents may generate emissions, affect curing time, and soften the mixture. High silt concentrations may generate dust.

Hot or cold mix methods may be used. Hot mix is prepared by blending coarse and fine aggregate and drying at 500 to 800°F. The dried aggregate is then mixed with bitumen at 300 to 350°F. In cold mix, contaminated solids are blended with asphalt emulsions in a pugmill. The asphalt-emulsion-coated material is stockpiled and allowed to cure for approximately 2 weeks. Pretreatment requirements include debris screening, dewatering, and size classification by screening or crushing to less than 3-inch diameter. The end product can be a stabilized base material for parking lots or roadways. Limiting exposure to air helps avoid potential swelling problems resulting from hydration of sulfides and reduced metals (NAVFAC, 2014a).

3.8.3 Upland Beneficial Use Alternatives

The Phase 2 upland, beneficial use, and sediment dewatering site study (USACE, 2010) identified seven upland beneficial use sites that could potentially accept dredged material from USACE Navigation Projects (Table 3-10): one redevelopment/construction site, four landfill capping/cover sites, and two habitat restoration areas. These alternative sites are described in more detail below. Detailed summaries for each site are included in the upland, beneficial use, and sediment dewatering site study report (USACE, 2010).

Brownfields and Redevelopment Sites

In Brownfield re-development, contaminated or clean dredged sediment may be used as fill for development projects at Brownfield sites, such as abandoned industrial sites and cleanup/remediation sites. The in-situ soil at a Brownfield sited under development may contain contaminants at levels that are deemed acceptable for the project. Opportunity, therefore, exists for such a project to use contaminated sediment with constituent levels that are consistent with those permitted for the project. For substantially clean Brownfield sites, leach testing of dredged sediment by may be required before placement as fill. Applicability of using dredge material for Brownfield re-development in the study area will be highly site dependent (e.g., proximity to underlying groundwater resources, local use of groundwater, proximity to residential areas, etc.) and final acceptance by the regulatory agencies would likely be determined based on these conditions and possibly the results of a risk assessment. Another consideration is the timing between needed dredging projects and the schedule for Brownfield redevelopment so that the site could use the dredged material.

Table 3-10. Upland Beneficial Use Alternatives.

Site ID	Type	State	Town	Site Name	Capacity (CY)
422/423	Brownfield	NY	Flushing	Flushing Airport Wetlands and Upland	140,000
251	Landfill Capping/Cover	CT	Manchester	Manchester Landfill	1,200,000
272[a]	Landfill Capping/Cover	CT	Windsor	Windsor-Bloomfield Landfill[a]	160,000
61	Landfill Capping/Cover	NY	Brookhaven	Town of Brookhaven Landfill	700,000
60[b]	Landfill Capping/Cover	NY	Islip	Blydenburgh Road Landfill Complex, Clean Fill Phase 1 + 2[b]	700,000
427	Habitat Restoration	NY	Brooklyn	Plumb Beach	47,700 – 64,400
429	Habitat Restoration	NY	Brooklyn & Queens	Jamaica Bay Marsh Islands	600,000 - 750,000

[a] Follow-up phone calls conducted in 2015 indicate that this landfill is no longer active. Therefore, this site was not included in the PEIS alternative screening (Chapter 6).

[b] There is a likely capacity issue at Site 60 (design year through 2015 or 2016). In addition, past trouble using dredged material at this site makes it unlikely that the site will accept dredged material in the future. For these reasons, this site was not included in the PEIS alternative screening (Chapter 6).

One redevelopment/construction site was identified as having potential capacity for dredged material. The Flushing Airport wetlands and upland site was formerly an airport (from the 1920s to 1980s) under the New York City Department of Transportation (NYC DOT) marine and aviation division. The site is now in remediation/redevelopment under the New York City Economic Development Corporation (NYCEDC). The project is required to use clean fill according NYSDEC CP-51 / Soil Cleanup Guidance (NYSDEC, 2010). Placement of fine-grained dredged materials is allowed, provided the materials meet these regulatory criteria.

Landfill Capping/Cover

Landfills require capping material to sequester waste material from the environment. Landfills are an upland placement site for dredged material. In most cases, dredged material would be used in some form of cover application (daily, intermediate, or final cover). Dredged material not suitable for ocean placement may be used when amended to immobilize contaminants and thereby protect groundwater and surface water. Daily cover is a thin layer of material placed over active portions of the site to minimize grazing by wildlife, control odor, and reduce dust. A thicker intermediate cover may be placed over portions of a landfill to further encapsulate the waste material while still allowing for infiltration to promote decomposition of the underlying waste. Final cover layers are designed to provide more complete isolation of the waste material and minimize infiltration and erosion. Amended dredged material has been used to close “orphaned” landfills in the NJ Meadowlands that were previously closed under older, less protective regulations. At Pennsylvania Avenue and Fountain Avenue landfills in New York City, amended dredged material was used below the imperious liner for closure and above the liner as a growing medium to restore habitat.

Four of the landfills in the study area can accept dredged material for use as daily cover or as final cap material. The sites can accept fine-grained dredged material, although cap material is generally required to be higher in organics to support vegetative growth. While tipping fees vary between landfills, they tend to be relatively high for dredged material. The costs associated with dewatering and transport of dredged material to the landfills usually results in this alternative being significantly higher in cost than other placement options.

Habitat Restoration/Enhancement or Creation

HARS-approved material, primarily sand removed from Ambrose Channel and other areas, has been used to restore and reconstruct marsh islands in Jamaica Bay, located in southern Kings and Queens Counties, along the Atlantic Coast. Despite intense development along its shoreline, Jamaica provides habitat for a variety of fish and wildlife species and is an important stop-over for migratory birds. Analyses have indicated that nearly 1,400 acres of tidal salt marsh have been lost since the early 20th century and most recently is has been estimated that salt marsh was being lost at approximately 47 acres per year. Under Section 207 of the Corps Continuing Authority Program, the Corps, in partnership with the Port Authority of New York and New Jersey, New York City Department of Environmental Protection and the New York State Department of Environmental Conservation, restored salt marsh habitat through the placement of sand from Ambrose Channel and other areas as part of the Corps' harbor deepening project being conducted in partnership with the Port Authority of New York and New Jersey.

In 2006 and 2009, approximately 80 acres of marshland were restored at Elders Point East Marsh Island and Elders Point West Marsh Island. Sand was placed in existing vegetated areas and exposed mudflats to raise the islands to an elevation suitable for low marsh growth. The areas were then vegetated. Subsequently, a total of 625,000 CY of sand was placed at Yellow Bar, Rulers Bar, and Black Wall and included plantings to create a variety of salt marsh habitat. The marsh islands are being monitored and, although they suffered some damage during Hurricane Sandy, the islands are being maintained.

Two habitat restoration sites in the study (Jamaica Bay Marsh Islands and Plumb Beach) have capacity for dredged material. The Jamaica Bay Islands have capacity for over 600,000 CY of clean sand, and Plumb Beach is in need of beach-compatible sand both to stem severe erosion along the beach and roadway and to enhance the beach and dune habitat. For Plumb Beach, a USACE project design volume was not available. Therefore, a volume estimate was made based on the beach nourishment calculations (USACE, 2010).

3.9 INNOVATIVE TREATMENT TECHNOLOGIES

Significant progress has been made in demonstrating the viability of sediment treatment technologies with beneficial use applications over the last several years. However, treatment technologies are not stand-alone alternatives to ocean placement but are considered a component of an overall regional dredged material management program. A certain percentage of navigation dredging material is anticipated to be unsuitable for ocean placement; this material would require either upland placement as is or treatment to reduce contaminant concentrations and allow for authorization of upland placement or beneficial use. These treatment technologies support USACE policies for using sediment as a resource that can reduce the need to extract virgin materials and provide local economic benefits.

Sediment decontamination treatment demonstrations (1994-2010) have been conducted by EPA Region 2 and funded by the Water Resources Development Act (WRDA) and the New Jersey Department of Transportation (NJDOT) Office of Maritime Resources. These demonstrations have shown that ex-situ sediment treatment with beneficial use can be realized on a commercial scale. The cost of treatment is more expensive than open-water placement based on the cost of infrastructure development, energy requirements, materials handling, and other factors, but such treatment can be cost-competitive for contaminated materials unsuitable for other placement options. More information on the demonstration studies can be found at Brookhaven National Laboratory (BNL) (1999) and at NJDOT (2015).

The cost and low throughput processing rates of treatment technologies generally make such options impractical as a single alternative for all material from a large or long-term dredging project. While a treatment processing methodology that handles only a few hundred cubic yards a day cannot work in tandem with dredging equipment that generates several thousand cubic yards a day, these technologies can cost-effectively handle material whose contaminant concentrations preclude offshore placement. The heterogeneous nature of sediments and contaminant loads typically require a range of treatment and placement options for a large project.

Innovative sediment decontamination technologies with the potential to produce value-added, marketable products have been in development since the early 1990s. Through EPA programs, three agencies have developed thermal, chemical, or biological processes that reduce contaminant concentrations, contaminant mobility, and/or toxicity of contaminated dredged material, as authorized by Section 405 of the WRDA of 1992 and Section 226 of WRDA 1996: the USACE, the NJDOT Office of Maritime Resources, and the U.S. Department of Energy (DOE), BNL. These technologies potentially can convert dredged sediments into valuable products, replacing raw resources and the impacts of their extraction, manufacturing, and transport.

Innovative sediment treatment technology applications with beneficial use were also demonstrated under the Long Island Sound Innovative Technology Demonstration Project. This effort was funded and conducted under the auspices of the USACE NAE and Bridgeport Port Authority working in unison with the CTDEEP, CTDOT, and EPA Region 2. The impetus for this demonstration was focused on contaminated dredged material from inner Bridgeport Harbor that would be unsuitable for ocean placement. The application of a high-temperature thermo-chemical process that generated construction grade cement as a post-treated beneficial use and a sediment washing liquid-solid separation process with oxidant addition to create a manufactured soil product was considered. Sediment treatment work conducted by the New York/New Jersey Harbor Sediment Decontamination Program was used as an analog because of the similarity in chemical concentrations and physical characteristics. The development of a regional processing facility in Bridgeport, Connecticut, that could process up to 500,000 CY of contaminated sediments over the course of 2 to 10 years based on throughput and processing technology was the environmental management focus. This alternative was dropped in the USACE Dredged Material 404 Evaluation for Bridgeport Harbor in favor of other alternatives such as CADs, CDFs, and landfills (USACE, 2012c). Long-term throughput of contaminated dredged materials (greater than 15 years) that encompasses an environmental business model for regional processing and beneficial use could be re-evaluated to be more cost competitive.

3.9.1 Aggregates/Cement Replacement

One technology for the manufacture of Portland cement replacement, Cement-Lock (Volcano Partners LLC, 2014), is ready for commercial deployment. The process uses a natural-gas-fired, high-temperature rotary kiln and propriety additives to dissociate (separate) organic contaminants and immobilize metals. The end product, when water-quenched and pulverized, is a high-quality pozzolanic material that can replace up to 40% of Portland in cement admixtures. Process heat is recycled to cogeneration to power the facility, with excess for export to the electrical power grid. The creation of the beneficial use product, Ecomelt, from Lower Passaic River, New Jersey, Superfund sediments was proven in a 2008 demonstration in Bayonne, New Jersey. Cement-Lock technology was specified by EPA in the preferred remedies for the Lower Passaic study area, New Jersey (EPA and USACE, 2014) and the Gowanus Canal, New York, Superfund sites (EPA, 2013).

The production of a light-weight aggregate (LWA) using cement-kiln technology was demonstrated on a pilot-scale level by Upcycle Associates. The contaminated sediments became a partial replacement for shale that is mined. A good-quality bloated LWA was produced.

3.9.2 Sediment Washing

Sediment washing is a process that uses liquid-solid separation techniques to extract, destroy, and partition sediment fractions which have contaminants attached to the sediment. Full-scale facilities have been constructed at several sites globally (BioGenesis, 2009), including the Lower Passaic River, New Jersey. The sediment-washing process uses high-pressure water jets and a proprietary mix of surfactants and chelating agents to strip organic and metal contaminants from dredged material. The end product is a clean manufactured soil material usable for fill, cover, or topsoil applications. A manufactured soil demonstration was conducted on the campus of Montclair State University in 2010. Sediments were decontaminated and a manufactured soil was blended using the clean fraction of the process with sand, lime, clay, and compost. Landscape plantings placed in the soil are thriving in 2014.

3.9.3 Vitrification

Vitrification is a high-temperature technology that uses excessive heat to dissociate/destroy contaminants and to further reduce the mobility of residual inorganic contaminants by incorporating them into a solidified glass matrix after rapid cooling to generate an end product that could be applied for beneficial use. Contaminated material is placed in a refractory-lined vessel melter that is configured with a hood to collect off-gases. The heat can be generated by a variety of means; for example, positioning graphite electrodes vertically in the melter, firing a rotary kiln with natural gas, or using a plasma torch. Typical operating temperatures range from 2,550ºF to 3.630ºF, temperatures sufficient to melt the waste matrix and destroy or volatilize organic contaminants. The off-gas treatment includes a baghouse particulate filter, high-efficiency particulate air (HEPA) prefiltration, a NOx (oxides of nitrogen) scrubber, a hydrosonic scrubber, a mist eliminator, a heater, and HEPA filters. Typically for hazardous material, the solidified glass melt is placed in an appropriate landfill (EPA, 2010). For contaminated sediments, applications such as roofing granules, architectural tiles, and road bed aggregate have been considered.

3.9.4 Other Ex Situ Technologies

Numerous technologies have been developed for ex situ remediation of upland contaminated soil. These technologies have been applied to sediments at pilot- or full-commercial scale. None are suitable for all organic or inorganic contaminants; however, several technologies could be co-located at a regional facility to address a wide range of contaminants. The end products generally are soil material or geotechnical fill that may be suitable for beneficial use or may require landfilling.

Chemical Treatment

Chemical Oxidation/Reduction

This technology uses chemical additives such as hydrogen peroxide, potassium permanganate, chlorine, ozone, persulfate, or Fenton's reagents to reduce toxicity or immobilize target organic contaminants. In this process, electrons are transferred to the contaminant from the oxidizing agent. Catalysts such as ultraviolet radiation or transitional metals may enhance the reactions. Efficiencies for certain organic compounds, such as PAHs, may be 90 to 95%. However, incomplete oxidization may lead to the formation of more-toxic intermediate compounds. Organic content and the presence of non-target compounds may affect efficiency or require additional additives or treatment.

Other considerations are residuals and process wastes. Residuals such as excess chemical agents, reaction by-products, and gas emissions during and after treatment may require additional treatment and long-term monitoring, or may limit the end product's suitability for beneficial end-use. Dewatering is required before and after treatment; wastewater can be recycled into the extraction process. In commercial operations, chemical oxidation can be used as pretreatment for other processes. One such operation uses potassium permanganate to treat organics, followed by stabilization of metals with Portland cement (Harbor Resource Environmental Group, 2005). This process was demonstrated in a pilot/full-scale application in 2005 under the NJDOT Office of Maritime Resources Sediment Treatment Program. In 2015, under a teaming agreement with Clean Harbors, Inc., the process is being further demonstrated on a commercial scale within the Gulf region.

Chelation

Chelation is used for immobilizing metals to reduce leachability. A chelating agent such as ethylenediamine-tetraacetic acid (EDTA) added to sediment forms stable bonds or complexes between the target metal and the agent. Wastewater from post-treatment dewatering requires treatment (Office of Coastal Zone Management, et al., 2012).

Chemical Dehalogenation

Dehalogenation refers to treatment that dissociates chlorine or other halogens and replaces the halogen with bicarbonate or glycol. The strategy is suitable for contaminants such as pesticides, PCBs, and dioxins/furans. A base-catalyzed decomposition process (BCDP) was developed by the EPA Cincinnati Risk Reduction Research Laboratory. In BCDP, screened material is mixed with an alkali or alkaline earth metal carbonate, bicarbonate, or hydroxide in a pugmill or in a heated solvent. The mixture is heated to approximately 660ºF to dewater and allow the organic contaminants to be partially decomposed and removed in another waste stream. The volatilized, partially decomposed contaminants are captured in a liquid phase reactor, condensed, and treated by reaction with sodium hydroxide and a hydrogen donor oil in the presence of a catalyst (a carbon source). The hydrogen donor can include fatty acids, aliphatic alcohols or hydrocarbons, amines, or other similar compounds. Pretreatment by thermal desorption may be required if concentrations of contaminants are in the parts-per-million range rather than the percent range (EPA, 2010). Bench-scale tests on Newtown Creek sediments collected from the New York/New Jersey Harbor achieved destruction efficiencies for dioxins, furans, and PCBs of greater than 99%, and concentrations in the treated sediment were at or below detection limits (Timberlake, 1995). Full-scale applications of this technology exist in Europe, Australia, and Mexico, but none in the United States (Vijgen, 2014).

In glycolate dehalogenation, an alkaline polyethylene glycol (APEG) reagent is used to dehalogenate halogenated organic compounds in a batch reactor. The halogen is removed from the halogenated organic compound and replaced with polyethylene glycol (PEG) to break the carbon-chlorine bond. Screened sediment is mixed with APEG reagent in the heated reactor treatment vessel to form a homogeneous slurry. Other reagents that may be included in the slurry are sodium hydroxide, dimethyl sulfoxide (DMSO), and sulfolane (SFLN) to increase the efficiency of the process. The slurry is then heated to between 77ºF and 302ºF and mixed and washed repeatedly to separate the APEG reagent from the treated soil. The APEG reagent is recycled and the soil dewatered. Processing typically would be performed on-site in a mobile unit. The throughput of a mobile unit is expected to range from 30 to 200 CY per day (NAVFAC, 2014b).

Both processes are stand-alone treatment processes, but they also may be used as pretreatment with other technologies. However, there are a number of limitations. Neither is suitable for large volumes of material. Volatile gas emissions must be collected and treated. Wastewater also must be treated, usually by advanced processes such as chemical oxidation, biodegradation, carbon adsorption, or precipitation. While BCDP can be used to treat halogenated VOCs, the glycolate process is not effective for those compounds (Van Deuren, et al., 2002).

Biological Remediation

Bioremediation

Bioremediation uses bacteria or fungi (mycoremediation) stimulated by soil amendments to remove or reduce the toxicity of environmental contaminants. The objective is to enhance naturally occurring populations of organisms. Biological remediation may occur on its own or may only effectively occur through amendments (such as fertilizers) that help encourage the growth of the pollution-eating microbes within the medium. Organic contaminants, including halogenated organic compounds, may be treated by bioremediation. Removal efficiencies vary considerably, from less than 20% to 99% based on the soil texture, soil chemistry, contaminants, climate, bioremediating organisms, additives used, and other factors.

Phytoremediation

Phytoremediation is a type of bioremediation in which plant processes transform or uptake contaminants into their above- or below-ground parts. These processes include the following (Estes & McGrath, 2014):

- Phytoaccumulation (uptake to above-ground biomass)
- Rhizostabilization (sorption to plant roots – typically metals)
- Rhizodegradation (interaction of roots, root exudates, soil, and microbes to achieve contaminant degradation)
- Phytodegradation (within-plant degradation of contaminants)
- Phytovolatilization (transfer of contaminants to atmosphere through evapotranspiration)
- Phytostabilization (exploitation of high water usage of select plants to contain groundwater flow)

Bioremediation is the operative process in land farming, land tilling, and composting. Slurry bioreactors (discussed below) are a mechanized form of bioremediation. While bioremediation is typically a low-cost alternative, there a number of limitations. Large areas may be required, volatile emissions may require enclosures and treatment of volatized contaminants, and, for some contaminants, natural biodegradation proceeds very slowly.

Heavy metals such as cadmium and lead are not readily absorbed or captured by microorganisms. Phytoremediation may be employed only in areas with lower levels of contamination due to plant toxicity effects (NAVFAC, 2014c). Additionally, there is a risk of increasing the bioavailability of metals such mercury. This is particularly a concern for phytoremediation. Certain plants (such as sunflowers, dandelions, and hops) that tend to hyperaccumulate inorganics and are used to remove metals from the environment can slowly poison wildlife that consume them. Therefore, at sites known to be high in inorganics and where wildlife use is likely, plants should be tested for high metals concentrations to control any hazards to wildlife (NAVFAC, 2014c). To remove metals from a site, plant material used for phytoremediation may be harvested and incinerated, with residuals placed in a landfill. Bioremediation and phytoremediation techniques have been used to treat materials placed in CDFs (Myers & Bowman, 1999). However, full-scale application is not widespread, and some applications of phytoremediation are still in demonstration stages.

Slurry Bioreactor

A slurry bioreactor is a controlled biological treatment vessel where the contaminated sediments are treated in a slurry form at a low solids content. The sediment is mixed with water to a predetermined concentration dependent upon the concentration of the contaminants, the rate of biodegradation, and the physical nature of the sediments. Slurry bioreactors can effectively treat a variety of organic contaminants, including chlorinated and non-chlorinated volatile organics, PAHs, PCBs, and pesticides (Robles-González, et al., 2008). Aerobic or anaerobic conditions can be maintained in the reactor as required for single or sequential treatment. This technique may be combined with other technologies in a treatment train.

Thermal Technologies

There are several fully commercial or demonstrated thermal-chemical technologies that can treat sediment. In general, these use temperature and additives to dissociate or destroy organic contaminants. Thermal desorption is not effective or intended for the treatment of inorganic wastes such as metals, although those with relatively low boiling points, such as mercury or lead, may be vaporized at higher operating temperatures.

Thermal Desorption

Thermal desorption is a physical separation process which heats wastes to volatilize water and organic contaminants. In general, organic contaminants are removed from the sediment and collected in waste streams, rather than dissociated or destroyed. Materials contaminated with heavy tars or high-viscosity fluids may inhibit heat transfer of media (soils and sediments) by fouling or plugging the desorption unit and therefore may not be candidates for thermal desorption (Feeney, et al., 1998).

Three types of conventional mobile or fixed thermal desorption units are available: direct fire, indirect fire, and indirect heat. In the direct fire type, fire is applied directly upon the surface of contaminated media to desorb contaminants from the soil. In the indirect fire type, a direct-fired rotary dryer heats an air stream which, by direct contact, desorbs water and organic contaminants from the soil. In the indirect heat type, an externally fired rotary dryer volatilizes the water and organics from the contaminated media into an inert carrier gas stream.

A vacuum system or a carrier gas transports the volatilized organic contaminants released from heated wastes to an off-gas treatment system. There, any particulates present are removed by conventional particulate removal equipment (such as wet scrubbers or fabric filters), and contaminants are removed either through condensation followed by carbon adsorption or through destruction in a secondary combustion chamber or a catalytic oxidizer.

Conventional thermal desorption processes can be categorized into two groups: high temperature thermal desorption (HTTD) and low temperature thermal desorption (LTTD). Prior to treatment, the dredged material must be processed to remove debris and dewatered. Dewatering may be mechanical or through amendments. For example, processing for the Gowanus Canal, New York, Superfund clean-up proposed the addition of Portland cement (at 7.5%) for dewatering and the stabilization of inorganic contaminants (EPA, 2013). The grain size of sediment, as well as characteristics such as moisture content, British thermal unit (Btu) value, cohesiveness, and plasticity, significantly affect treatment efficiency and throughput. Typical residuals from thermal desorption systems are the treated off-gas, spent carbon, condensed water, wastewater (treated or untreated), treated materials, noncontact combustion gases, particulates, filters, and catalysts.

High Temperature Thermal Desorption

In HTTD, wastes are heated to 600 to 1,000°F. HTTD is frequently used in combination with incineration, solidification/stabilization, or dechlorination, depending upon site-specific conditions (Feeney, et al., 1998).

Low Temperature Thermal Desorption

In LTTD, wastes are heated to between 200 and 600°F. LTTD is a full-scale technology that has been proven successful for benzene, toluene, ethylbenzene, and xylenes (BTEX) or TPH-contaminated soils (Feeney, et al., 1998). Contaminant destruction efficiencies in the afterburners of these units are greater than 95%. The same equipment could probably meet stricter requirements with minor modifications, if necessary. Decontaminated soil retains its physical properties. Unless the soil is being heated to the higher end of the LTTD temperature range, organic components in the soil are not damaged, which enables treated soil to retain the ability to support future biological activity.

Incineration

Incineration is performed by supplying heat from fuel combustion to cause thermal decomposition of a waste feed of typically organic contaminants through cracking and oxidation reactions at high temperatures. Most organic compounds are destroyed at temperatures between 1,100°F and 1,200°F; waste incinerators are therefore operated between 1,400°F and 3,000°F. In addition to the temperature applied, the residence time of the waste in the incinerator and the mixing of the waste are important to ensure complete destruction of the waste and efficient operation. The organic compounds primarily are converted into carbon dioxide and water vapor. Other products of incineration can include nitrite oxides, nitrates, and ammonia (for nitrogen-containing wastes); sulfur oxides and sulfate (for sulfur-containing wastes); and halogen acids (for halogenated wastes) (NAVFAC, 2014d).

Contaminated soils typically are treated in a rotary kiln or a fluidized bed incinerator. The first unit is the primary combustion chamber (i.e., primary burner) or kiln, which receives the contaminated media. In this unit, the organic contaminants are volatilized and destroyed. The residual material (such as sediment in the kiln) is gravity-dropped and cooled for placement or treated if necessary (e.g., solidification/stabilization to reduce metal leachability) prior to disposal. The off-gas from the kiln is collected in a second unit, the secondary combustion chamber (SCC) (afterburner), where uncombusted organics and other by-products are further destroyed. Off-gas is collected from the afterburner, cooled, and treated to prevent air pollution. The treatment varies depending on the type of contaminants and material initially treated.

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4 AFFECTED ENVIRONMENT

This chapter presents a general description of the environments where dredged material from USACE and other Federal agency navigation projects in the Long Island Sound region can be placed or used for alternative purposes such as beneficial use. The individual chapter sections are structured to first describe the general regional characteristics of each resource or system, then to describe those specific resources that may be affected by placement of dredged material within alternatives sites identified in Chapter 3. The alternative sites have been grouped by the environments in which they are located (Open Water, Nearshore/Shoreline, and Upland) to facilitate the presentation and discussion of resource data.

This chapter differs somewhat from descriptions of affected environments presented in typical EISs or environmental impact reports, because it is designed to support a programmatic level of analysis, not to determine the impacts of dredged material placement or use at a single preferred alternative. This PEIS compares the effects of placement at *types* of alternatives: open water, confined placement, beneficial use, and innovative treatment. Information specific to individual site alternatives for dredged material placement is provided if available; however, site-specific NEPA documents for individual placement projects will draw upon this analysis and will be required to address environmental effects at the project level.

The environmental consequences analysis (Chapter 5) is structured to consider the known impacts of dredged material placement at each of these alternative types, then to assess the potential impacts associated with each of the specific alternative sites. That analysis builds on the information presented in this chapter.

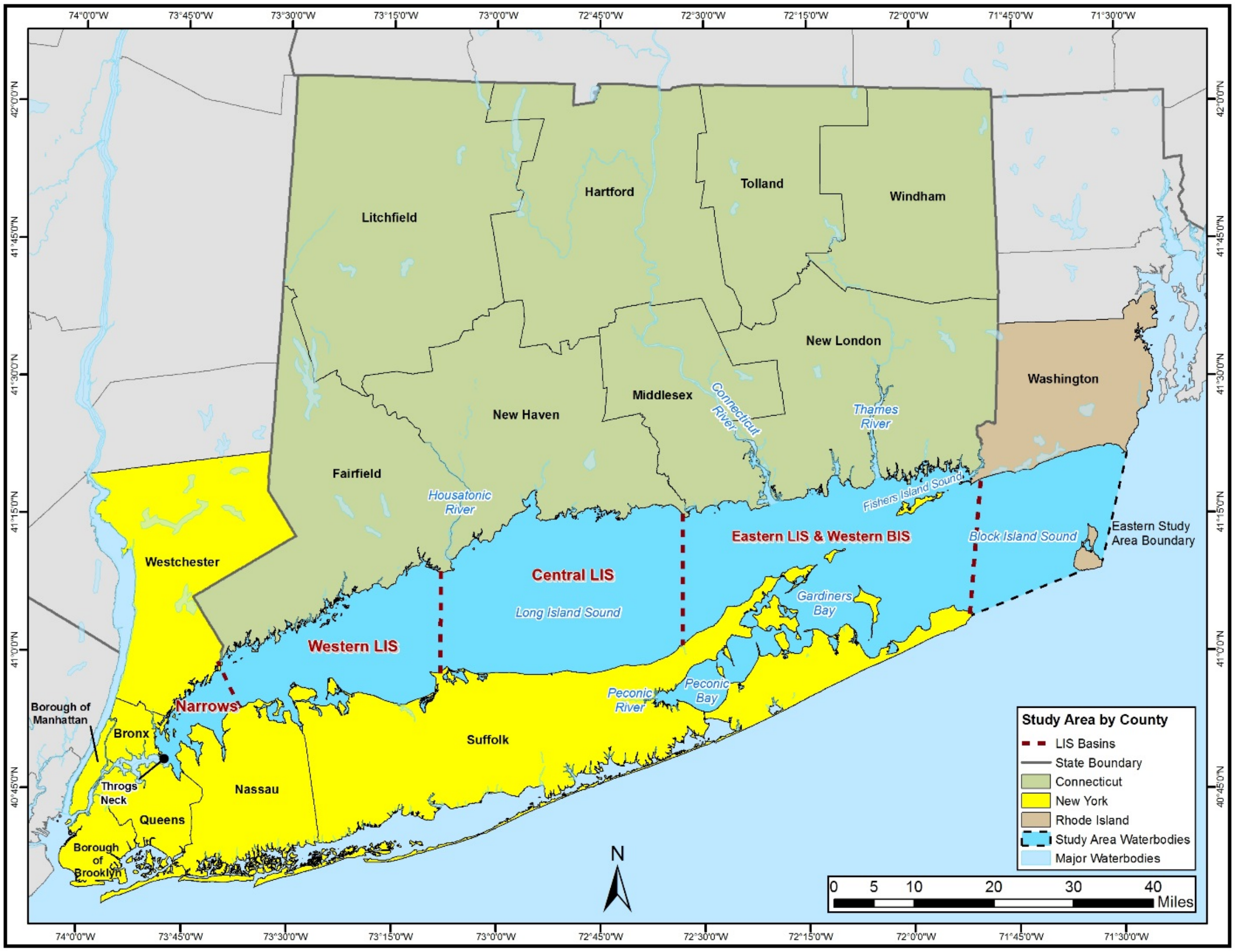
4.1 LONG ISLAND SOUND STUDY AREA

The study area for this PEIS is the Long Island Sound Estuary and surrounding watersheds (Figure 4-1). Long Island Sound is a 110-mi-long, semi-enclosed estuary located between the coastline of Connecticut and the northern coastline of Long Island, New York. The Connecticut-New York state line runs east-west through the middle of Long Island Sound. Unlike most estuaries, Long Island Sound is connected to the ocean at both ends. The eastern end ("the Race") of Long Island Sound presents an open passage to the North Atlantic Ocean, while the ocean passage at the western end is more restricted, traveling through the Narrows, along the East River, and around the western tip of Long Island.

Long Island Sound is one of the most significant coastal areas in the nation; its watershed, which includes an area of more than 16,000 mi^2, traverses all of Connecticut and parts of New York, Massachusetts, New Hampshire, Rhode Island, and Vermont (EPA, 1994). Three major rivers (the Connecticut, Housatonic, and Thames) deliver freshwater to the Sound, which is bounded by Connecticut and New York's Westchester County to the north, by New York City to the west, and by Long Island to the south. Long Island Sound intersects Washington County, Rhode Island, at the easternmost boundaries of Connecticut and New York (Figure 4-1).

For discussion purposes, Long Island Sound can be divided into three major regions defined by submarine features: the Western, Central, and Eastern Basins. As shown in Figure 4-1, the Western Basin is the area from the Narrows (between Throgs Neck and Willets Point, New York) to the Stratford Shoal (between Stratford Point, Connecticut [near Bridgeport, Connecticut], and Port Jefferson, New York). The Central Basin stretches from the Stratford Shoal to the Mattituck Sill (between Mulberry Point, Connecticut [near Guilford, Connecticut], and Mattituck Point, New York). The Eastern Basin extends from the Mattituck Sill to the Race at the eastern end of Long Island Sound and includes Peconic Bay, Gardiners Bay, Fishers Sound, and western Block Island Sound (Figure 4-1). These boundaries were used in this PEIS for organizing and summarizing resource data for Long Island Sound and do not reflect jurisdictional or regulatory boundaries. The only portion of Block Island Sound evaluated in this PEIS is the western portion of the Sound located within the Eastern Basin (as described above) and its nearshore waters along the coasts of Washington County and Block Island.

The terrestrial portion of the study area includes Washington County in Rhode Island (including Block Island), the State of Connecticut, and Westchester, Bronx, Queens, Suffolk, and Nassau counties of New York, as well as the Boroughs of Brooklyn (Kings County) and Manhattan (New York County), New York (Figure 4-1).



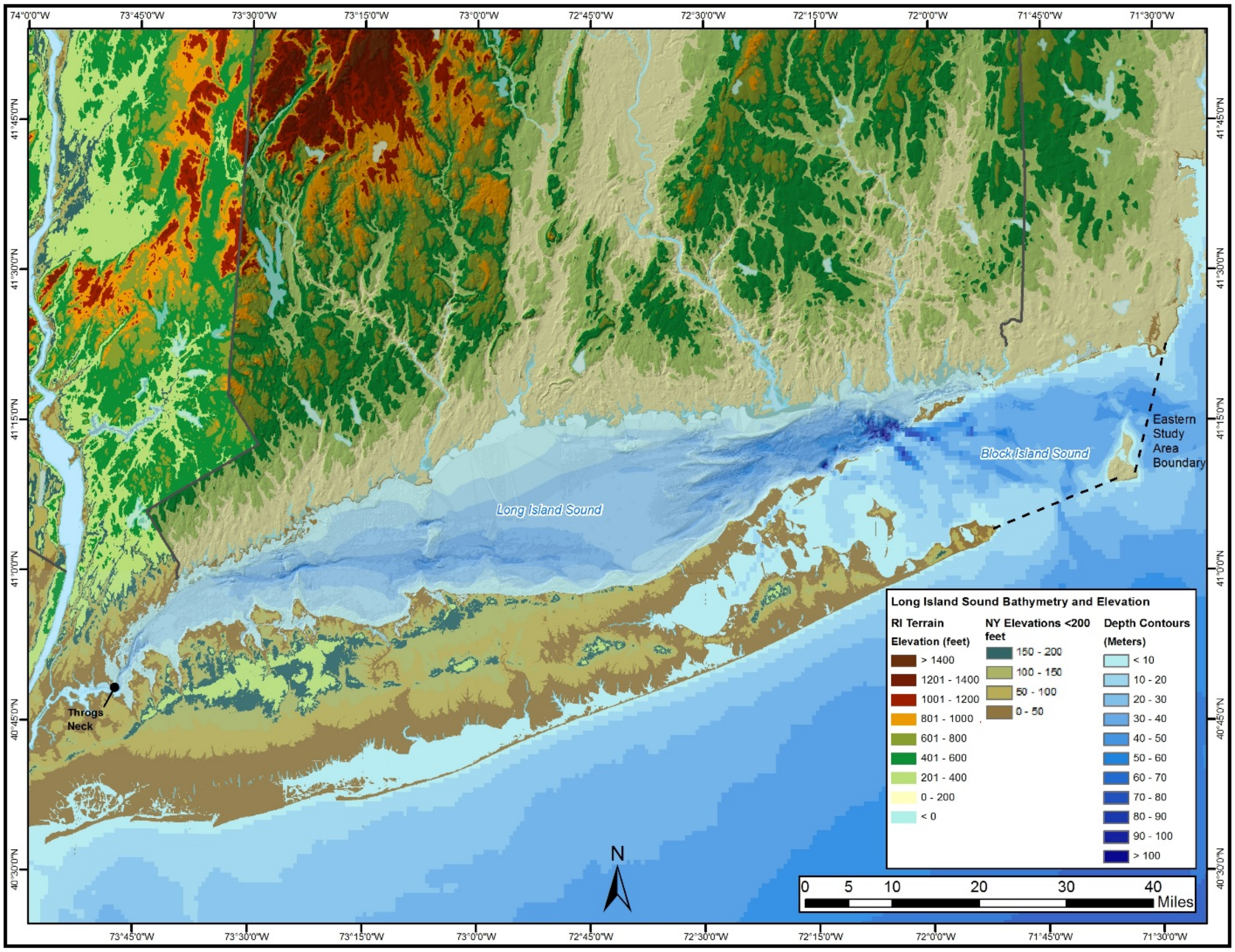
Note: The basin boundaries shown here were used for summarizing resource data only, and they do not represent jurisdictional or regulatory boundaries within Long Island Sound.

Figure 4-1. Long Island Sound PEIS Study Area.

4.2 GEOLOGICAL SETTING AND LANDSCAPE

4.2.1 General Long Island Sound Setting

The geological setting of the Long Island Sound study area is a primary driver of dredged material management alternatives. Long Island Sound lies at the junction of the glacially modified bedrock landscape of New England and the sediment-dominated Atlantic Coastal Plain (Lewis, 2014). Long Island Sound has an east-west axis roughly parallel to the coast of southern New England (Figure 4-2). The orientation of the basin is controlled by the elongated moraine complex that borders the southern New England coastline. This unique combination results in a striking contrast between the northern shore and southern shore of Long Island Sound. The northern shore is bedrock-controlled with dominant north-south drainage, headlands, and pocket beaches and marshes. The southern shore is sediment-dominated with large amounts of unconsolidated materials, limited drainage, and a long, straight coastline.



Sources: Gesch (2007); Gesch, et al. (2002); CTDEEP (2014a);Bonynge (2008); NOAA (1998); Long Island Sound Resource Center (2014).

Figure 4-2. Long Island Sound Bathymetry and Land Topography.

The location of harbors, the sources and types of sediments, and any opportunities for beneficial placement are strongly affected by the geological history of southern New England compared to Long Island. A brief review of this history will help provide the context; a more detailed history is available in Lewis (2014). The structure of the southern New England landscape was formed beginning over 500 million years ago, when large blocks of continents, called 'terranes,' were pushed together and subsequently nearly pulled apart. The dominant forces were east-west, and the bedrock formed from the blocks aligned in north-south trending segments divided by fractures and faults. Streams formed along these joints and coalesced into a drainage system with a strong southward flow in subparallel watersheds divided by north-south ridges. Glacial erosion and deposition did little to change this pattern; meltwater streams occupied these bedrock valleys and discharged to the south. The resulting landscape consists of north-south streams and rivers draining bedrock well to the north of Long Island Sound and depositing fine-grained erosional remnants of the bedrock in isolated pockets between rock headlands. Harbors located in these pockets are frequently rock-bound and filled with fine-grained sediment.

The structure of Long Island, in contrast, was almost entirely defined by deposition of Coastal Plain deposits from the Cretaceous Period (66 million to 140 million years ago) and by subsequent modification and deposition from glacial activity. The east-west orientation of Long Island is defined by two glacial moraines; drainage from the crest of these moraines is short and limited. Most of the island's surface is covered in unconsolidated sands and gravels that are highly permeable. Most harbors on Long Island are located between headlands formed by resistant Coastal Plain or glacial deposits rather than bedrock. The harbors are shallow and contain material eroded from bluffs of clay or unconsolidated sediments, generally sands and gravels.

Long Island Sound was formed by glaciation, glacial retreat, and marine submergence (Stone, et al., 2005). During the Pleistocene Period, and at a time when sea level was lower and the coastline was out along the continental shelf, at least four ice sheets advanced over Long Island Sound, scouring the bedrock in Connecticut and depositing glacial drift in the vicinity of present-day Long Island (Lewis, 2014). The last ice sheet receded between 20,000 and 22,000 years ago, leaving a series of recessional moraines along the north shore of Long Island (Stone, et al., 2005). This moraine complex dammed glacial meltwater to form an extensive glacial lake, Lake Connecticut, which nearly filled with meltwater deposits including lake clays. Erosion of a spillway at the eastern end of the Race drained the lake, exposing the lake bed 18,000 years ago (Stone, et al., 2005). At the same time, sea level began to rise, eventually submerging the Long Island Sound basin, perhaps several times (due to rebound of the earth after the glaciers melted). The fluctuations of sea level and glacial retreat and advance resulted in the formation of complex layers of sediment in the basin of Long Island Sound that have been extensively reworked by tidal and atmospheric storm forces.

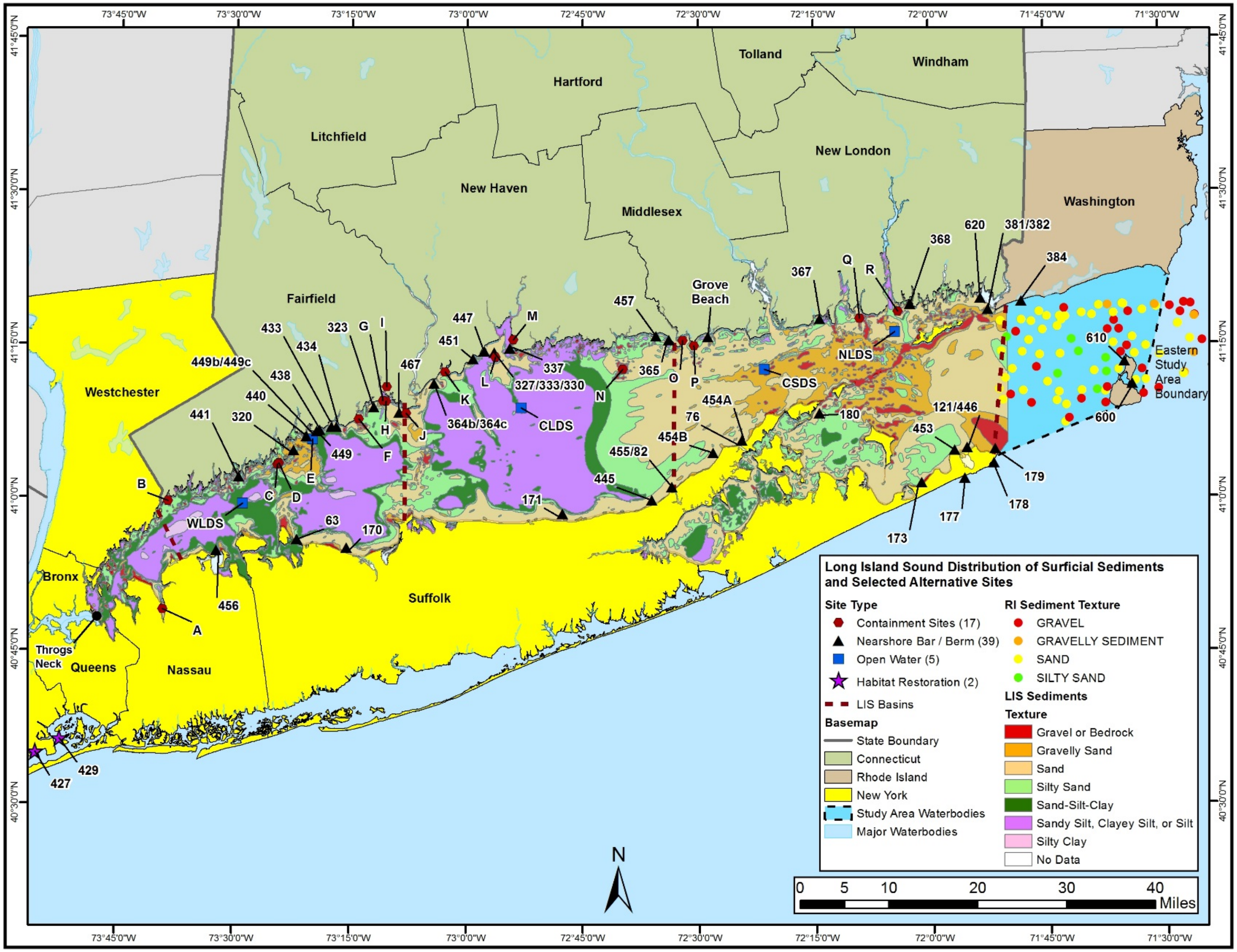
Glaciolacustrine and marine deltaic deposits at the eastern end of Long Island Sound were eroded, sorted, and transported westward (Knebel & Poppe, 2000). Marine mud deposits, now found in the Western and Central Basins of Long Island Sound, accumulated during sea level rise. The present-day geomorphology of Long Island Sound is characterized by irregular, hummocky topography in the eastern part of the Sound and broad, relatively flat basins separated by shoals in the western and central part of the Sound. The irregular topography has been shaped by strong physical forces (storms, tidal exchange), while the shoals are submarine outcrops of coarse-grained glacial drift.

Long Island Sound has a mean depth of 79 ft. Each of its basins has distinct sedimentological characteristics (Figure 4-3) (Poppe, et al., 2001). The Narrows from Throgs Neck to Willets Point, New York, is a restricted basin bounded by the East River to the west with relatively weak bottom currents (Signell, et al., 2000) but complex tidal circulation (O'Donnell, et al., 2014a). This portion of the Western Basin is predominantly silt with patches of silty sand and gravel on shoal areas that extend from the shoreline. The rest of the Western Basin (Willets Point to Stratford shoal) has much more complex sediment distribution, including silty sands, sands and gravels on the Norwalk shoal complex, and silt on the floor of the deepest part of the basin (Figure 4-3). The topography in the Western Basin consists of relatively flat areas west and east of the Norwalk shoal complex (Figure 4-3). The entire basin contains an east-west axial depression roughly in the center of the Sound. The axial depression transects the Norwalk and Stratford shoal complexes, where it becomes very narrow (1,600 ft) and deep (200 ft) (Knebel & Poppe, 2000). These areas of shoal cut by the depression have the coarsest sediments with gravel and sand bedforms. The Norwalk and Stratford shoal complexes have maximum relief of about 130 ft; these complexes are oriented roughly north-south across the Sound and have distinctive headlands and rocky islands at the shorelines.

The Central Basin is relatively flat with a broader depression that is deepest along the northern shore of Long Island (Figure 4-2). The basin has a broad, flat floor with an increase in slope towards the Connecticut shore. The sediments within the basin are distinctive olive-green silt; these sediments include silty sand and silt on narrow shoals that extend from the Housatonic delta and New Haven harbor (Figure 4-3). The eastern end of the Central Basin is marked by the Mattituck Sill. The sill is actually an erosional scarp with a series of east-west tidal ridges and channels that grade from a broad band of sand-silt-clay to silty sand to sand (Figure 4-3). The sand-silt-clay horizon represents the transition from depositional conditions to tidal and storm driven sediment transport (Knebel & Poppe, 2000).

The Eastern Basin has a highly complex seafloor topography, with east-west tidal ridges and channels (including Long Sand shoal) that grade into very hummocky terrain with scour holes and knolls as the Sound narrows to the Race between Plum Island and Fisher’s Island (Figure 4-2). Water depths on the ridges can be as shallow as 65 ft near the Connecticut River and as deep as 330 ft in the scour holes. Sediments in this region are generally coarse, with well-sorted sands on the tidal ridges and gravelly sand and gravel in the scour depressions (Poppe, et al., 2000).

The eastern part of the study area includes the Peconic Estuary and parts of Block Island Sound (Figure 4-3). The Peconic Estuary is located between the north and south forks of Long Island and encompasses Peconic River and Bay, Gardiners Bay, other smaller bays. Peconic Bay is shallow with variable sediment ranging from sand to silt to sand-silt-clay. Inside Gardiners Bay, the seafloor is shallow and relatively smooth with a broad distribution of silty sand and sand on shoal areas (Figure 4-3). Outside Gardiners Bay in Plum Island Sound and Block Island Sound, the seafloor is irregular and complex, with tidal channels and ridges (Figure 4-2). The sediments range widely from silty sand behind Montauk Point to extensive deposits of gravel and sand



Sources: Poppe, et al. (2001); Poppe (2012).

Figure 4-3. Long Island Sound Sediment Map.

(Figure 4-3). The barrier islands of southwestern Rhode Island are part of a glacial moraine that extends out to Fire Island, New York. Like its geological cousins, Block Island is composed of loose glacial deposits and a small amount of other unconsolidated or weakly consolidated and sedimentary rock. Bedrock lies far below the surface, and since its formation, Block Island is geologically dynamic, having been subjected to steady erosion by winds, currents and storms (Rhode Island Historical Preservation Commission, 1991).

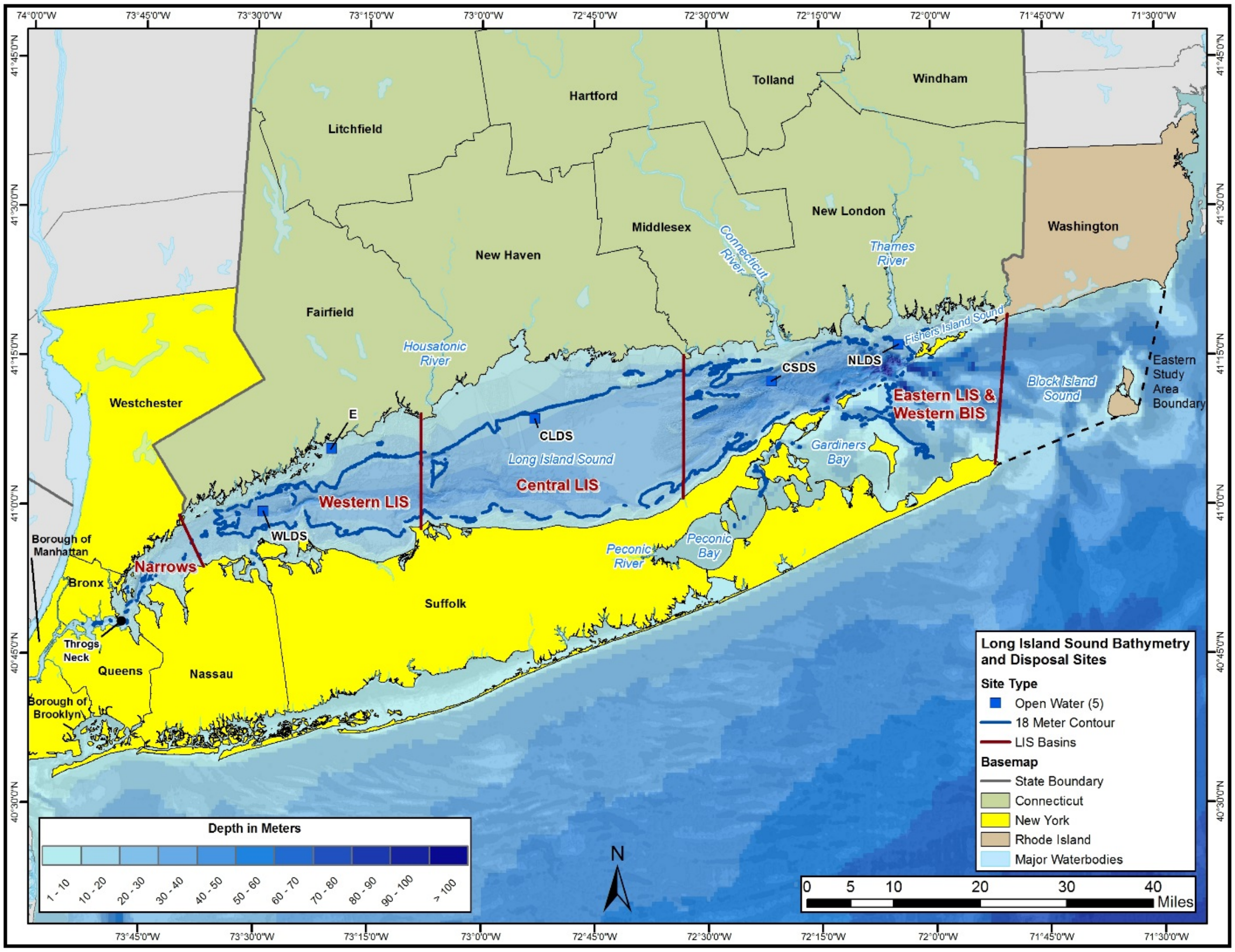
4.2.2 Geologic Setting of the Open-Water Environment

The open-water environment of Long Island Sound is the part of the estuary deeper than about 40 ft. In general, the portion of the open-water environment of Long Island Sound that is suitable for placement of dredged material under conditions where it will remain deposited is the part of the estuary deeper than about 59 ft; the exception is the eastern portion of the central Sound, which is influenced by strong tidal currents that flow through the Race (Figure 4-4). There are currently four open-water placement sites for dredged material in Long Island Sound (Figure 4-4): WLDS, CLDS, CSDS, and NLDS. WLDS, CLDS, and NLDS are retentive sites where dredged material placed at the site remains at the site. CSDS is the only dredged material disposal site of these four that is managed as a dispersive site, where dredged material placed at the site is expected to be transported out of the area by bedload transport from strong tidal currents and sediment resuspension during storm events. Confined placement refers to areas where a low mound of dredged material on the seafloor is covered with additional layers of dredged material to ‘cap’ or confine the initial placement (Fredette, et al., 1992). There is one proposed confined open-water placement site alternative for dredged material in this region of Long Island Sound: Site E - Sherwood Island Borrow Pit E.

Western Long Island Sound Disposal Site

The WLDS site occupies an area of seafloor located in the Western Basin of Long Island Sound with sand-silt-clay deposits (Figure 4-3). The seafloor at the WLDS site is a plane, gently sloping downward from north to south and bisected by an axial depression that runs from east to west. Water depths range from 75 ft in the northwest corner to 85 ft in the northeast corner, down to 98 ft along the southern boundary, with the 118-ft-deep cut of the axial depression occupying one quarter of the area of the site in the southern half (ENSR, 2007). Distinct mounds from past dredged material placement activities are present, with peaks almost 12 ft above the seafloor and at a minimum water depth of 89 ft, including some in the axial depression (ENSR, 2007).

Natural sediments at WLDS consist primarily of fine silt and clays, as confirmed by the results of sampling conducted there in support of the Long Island Sound Dredged Material Site Designation EIS (EPA, 2004) [Appendix H-1]). The site is in an area of sediment accumulation, which is indicative of a generally low current regime. In particular, there is an area that shoals rapidly along the southern border of WLDS. Bokuniewicz & Gordon (1980a) estimated that the area in which WLDS is situated has accumulated 200 to 400 grams per square meter per year ($g/m^2/yr$) of sediment during the last 8,000 years.



Sources: NOAA (1998); Long Island Sound Resource Center (2014).

Figure 4-4. Bathymetric Map of Long Island Sound (59-ft [18 m] Contour Highlighted).

Central Long Island Sound Disposal Site

The CLDS occupies an area of seafloor located in the northern Central Basin of Long Island Sound at the tip of a historic submerged delta outside New Haven Harbor (Figure 4-4). The seafloor at CLDS slopes from a depth of 59 ft at the northwest corner to 72 ft in the southeast corner, with distinct disposal mounds from past dredged material placement activities rising to depths as shallow as 46 ft (AECOM, 2013).

The bottom sediments at the CLDS site are composed of fine silts and clays characteristic of the low-energy environment found in deep areas of the Western and Central Basins. This characterization was confirmed by the results of sampling conducted in support of the Long Island Sound Dredged Material Site Designation EIS (EPA, 2004) [Appendix F]). The site is in an area of sediment accumulation which is indicative of a generally low current regime. Bokuniewicz & Gordon (1980a) estimated that the area in which CLDS is situated has accumulated 200 to 600 g/m^2/yr of sediment during the last 8,000 years.

Cornfield Shoals Disposal Site

The CSDS occupies an area of seafloor located in the Eastern Basin of Long Island Sound south of the mouth of the Connecticut River (Figure 4-4). Of the four open-water placement sites, the CSDS is the only one managed as a dispersive site. The predominant topographic features are a smooth, sandy bottom and sand wave bedforms oriented in an east-west direction that gently slope from northeast to southwest. A June 2004 bathymetric survey of the CSDS found no distinct disposal mounds, which is consistent with the dispersive nature of the site (ENSR, 2005a). Water depths ranged from 151 ft in the northeast corner to a maximum depth of 189 ft in the southwestern quadrant (ENSR, 2005a). The coarse particle size of sediments at the site, sand and gravel, are a result of high-energy physical processes from tidal currents, atmospheric storms, and the Connecticut River outflow in the area. Observations of clay nodules from glacial lake deposits also provide evidence of scouring at the site (SAIC, 1988).

New London Disposal Site

The NLDS occupies an area of seafloor located in the Eastern Basin of Long Island Sound at the mouth of the Thames River and west of Fishers Island Sound in sandy deposits (Figure 4-4). The 1-nmi^2 NLDS has water depths ranging from 46 ft over the NL-RELIC Mound to 79 ft at the southern disposal site boundary (AECOM, 2009). A broad trough runs northwest to southeast in the southwest quadrant of NLDS (AECOM, 2009). The seafloor sediments in the site range from silt clay with shell fragments to fine sand (AECOM, 2009).

Confined Open-Water Site E Alternative

The Sherwood Island Borrow Pit (Site E) alternative site is a potential 100-acre confined placement site approximately 1/2 mi offshore of Sherwood Island State Park, Westport, Connecticut. Because this site is located outside of a harbor within the waters of Long Island Sound, it is subject to MPRSA and is considered an open-water alternative site. The site consists of an existing, historically used borrow pit approximately 30 ft deeper than the surrounding area, which has average depths of -20 ft mean low water (MLW). The area surrounding the borrow pit site is characterized as gravel, gravelly sand, sand/silt/clay, silty sand, and sand (USACE, 2010a). The material at the bottom of the pit is described as “granular” (USACE, 1985).

4.2.3 Geologic Setting of the Nearshore/Shoreline Environment

The nearshore/shoreline environment of Long Island Sound is the part of the estuary shallower than about 40 ft. Placement alternatives that could occur in this zone, as well as along the Rhode Island barrier islands and Block Island shoreline, include berm and beach replenishment as well as island and shoreline restoration, depending on the characteristics and appropriateness of the dredged material. Confined placement alternatives that could occur in this zone include CAD cells, as well as CDF sites on the shoreline or as constructed islands. Confined placement options are designed to contain dredged material within a structure or by layering additional dredged material to cap and confine the initial layer of placed sediment. Areas with environmental conditions that would support the beneficial use of dredged material, such as protected low-energy areas, have been identified as alternatives (Figure 4-3).

The diverse shoreline of Long Island Sound encompasses rocky intertidal areas, beaches, tidal flats, salt marshes, and industrialized and developed areas. On the northeastern end of the Sound, Fishers Island in New York State and the southwestern shore of Rhode Island were formed from rocky till of the terminal glacial moraine that once extended from the North Fork of Long Island all the way to the peninsula of Watch Hill, Rhode Island. Along the northern shore, rivers that flow through glacial meltwater-carved valleys have infilled these areas, creating small deltas and muddy harbors and supporting salt marsh development. The longest river in New England, the Connecticut River, carries sediment from an extensive watershed, resulting in large shoals at its mouth that restrict navigation. There are pocket beaches between bedrock protrusions or rock headlands, which reduce wave energy and the longshore transport of sand along the north shore. Barrier spits tend to be small. The south shore has long expansive beaches and bluffs of till and glacial drift that erosional processes have straightened, as the bedrock is buried deep under coastal plain and glacial sedimentary deposits. Along the south shore, the sediment in the Narrows and the western part of the Western Basin is siltier than the sandy shoreline to the east. Gardiners and Peconic Bays at the eastern end has a mixture of silty sands in protected areas and gravelly sand and bedrock in areas exposed to the dynamics of ocean waters, which flow through the Race separating Long Island from Fishers Island.

Confined Placement

In-Harbor CAD Cells

There are three In-Harbor CAD cell alternatives located in Connecticut: Bridgeport Outer Harbor West (G), Bridgeport Outer Harbor Southeast (H), and Morris Cove (M) (Figure 4-3). CAD cells can be sited by using existing seafloor depressions and borrow pits or through newly excavated pits that are used for placement and containment of dredged materials. All of these alternatives are located in protected harbor or cove areas. The area and sediment grain size of these alternative sites are presented in Table 4-1.

Island CDFs

There are six Island CDF alternatives located in Connecticut: Greenwich Captain Harbor (B), New Haven Breakwaters (L), Falkner Island (N), Duck Island Roads (P), Twotree Island (Q), and Groton Black Ledge (R) (Figure 4-3). The proposed Island CDFs would be constructed in shallow coastal water adjacent to islands, using confinement, retention dikes, or other structures to isolate the dredged material from the surrounding water. More details are provided in USACE (2010a). The area and sediment grain size of these alternative sites are presented in Table 4-1.

Shoreline CDFs

There is one Shoreline CDF alternative in New York, Hempstead Harbor (A). Seven alternatives are in Connecticut: Norwalk Outer Harbor Islands Marsh (C), Norwalk Outer Harbor Islands Shore (D), Penfield Reef (F), Bridgeport Yellow Mill Channel (I), Stratford Point (J), Milford Harbor (K), and Clinton Harbor (O) (Figure 4-3). The proposed Shoreline CDFs would be constructed in shallow coastal water adjacent to shoreline land, using confinement, retention dikes, or other structures to isolate the dredged material from the surrounding water. More details are provided in USACE (2010a). The area and sediment grain size of these alternative sites are presented in Table 4-1.

Table 4-1. Geological Resources in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Area or Capacity/Geology
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	14 acres; requires excavation; silty sand
		H	16 acres; requires excavation; silty sand
		M	30 acres; existing borrow pit; sand/silty sand
	Island CDF	B	49 acres; gravel, silty sand
		L	1,150 acres; sand, silty sand, sandy silt
		N	240 acres; gravel and sand
		P	48 acres; sand
		Q	80 acres; gravel, gravelly sand, sand
		R	125 acres; rocky shoal; gravel, gravelly sand, sand and silty sand
	Shoreline CDF	A	116 acres; silty sand, sand
		C	78 acres; salt marsh creation; silty sand, sand
		D	33 acres; gravelly sand
		F	1,035 acres; small island and submerged reef; gravel, gravelly sand, sand and silty sand
		I	16 acres; industrial channel; sandy silt
		J	1,090 acres; gravel, gravelly sand, sand
		K	11 acres; gravelly sand, sand
		O	100 acres; salt marsh creation; sand
	Nearshore Bar Placement/ Nearshore Berm Sites[1]	177	33,700 CY; medium sand
		178	84,300 CY; cobble to coarse sand
		179	131,100 CY; cobble to coarse sand
		121/446	202,400 CY; medium to fine sand
		453	105,100 CY; medium to fine sand
		173	276,000 CY; coarse sand
		180	204,100 CY; medium sand
		454A	155,100 CY; coarse sand
		454B	72,800 CY; coarse sand
		455/82	100,000 CY initial construction; 92,000 CY every 9 years; medium sand
		445	129,600 CY; medium to coarse sand
		171	197,800 CY; coarse to medium sand
		170	242,800 CY; medium to coarse sand
		63	248,300 CY; medium to fine sand
		456	96,200 CY; medium sand
		441	28,200 CY; coarse sand
		320	30,200 CY; medium to coarse sand
		440	58,400 CY; coarse sand
		449	106,000 CY; coarse sand
		438	12,700 CY; coarse sand
		433	27,200 CY; coarse sand
		434	20,100 CY; coarse sand
		323	143,100 CY; medium sand
		467	45,300 CY; medium sand
		364	25,400 CY; fine sand
		451	8,200 CY; medium to coarse sand
		447	55,000 CY; medium sand

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[1] Generally placed along the ~15 ft depth and high relief mounds

Table 4-1. Geological Resources in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Area or Capacity/Geology
Nearshore/ Shoreline Environment (Continued)		327/333/330	214,700 CY; medium sand
		337	55,600 CY; medium sand
		457	8,700 CY; coarse to medium sand
		365	140,00 CY; medium sand
		GP	62,800 CY; medium sand
		367	48,600 CY; medium sand
		368	72,300 CY; coarse sand
		381/382	154,900 CY; medium to fine sand
		384	70,500 CY; medium to fine sand
		600	192,274 CY; poorly graded medium sand
		610	194,495 CY; sandy cobble
		620	80,000 CY; sand
	Beach Nourishment	323	130,900 CY; well sorted medium-grained sand with shell hash
		433	15,700 CY; Poorly sorted coarse-grained sand
		434	6,300 CY; Poorly sorted medium to coarse-grained sand
		436	24,700 CY; Moderately sorted medium to coarse-grained sand
		365	562,700 CY; Moderately sorted medium-grained sand
		457	4,300 CY; Poorly sorted coarse to medium--grained sand with gravel
		364	21,000 CY; Poorly sorted fine-grained sand with shell material
		444	5,300 CY; Poorly sorted medium-grained sand
		451	500 CY; Poorly sorted medium to coarse-grained
		337	3,400 CY; Well sorted medium grained sand with gravel
		320	31,900 CY; Well sorted medium grained sand on south end; Poorly sorted coarse sand to gravel on north side
		441	20,100 CY; Poorly sorted coarse sand
		442	38,700 CY; Poorly sorted coarse-grained sand
		450	54,400 CY; Poorly sorted coarse-grained sand with shells
		447	63,100 CY; Well sorted medium grained sand
		438	2,800 CY; Poorly sorted coarse-grained sand
		440	65,800 CY; Poorly sorted coarse-grained sand on east-facing beach. Cobble and gravel on southwest-facing beach
		449	71,400 CY; Poorly sorted coarse-grained sand on east-facing beach, becoming coarser with pebbles and debris toward northern end of this beach.
		181	33,750 CY; Well sorted fine-grained sand
		453	400,000 CY initial construction; 20,000 CY every year; Moderately well sorted medium to fine-grained sand

Table 4-1. Geological Resources in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Area or Capacity/Geology
		63	600,000 CY initial construction; 124,000 CY every 5 years; Well sorted medium to fine-grained sand
		456	77,200 CY; Poorly sorted medium-grained sand with gravel
		454E	162,800 CY; Poorly sorted coarse-grained sand with gravel
		454W	50,700 CY; Poorly sorted coarse-grained sand with gravel
		455/82	100,000 CY; Well sorted medium sand with some pebbles
		384	32,000 CY; Well sorted medium to fine-grained sand
		367	10,400 CY; Well sorted fine sand
		368	131,200 CY; Mostly pebbles and some gravel at east end. Coarse sand and gravel with pebbles at west end
		171	164,100 CY; Poorly sorted coarse to medium-grained sand with gravel
		173	319,600 CY; Poorly sorted coarse-grained sand
		177	20,100 CY; Well sorted medium-grained sand
		178	76,900 CY; Cobbles
		179	147,300 CY; Cobbles with intermixed sand
		170	160,600 CY; Moderately well sorted medium to coarse-grained sand
		180	119,900 CY; Moderately sorted medium-grained sand with some gravel and shells
		445	120,000 CY; Medium to coarse-grained sand
		446	427,400 CY; Well sorted medium to fine-grained sand
		343	1,200 CY; Poorly sorted medium to coarse-grained sand with gravel
		474	100 CY; Poorly sorted coarse-grained sand
		339	6,400 CY; Moderately well-sorted medium-grained sand with crushed shells
		459	5,300 CY; Poorly sorted medium grained sand to coarse sediment with gravel
		348	1,700 CY; Well sorted fine sand
		480	3,300 CY; Well sorted medium to fine-grained sand
		467	23,200 CY; Poorly sorted medium-grained sand with shell hash
		468	31,700 CY; Cobble
		325	51,200 CY; Well sorted medium grained sand
		327	11,600 CY; Medium grained sand with shell hash
		329	17,700 CY; Well sorted medium-grained sand
		330	17,700 CY; Well sorted medium grained sand

Table 4-1. Geological Resources in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Area or Capacity/Geology
		331	29,800 CY; Coarse to medium-grained sand
		332	27,700 CY; Well sorted medium-grained sand
		333	1,800 CY; No beach; rocky headland; beach parcels on either side
		344	600 CY; Well sorted coarse sand
		345	42,200 CY; Well sorted medium to coarse-grained sand
		121	9,000 CY; Well sorted medium-grained sand
		64	128,800 CY; Poorly sorted medium sand
		67	3,600 CY; Poorly sorted medium sand with pebbles
		68	2,400 CY; Well sorted medium sand
		111	23,900 CY; Poorly sorted medium to coarse-grained sand with pebbles
		76	23,200 CY; Poorly sorted coarse-grained sand
		79	14,400 CY; Moderately well-sorted coarse-grained sand
		381	22,600 CY; Well sorted medium to fine-grained sand
		382	68,100 CY; Well sorted medium to fine-grained sand
		437	41,600 CY; N/A
		600	66,667 CY; poorly graded medium sand
		610	66,667 CY; sand with stone and cobble in some areas
		620	80,000 CY; medium to fine sand

Generally placed along the ~15 ft depth and high relief mounds
Sources: USACE (2010a); USACE (2012a); USACE (2012b).

Beneficial Use

Nearshore Bar/Berm Placement

There are 39 nearshore bar and berm placement alternatives (Figure 4-3). Similar to direct beach nourishment, nearshore bars and berms can provide protection and sediment to nourish the littoral system and shoreline. Generally, berms are placed along the ~15 ft depth as high-relief mounds. Feeder berms would consist of clean sands or sands mixed with some finer materials and would temporarily affect surface sediments. Stable berms are generally longer-lasting features constructed in deeper water or low-energy environments, where sediment transport is limited. These berms can be constructed with finer-grained material since the environment is not conducive to wave- or current-induced sediment transport. Stable berms can also promote sedimentation and reduce erosional processes (protect shorelines) by reducing wave energy. Location, length, and additional details are provided in USACE (2012b). The capacity and grain size of these alternative sites are presented in Table 4-1.

Beach Nourishment

There were 67 beaches identified for potential beach replenishment: 24 in New York, 37 in Connecticut, and 6 in Rhode Island. Beach renourishment supplies additional sand with similar grain size on a beach and for dune restoration. Most of the beaches identified consisted of medium- to coarse-grained sands; Table 4-1 describes the grain size for each beach area. The beach nourishment volumes presented in Table 4-1 provide a conservative low-end estimate calculated using the equilibrium beach profile theory methodology (USACE, 2010a). More detailed site information is available in USACE (2010a).

4.2.4 Geologic Setting of the Upland Environment

The geological setting of the upland environment is addressed in particular for cases where the environmental, geohydrological, and engineering characteristics must be considered for restoration or reconstruction projects.

The potential upland alternative sites available at the time of PEIS publication are shown in Figure 4-1 and are listed in Table 4-2. The geologic past and surficial geology of the Connecticut Valley, where the Connecticut landfills are located, has been described (Section 4.2.1), along with the history of glacio-fluvial processes forming the morphology beneath the Long Island landfills and the coastal construction and restoration projects. The geological and hydrological resources associated with the relevant program upland areas are listed in Table 4-2.

Confined Placement

Landfill Placement

The surficial geology and soil makeup at the Landfill Placement site is of minor relevance since this alternative is located at an operating and regulated facility.

Beneficial Reuse

Landfills Capping/Cover

The surficial geology and soil makeup at the Landfill Capping sites is of minor relevance since all landfill alternatives are located at operating, regulated facilities. These facilities may be able to accept clean fill for cover, which would need to meet engineering and environmental characteristics of the design including infiltration, drainage, vegetation, and erosion specifications.

Brownfields and Other Redevelopment

The reconstruction and restoration projects are located on Long Island and underlain by sole-source aquifers. Surface soils at the former Flushing Airport (Alternative 422/423) have not been mapped due to inaccessibility, but standing water exists at the site, and adjacent soils include urban land with a tidal marsh substratum and soils with very limited drainage capacity (USDA, 2014).

Habitat Restoration, Enhancement, or Creation

Restoration projects identified in New York's Jamaica Bay region include island and shoreline marsh restoration sites (429). One of the important functions served by coastal marshland is the buffering they provide to adjacent areas during extreme weather events. In the event of a Category I hurricane, the islands within Jamaica Bay are at a high risk to be inundated and subjected to destructive surf zone forces (NYC, 2014). Marshland has been added to the islands of East and West Elders Point, and plans to restore marsh to Yellow Bar, Black Wall, and Rulers Bar exist. Furthermore, the Jamaica Bay Environmental Restoration Project proposes to restore 550 acres along the bay perimeter, including Dead Horse Bay, Paedegat Basin, and Fresh Creek (USACE, 2011). Each of these future projects will require tens to hundreds of thousands of cubic yards to complete, and surficial material will need the physical and chemical properties necessary to support the restoration designs. Added marshlands along the perimeter and within Jamaica Bay will serve to increase climate change resiliency, with added protection during severe storms.

The remaining restoration site located in Brooklyn (Alternative 427) is a barrier beach and also at high inundation and surf zone erosion risk under Category I hurricane conditions (NYC, 2014). The beach is located near the western margin of Jamaica Bay and provides storm protection to the local area. A vegetated area, a public bikeway, and the Belt Parkway border the landward edge of the beach, and the area was last replenished in 2013 (WatersWeShare, 2013); (TWC News, 2013).

Table 4-2. Geological Resources in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	Landfill Placement	59	Sand and gravel
	Landfill Cover/ Capping	60	Soil data not available
		61	Soil data not available
		251	Soil data not available
		272	Soil data not available
	Brownfields & Other Redevelopment	422/423	Denied access but in adjacent soils: good seedling survival, very limited subsurface drainage; tidal marsh substratum common; typically sand-silt mixtures
	Habitat Restoration / Enhancement or Creation	427	Soil data not available
		429	Soil data not available

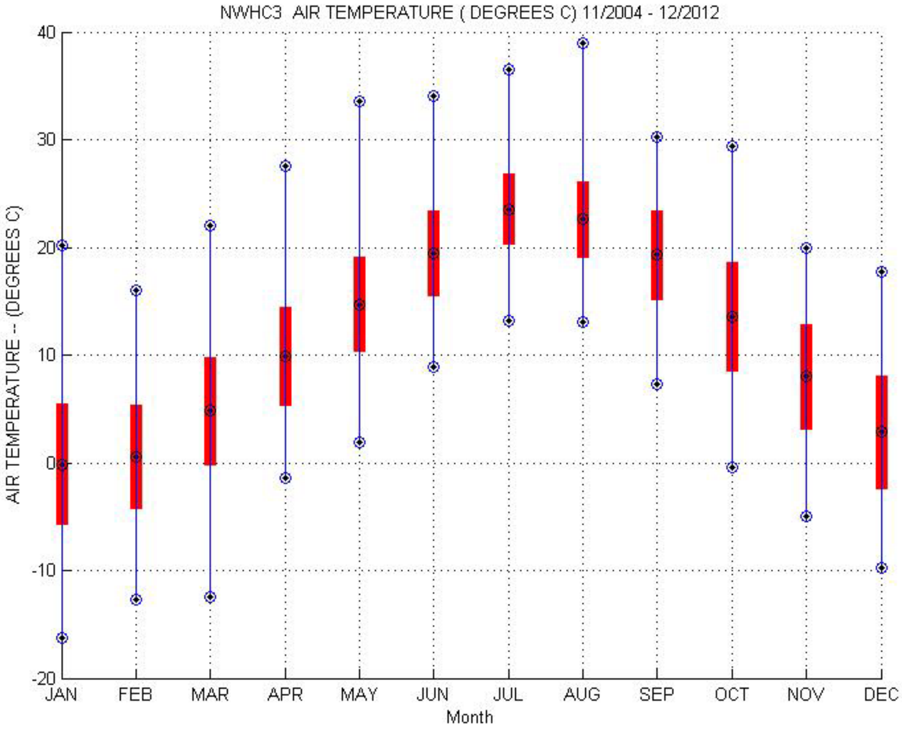
Sources: NYSDEC (2013a), CTDEEP (2014b), USDA (2014), USACE (2011).

4.3 METEOROLOGY

4.3.1 General Long Island Sound Setting

A study sponsored by USACE and EPA in 2001 provided meteorological information relative to open-water placement by combining an analysis of data from previous studies and a field data collection program in the spring of 2001 (EPA, 2004) [Appendix G]). The modeling efforts for the Long Island Sound Dredged Material Site Designation EIS (EPA, 2004) [Appendix G]) focused on these data because they provide information on long-term trends. Recent meteorological data obtained from the National Oceanic and Atmospheric Administration (NOAA, 2014a) were used to update conditions in Long Island Sound for this PEIS. The results of the 2001 evaluation were also reviewed to confirm consistency with the long-term data obtained from the larger NOAA study.

These studies document that the climate in the area of Long Island Sound is typical of the northeastern United States, with hot summers and cold, stormy winters. Large ranges of air temperature are observed both daily and annually (Figure 4-5). The average precipitation is about 40 inches per year, distributed evenly across the seasons. Fog in Long Island Sound is not common, but when it does occur, it occurs most frequently during the late winter and spring seasons when a warm moist southerly flow of air passes over cold ocean water.



Location: 41.283 N 72.908 W (41°17'0" N 72°54'28" W)

Source: NOAA (2014a).

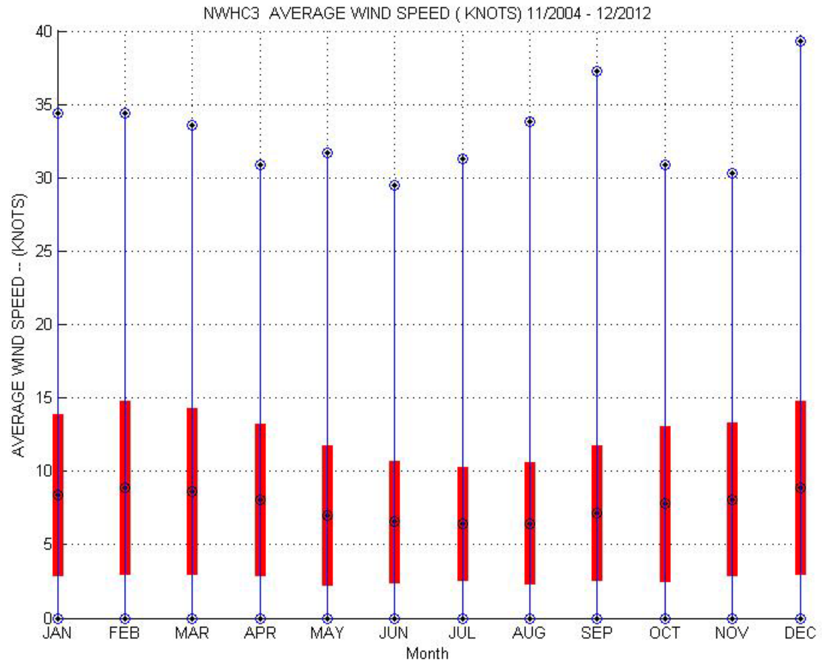
Figure 4-5. Average Air Temperature at Station NWHC3 - 8465705 - New Haven, CT.

Wind Speed

Average wind speeds measured from 2004 through 2012 at an onshore weather buoy in New Haven, Connecticut, ranged from about 6 knots (7 mi/hour) in July to about 9 knots (10 mi/hour) in December and February, but with maximum winds of almost 40 knots in December (Figure 4-6). Prevailing winds are from the south and southwest in the summer, and from the north and northwest in the winter. Occasional two- to three-day winter storms from the northeast ("northeasters") can produce severe conditions with high winds, cold rain, and steep seas.

Recent measurements of winds at two buoys in western and central Long Island Sound have revealed that extrapolation from long-term wind records on shore may underestimate wind stress in open water (O'Donnell, et al., 2014a). The winds in southern New England and the Middle Atlantic Bight have a distinct seasonal pattern, with monthly mean surface wind blowing to the southeast in winter and with much lower velocity to the northeast in summer (Klink, 1999); (Lentz, 2008). Observations in Long Island Sound show a general pattern consistent with these regional cycles (O'Donnell, et al., 2014a) but much stronger winter winds at central Long Island Sound than at western Long Island Sound.

Long-term wind measurements from four stations located throughout Long Island Sound were analyzed to characterize the effect of wind on bottom currents (USACE, 2001). Strong winds along the axis of Long Island Sound either from the west or east have the strongest effect on near-bottom currents. Historical data from four locations showed that winds have a westward component about 32% of the time (USACE, 2001).



Location: 41.283 N 72.908 W (41°17'0" N 72°54'28" W)

Source: NOAA (2014a).

Figure 4-6. Average Wind Speed (Knots) at Station NWHC3 - 8465705 - New Haven, CT.

Storms

Northeasters (extra-tropical cyclones, including hurricanes) are the major storm influence on Long Island Sound (O'Donnell, et al., 2014a). The response of Long Island Sound to these storms (and tropical cyclones) has a profound effect on the suitability of nearshore and open-water placement alternatives. Evaluation of tropical cyclones passing through the Sound between 1959 and 2007 has highlighted storm surge and wind wave set-up as the dominant effects (Colle, et al., 2010). Storm surge is defined as the rise in water level from wind stress and barometric pressure on top of tides; wind wave set-up is defined as the rise in water level that occurs when storm winds from the east force water into the Sound. The sea level record at the Battery (Manhattan) shows that flooding events have increased since 1959, but if sea level rise of 0.1 inch/year is removed from the record, there is no increase (Colle, et al., 2010). Minor changes in water levels in the Sound can exacerbate flooding of coastal areas. The response of the sea level in the Western Basin to major storm events has been modeled by Bowman, et al. (2005) and Zheng (2006). They have shown that wind wave set-up (Bokuniewicz & Gordon, 1980b) has a major effect on water levels. When this occurs on top of the tidal increase, substantial flooding occurs, particularly in the western end of the Sound. The degree and nature of flooding due to cyclones is highly dependent on the timing and direction of the wind field (O'Donnell, et al., 2014a).

Hurricane Irene made landfall in North Carolina as a category 1 hurricane and moved northnortheastward, decreasing in intensity to a tropical storm when the eye passed over New York City on August 28, 2011 (Coch, 2012). The size of the storm and intensity of rainfall ahead of the storm caused catastrophic inland flooding in New Jersey, Massachusetts and Vermont. The flooding in the Connecticut River watershed and much of coastal Connecticut led to high levels of nutrient and suspended sediment discharge into Long Island Sound affecting nearshore and mid-Sound locations. Sediment concentrations reached 1,000 mg/l at the mouth of the Connecticut River (Kratz, 2012).

Hurricane Sandy made landfall as a post-tropical cyclone near Brigantine, New Jersey on October 29, 2012, impacting Long Island Sound with storm surge, high waves, and wind. Sandy caused water levels to rise along the entire east coast of the United States with the highest storm surges and greatest inundation on land occurring in New Jersey, New York, and Connecticut, especially in and around the New York City metropolitan area. In many of these locations, especially along the coast of Staten Island and southward-facing shores of Brooklyn, Queens and Long Island, the surge was accompanied by powerful damaging waves.

Climate Change

Climatic change in the Long Island Sound region will affect the meteorology and circulation of Long Island Sound as well as nearshore sediment transport and ecological conditions. Results of climate change include sea level rise, changes to wind stress fields, longer periods of water column stratification, an increase in the frequency and intensity of coastal storms (wave climate, tidal surge, flooding), temperature increases leading to alterations in food webs, shifts in high-value living resources, and acidification from increased levels of carbon dioxide. The alterations in physical processes in turn affect the chemistry, such as dissolved oxygen (DO) levels and salinity, and the biology of Long Island Sound and ecological processes (Tedesco, et al., 2014).

Studies of water temperature patterns have observed that average surface temperature has been relatively constant in the summer but has increased in the winter over the long term (Lee & Lwiza (2005), Stachowicz, et al. (2002)). Fall-winter surface heat fluxes are the dominant influence on the water temperature of Long Island Sound (Lee, 2009), and regional climate change is thought to drive this warming trend (O'Donnell, et al., 2014a).

Since 1946, the wind direction has been shifting toward 203 °, which would produce the most vertical stratification (O'Donnell, et al., 2014a). Changes in wind dynamics have increased the duration of water stratification, which has a cooling effect on bottom waters (O'Donnell, et al., 2014a). In Western Long Island Sound, the difference between surface and bottom waters has increased by about 1.5°C during the summer months from 1946 to 2006, with a reported cooling trend in bottom temperature (Wilson, et al., 2008). In addition to climate change, ongoing development may be increasing the urban heat island effect in the western region of Long Island Sound and affecting wind patterns.

Climate change will likely affect the volume and timing of delivery of freshwater to the Sound through changes in precipitation and evaporation. The Long Island Sound region has become wetter than in the past, with a 13% increase in yearly average precipitation over the last 20 years and possibly up to 20% over 40 years (Tedesco, et al., 2014). Although the increase has been distributed evenly over the year, the form of the precipitation (i.e., whether it is rain or snow) might have a large impact on the system. The timing of seasonal peak river flows is shifting to earlier in the year for the nearby Hudson River and regional rivers (USGS (2011a); O’Donnell, et al. (2014a)).

Similar to wind impacts, the earlier spring snowmelt flows and warming increase the duration of water column stratification in the Sound. The large influx of freshwater contributes to haline stratification, as freshwater is less dense than the seawater. Climate change thus has extended stratification periods and shortened the mixing periods of surface and bottom waters. Less mixing results in reduced replenishment of DO in bottom waters and an increased amount of time over which hypoxic conditions may occur (Tedesco, et al., 2014). It is possible that in the future, decreased snow volumes and earlier melts will result in even earlier peak flows or no large spring freshwater influx. Changes in water column stratification have profound effects on the ecology of phytoplankton and zooplankton as well as bottom water chemistry (Tedesco, et al., 2014).

Sea Level Rise

Globally, sea level is rising due to the thermal expansion of seawater, melting of glaciers and ice sheets, and reduced water storage on land (IPCC, 2014). Along the Mid-Atlantic and New England Coast, the rates of sea level rise have been three to four times faster than the global average rate (Sallenger, et al., 2012). Based on four NOAA tide gauges (New London, Bridgeport, Kings Point/Willets Point, Montauk) around Long Island Sound, from 1986 to 2010 relative sea level has risen by about 4.5 inches. The rate of rise, about 0.2 inch per year, is projected to increase substantially in the future. Although sea level rise will not alter the wave field of Long Island Sound, the direction and speed of waves may change in response to changing wind and shoreline patterns (O'Donnell, et al., 2014a). Sea level rise combined with storm surge and wave action pose risks of flooding, shoreline erosion and alteration, and wetland deterioration and loss. Sea level rise will impact nearshore erosional and sedimentation processes. Sea level rise also results in saltwater intrusion into groundwater that causes coastal water tables to rise, presenting an additional flooding risk to low-lying areas (Tedesco, et al., 2014). Tedesco, et al. (2014) have identified the steep bluffs of the Long Island shoreline as possibly the most vulnerable to sea-level-related erosion due to undercutting at the water's edge, and have postulated that changes could occur to the mouth of Long Island Sound, altering the physical dynamics with the ocean.

Shepard & Wanless (1971) have reported that in the 18th and 19th centuries, prominent headlands in the vicinity of Oak Neck on Long Island were eroded some 490 ft. Davies, et al. (1973) found a bluff recession rate in the 20th century of some 1.6 ft per year, with a range of 0 to 5.2 ft at 19 locations from Oak Neck Point near Oyster Bay to Orient Point, a distance of some 60 mi. This bluff erosion feeds the littoral drift and the beaches of the north shore (Bokuniewicz & Tanski, 1983). For example, the bluffs of Nissequogue currently feed Long Beach, causing the spit to prograde to the east-northeast about 6 ft per year (Swanson & Bowman, in preparation). Bokuniewicz & Tanski (1983), in their sediment budget resulting from bluff erosion, estimate that about 85% of the eroded material ends up in the deep waters of the Sound with about 3% going to wetlands. Very little material permanently remains on the beaches; hence, they are generally receding.

The changes in climate that influence the physical oceanography of Long Island Sound will reverberate throughout the ecosystem. As a result, the magnitude and timeframes over which physical processes operate need to be better understood and accounted for to support management. This is particularly true in the design aspects of coastal development and related infrastructure initiatives. It is also true for diagnosing and responding to Long Island Sound's lobster mortality events and the chronic annual hypoxia, since both appear to be closely tied to altered physical drivers that may further change in the coming decades (Tedesco, et al., 2014).

4.3.2 Open-Water Environment Meteorology

The meteorology of the open-water environment, where the unconfined and confined open-water placement alternative sites are located, is similar to that of the general Long Island Sound setting described above. There is a gradient of tidal exchange, near-bottom currents and exposure to open circulation from the western to eastern Sound. However the impacts of storms, climate change and sea level rise are likely to be amplified in the western Sound (Tedesco, et al., 2014).

Western Long Island Sound Disposal Site

Storms - At the WLDS, the disturbance potential from storms (waves and currents) is limited by fetch and distance from the open coast, but it is still likely to be greater than CLDS (see Section 4.4.2, (USACE, 2001)). An important distinction about the western Sound is that setup and storm surge can be amplified by the seiche dynamics of the Sound (O'Donnell, et al., 2014a). During Hurricane Sandy, tide levels at Bridgeport were recorded 0.304 meters above the previous historic record, from a December 1992 winter storm (Zervas, 2013). The combination of wind setup, duration and storm surge caused an amplification of normal seiche conditions and extreme tide levels accompanied by flooding. At WLDS conditions during storms of this magnitude would be expected to increase near bottom currents.

Climate Change and Sea Level Rise – Sea level rise is not expected to change circulation patterns or affect sediment transport dynamics at the WLDS, but regional shifts in wind field intensity and direction from temperature change could affect circulation (O'Donnell, 2014b). The most notable change at WLDS is likely to be an increase in stratification and greater cooling of bottom waters in summer. This could affect hypoxia, water chemistry and the dynamics of phytoplankton and zooplankton near the site (Tedesco, et al., 2014).

Central Long Island Sound Disposal Site

Storms – At the CLDS, the disturbance potential from storms (waves and currents) is limited by fetch and distance from the open coast, and it is likely to be the lowest of the open water alternatives (see Section 4.4.2, (USACE, 2001)). CLDS is located near the midpoint of the tidal seiche (the node of the seiche is slightly east of the Race, (Swanson, 1971)) and is situated in the widest (N-S) section of the Sound so storm-induced tidal exchange is likely to be the lowest of the alternatives. Several Hurricanes have passed directly over CLDS with limited impact largely due to the track of the storms (south to north).

Climate Change and Sea Level Rise - Sea level rise is not expected to change circulation patterns or affect sediment transport dynamics at the CLDS, but regional shifts in wind field intensity and direction from temperature change could affect circulation (O'Donnell, 2014b). The greatest impacts from increased rainfall intensity associated with climate change might be due to flooding in the Connecticut River Valley and discharge into the Sound through the Connecticut River and Quinnapiac River (CTDEEP, 2010a). Increased seasonal discharge can increase stratification and affect bottom water conditions (temperature and seston deposition, (ENSR, 2004), (ENSR, 2005d)). Intensification of population pressure and changing climate is predicted to increase sedimentation and nutrient inputs to the Sound in general (Tedesco, et al., 2014).

Cornfield Shoals Disposal Site

Storms – Although Cornfield Shoals has the strongest near-bottom current speeds of the alternatives, modeled response to a simulated Hurricane Sandy projected a decrease in bottom stress from fair-weather (-11%) and storm conditions (-6%) as a consequence of modification of the circulation (eastward winds reduce west residual flow, (O'Donnell, 2014c). Storms may also bring substantial rainfall and increased discharge from the Connecticut River (see below).

Climate Change and Sea Level Rise - The greatest impacts from increased rainfall intensity associated with climate change might be due to flooding in the Connecticut River Valley and discharge into the Sound (CTDEEP, 2010a). Intensification of population pressure and changing climate is predicted to increase sedimentation and nutrient inputs to the Sound (Tedesco, et al., 2014). Cornfield Shoals is located at the mouth of the Connecticut River and will likely change character if sediment load is increased (larger burden of sediment may create changes in bedload transport at site).

New London Disposal Site

Storms – Although New London has relatively weak residual near-bottom current speeds, modeled response to storms was predicted to be as much as 33% higher than fair-weather conditions (O'Donnell, 2014c). However simulated Hurricane Sandy conditions were predicted to result in a decrease in bottom stress from fair-weather (-10%) and storm conditions (-30%) as a consequence of modification of the circulation (eastward winds reduce weak west residual flow, (O'Donnell, 2014c)). New London Disposal Site has the potential to be affected by increased sediment transport from storms but the frequent winnowing of surface material and development of a lag deposit has reduced erosion of existing dredged material mounds at the sites (see Section 4.4.2; (AECOM, 2010)).

Sea Level Rise - Sea level rise is not expected to change circulation patterns or affect sediment transport dynamics at the NLDS, but regional shifts in wind field intensity and direction from temperature change could affect circulation (O'Donnell, 2014b). The greatest impacts from increased rainfall intensity associated with climate change might be due to flooding in the Thames River Valley and discharge into the Sound through the Thames River (CTDEEP, 2010a). Increased seasonal discharge can increase stratification and affect bottom water conditions (temperature and seston deposition, (ENSR, 2004), (ENSR, 2005d)). Intensification of population pressure and changing climate is predicted to increase sedimentation and nutrient inputs to the Sound in general (Tedesco, et al., 2014).

4.3.3 Nearshore/Shoreline Environment Meteorology

The meteorology of the nearshore environment, where the nearshore and shoreline placement alternative sites are located, is similar to that of the general Long Island Sound setting described above.

Storms **–** Little specific information is available on nearshore placement alternative storm risk, but it is clear that coastal storms are likely to affect nearshore and shoreline placement alternatives more than other alternatives (CTDEEP, 2010a). Hurricane storm inundation projections can be used to assess risk at each alternative (http://ctecoapp1.uconn.edu/ctcoastalhazards/).

Climate Change and Sea Level Rise – Inundation maps and sea level rise forecasts for individual alternatives can be assessed based on updated mapping tools (http://ctecoapp1.uconn.edu/ctcoastalhazards/).

4.3.4 Upland Environment Meteorology

The meteorology of the upland environment, where the upland placement alternative sites are located, is similar to that of the general Long Island Sound setting described above.

Climate Change and Sea Level Rise – Sea level rise may displace coastal infrastructure inland but there are no direct expectations of sea level rise flooding upland sites, except at Site 422/423 (which has tidal wetlands present) and Sites 427 and 429, which are near the coastline. Upland alternatives are at greatest risk from climate change effects on rainfall (intensification of rain storms, riverine flooding, groundwater levels; (CTDEEP, 2010a)).

4.4 PHYSICAL OCEANOGRAPHY

4.4.1 General Long Island Sound Setting

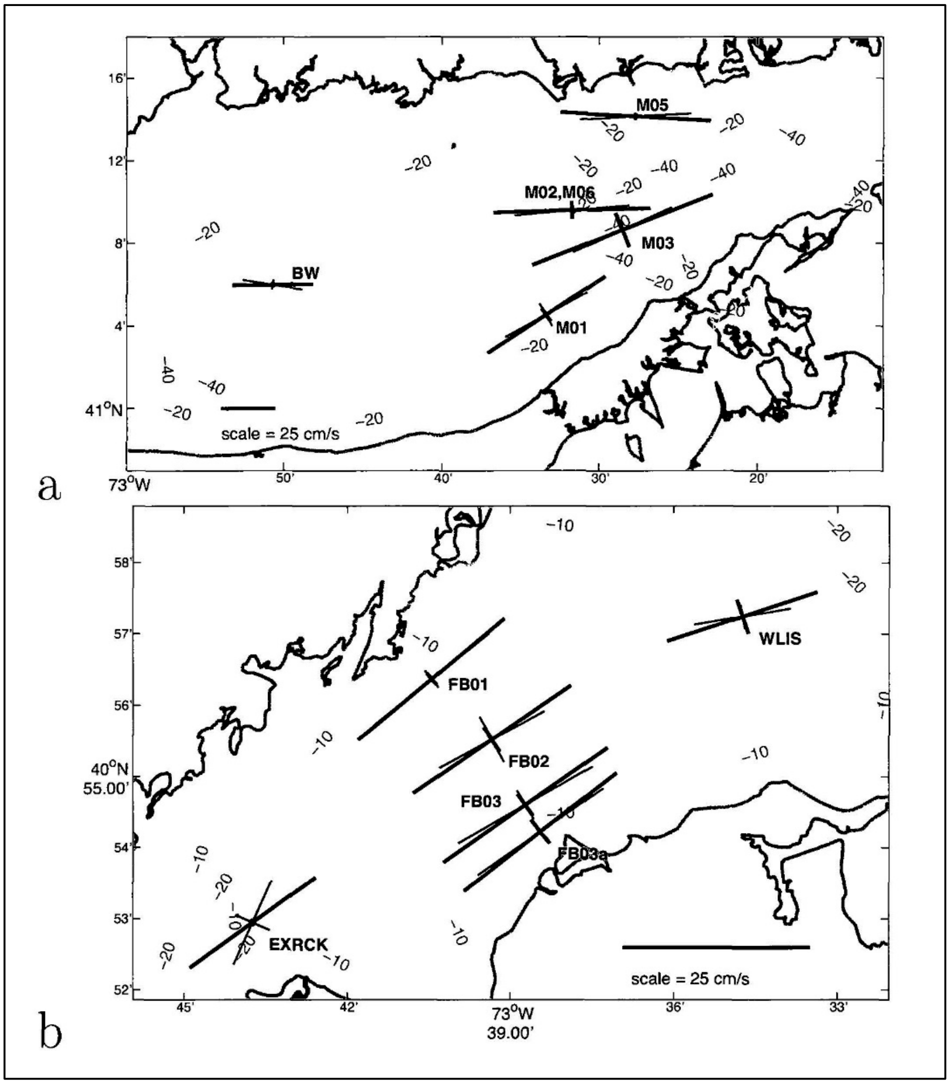
This section describes the physical oceanography (currents, waves, and density structure) of Long Island Sound in general. Information about the physical oceanography of Long Island Sound as it relates to placement of dredged material in open-water and nearshore locations was derived primarily from a recent review of Long Island Sound physical oceanography (O'Donnell, et al., 2014a). The review synthesizes the results of measurement programs conducted in the past decade as well as numerous studies conducted since 1956 when the last comprehensive review was published (Riley, et al., 1956). The review has been supplemented by recent data collection and modeling in eastern Long Island Sound (O’Donnell (2014b), (2014c)).

The transport, dispersion, and eventual fate of sediment in the marine environment depend upon the physical characteristics of the sediment and the structure (density, temperature, and salinity gradients both vertical and horizontal) and dynamics of the water column. The physical parameters that are important in the transport and dispersion of sediment include currents, waves, and the density structure of the water column. Currents directly affect the transport and dispersion of sediment by imparting shear stress to the surface sediments and transporting suspended sediments. In shallow water, waves can resuspend sediments previously deposited on the seafloor. These resuspended sediments may then be transported by local currents. The density structure of the water, relative to the density of the sediment, influences how long the sediment remains in the water column.

Currents

Currents in Long Island Sound are driven by three distinct processes—tides, density, and wind—which interact to fashion the overall circulation of the Sound.

Tidal currents are the dominant source of water movement in Long Island Sound. Tidal currents generally run east-west along the axis of the Sound and are substantially stronger in the eastern portion of the Sound closest to the open ocean (Figure 4-7). Peak surface tidal currents through the Race are typically 3.9 ft per second and can exceed 5.2 ft per second during spring tides. Westward from the Race, tidal current speeds decrease rapidly as Long Island Sound widens. Tidal currents in the Western and Central Basins are typically 0.7 to 1 ft per second. Bottom tidal currents are strongest in the eastern region of Long Island Sound, with peak bottom velocities of 2 to 2.3 ft per second during spring tides, but weaken toward western Long Island Sound to 0.6 to 0.7 ft per second. Oscillatory tidal currents produce no net transport, but when they interact with bottom features and the shoreline, residual currents result. Tide-induced residual flows are much weaker than the tidal currents that drive them, but may be locally significant and result in net transport of water masses and possibly fine particles. While tide-induced residual currents are quite significant in the eastern portion of the Sound, bottom residual currents are weak (less than 0.07 ft per second) throughout the Western and Central Basins (Signell, et al., 2000).



Source: Bennett (2010).

Shown are 3-m (9.8 feet) depth (heavy line) and near-bottom depth (light line) for acoustic doppler current profiler (ADCP) deployments in eastern (a) and western (b) Long Island Sound. Semi-major and semi-minor axis amplitudes are shown centered at the location of the deployment. Note the different velocity scales for the two figures.

Figure 4-7. M2 Tidal Ellipses in Eastern and Western Long Island Sound.

The rise and fall of the tide on the continental shelf forces the tides of Long Island Sound through the Race (tidal forcing through the East River also affects local currents, but its effect on Long Island Sound as a whole is negligible). The amplitude of the rise and fall of the tides is increased by a factor of three from the Race to Kings Point in the west (Koppelman, et al., 1976). The increase in tide amplitude is a result of a resonance between the length of the Sound and the wavelength of the local semidiurnal (twice a day) tidal wave (Redfield, 1950). This simple model of the tidal exchange has been shown to be complicated by the shape of the Sound and its complex bathymetry (Winant, 2007). Further complexity is introduced when lateral tidal forces (north-south in Long Island Sound) are considered. The dynamics of tidal circulation in the Sound have been modeled recently using the Regional Ocean Modeling System; the models have predicted a clockwise lateral circulation during flood tides and a counterclockwise circulation during ebb tides (Hao, 2008). These modeling approaches have been largely verified by recent measurement programs (Bennett, et al., 2010). Bennett (2010) presents results in tables and figures that can be utilized for assessment of tidal circulation in specific locations in the Sound (Figure 4-7).

Waves

Orbital (to-and-fro) wave motions are present under all surface waves. They vary with wave height, being strongest near the surface and weakening with increasing depth below the waves. In shallow waters, these orbital motions are frequently present near-bottom and may provide enough energy to resuspend bottom sediments without transporting them. However, once mixed into the water column by waves, particles may be transported by any net current flow (Signell, et al., 2000).

Recent measurements of winds at two buoys in western and central Long Island Sound have revealed that extrapolation from long-term wind records on shore may underestimate wind stress in open water (O'Donnell, et al., 2014a). The winds in southern New England and the Middle Atlantic Bight have a distinct seasonal pattern, with monthly mean surface wind blowing to the southeast in winter and with much lower velocity to the northeast in summer (Klink, 1999); (Lentz, 2008). Observations in Long Island Sound show a general pattern consistent with these regional cycles (O'Donnell, et al., 2014a) but much stronger winter winds at central Long Island Sound than at western Long Island Sound.

The effects of the variable wind patterns (Section 4.3) result in substantial differences in wave heights between the Western Basin and the Central Basin. Bokuniewicz & Gordon (1980a), (1980b) and Signell, et al. (2000) estimated the wave-induced bottom currents using the predictions of fetch-limited wave models to interpret patterns of sedimentation, but only recently have direct measurements been available to confirm the models (O'Donnell, et al., 2014a). Six years of observations of a three-axis directional wave gauge at the central Long Island Sound buoy and a single-axis sensor in western Long Island Sound revealed patterns in wave heights related to the direction of wind stress, which vary with season. The most frequent winds are along-Sound from the west-southwest; under these conditions, wave heights are larger at central Long Island Sound. During periods of strong winds, the waves in the central Sound can be 3 ft larger than at the western Sound. In contrast, when the wind stress is from the east-northeast, the waves' sizes in the two basins are the same. Strong winds from the south are infrequent in southern New England, but the wave height at central Long Island Sound increases relative to western Long Island Sound during southerly winds.

Seasonally, the wave climate in western Long Island Sound is quite different from that in the central Sound. Waves generally have larger amplitude and longer period in the central Sound, especially in winter. In contrast, waves in the western Sound are largest when the winds are easterly (O'Donnell, et al., 2014a). This differential has some consequences for potential wave-driven sediment transport in the shallower portions of the Sound.

These observations are consistent with fetch limitation theory (Bokuniewicz & Gordon [(1980a), (1980b)] and Signell, et al. (2000). Locally generated waves tend to be steeper and have shorter periods (i.e., the time it takes for successive crests to pass a fixed point) than fully developed waves propagating in the open ocean. The oscillatory motions beneath steep waves do not penetrate as deeply as those beneath fully developed waves. When the wind is from the east, the fetch at both buoys is large and the wave statistics are similar. For all other directions, the fetch at the western Long Island Sound buoy is much smaller than at central Long Island Sound, and so are the waves. Potential sediment transport at both sites is largely driven by the along-Sound wind and waves from the east combining with tidal forcing and storm surge.

Density Structure and Salinity

When freshwater is discharged into salt water, the lighter freshwater can ride above the heavier salt water, resulting in a vertical density stratification of the water column. Some mixing occurs as the upper layer of freshwater flows seaward over the landward-flowing lower layer of salt water (estuarine circulation), producing turbulence at the interface between the freshwater and salt water. Tidal currents transport the entire water mass up and down the estuary with each flood and ebb tide cycle. This also causes some mixing between the two layers and results in salt water mixing upward and freshwater mixing downward. However, the stratification can persist for many months, resulting in density-driven currents that affect the entire Sound.

The general circulation of the waters in Long Island Sound (which affects water quality and transport of suspended particles) is strongly influenced by the density structure of the water column. This is particularly true of longer cycles of circulation; however, vertical gradients in density can inhibit wind-mixing and drive other short-period events, including lateral transport. Long Island Sound, like all estuaries, has salinity gradients, hence density gradients, resulting from the flow of freshwater from rivers and streams interacting with salt water from the Atlantic Ocean.

Density-driven circulation (estuarine circulation) leads to transport of freshwater to the ocean and salt water toward land. Density of water in the Sound is controlled by temperature and salinity; these variables can be measured and mapped to quantify circulation and the density structure of the Sound at short and long time scales (Figure 4-8 through Figure 4-10). Long-term data on the temperature and salinity distribution in Long Island Sound have been collected by CTDEEP (2014c).

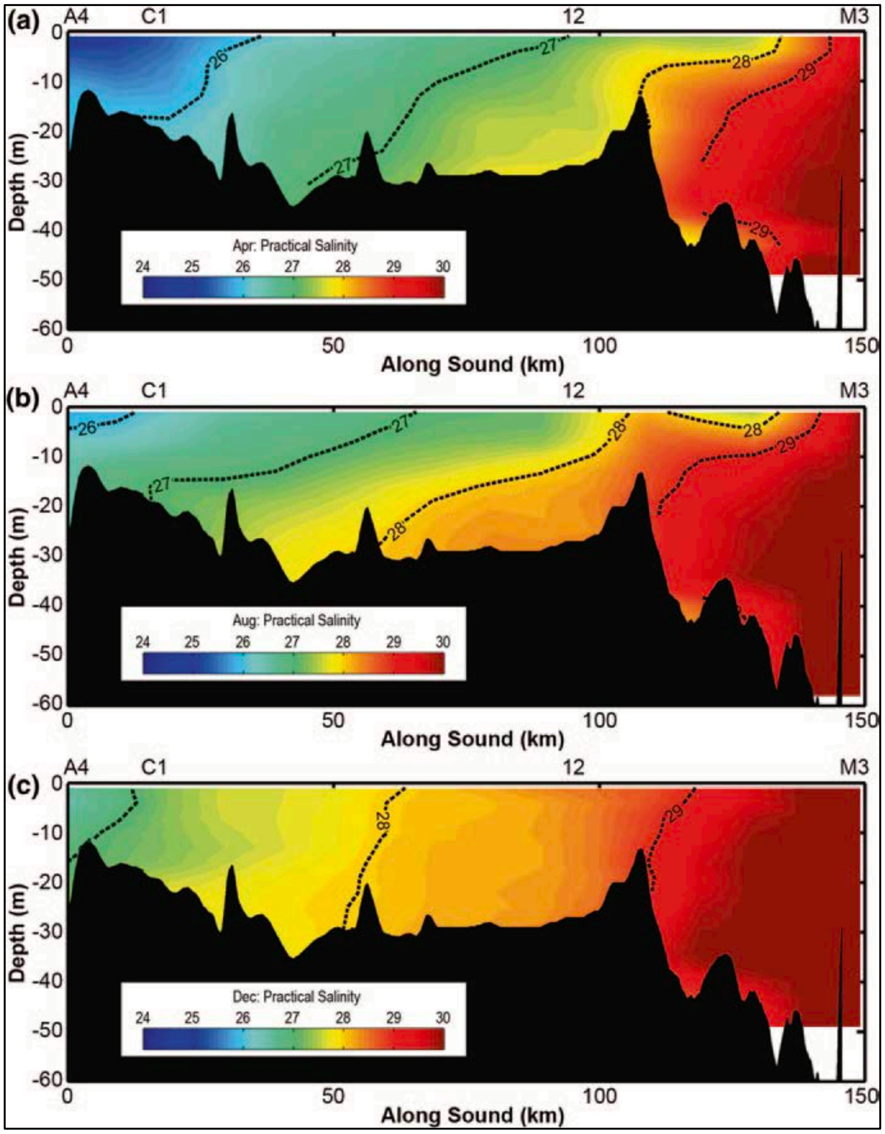
The movement and mixing of freshwater in the Sound is further complicated by the presence of the wind-driven currents and wave-induced mixing, but the exchange of Sound water with ocean water through the Race results in markedly more saline water in the eastern end of the Sound relative to the western end. Throughout the year, the lowest salinity is in the western Sound (25.0 to 27.0 practical salinity units [psu]) and the highest salinity is at the Race (29.5 to 31.0 psu). The change in salinity is generally more abrupt within 12 mi of either end of the Sound and is more gradual through the central part of the Sound (Figure 4-8). Throughout the Sound, the lowest levels of salinity occur in May and the highest levels in December. In spring, the freshet from the Connecticut River and Hudson River (through the Harlem and East Rivers) drives the largest horizontal gradients, while mixing in the winter reduces the gradient throughout the Sound (Figure 4-8).

While salinity stratification persists throughout the year, with typical top-to-bottom differences of 0.5 to 1 psu and much higher local differences during the spring freshet, temperature stratification is seasonal (Figure 4-9). The western Sound's surface waters begin to warm in April; by June, strong thermal stratification throughout the Sound develops. During the summer months, thermal stratification of over 5°F (surface-to-bottom temperature differences) is typically observed throughout most of the Sound (Signell, et al., 2000). In August, bottom waters of temperature often exceeding 68°F are observed, with surface temperatures over 75°F measured in some years (CTDEEP, 2012a). A large horizontal temperature gradient has been observed at the Mattituck Sill that isolates the Central Basin from the Eastern Basin (Figure 4-9) (O'Donnell, et al., 2014a). By early September, the combined effect of decreasing heat flux and increased mixing by storms causes the breakdown of thermal stratification, and the water column returns to a thermally well-mixed state. By December, the temperature falls to between 45°F and 50°F, with the coldest water in the Western Basin (Figure 4-9). Surface ice formation can occur if atmospheric temperatures remain well below freezing for sufficiently long periods, especially in protected harbors and embayments.

Combining the effects of freshwater (salinity) and temperature on the density structure reveals a strong longitudinal density gradient through the Sound throughout the year with stratification in the summer (Figure 4-10). These gradients maintain an estuarine circulation with a net eastward surface flow and net westward bottom flow (Wilson, 1976). The lateral density structure (north-south) has been much more challenging to characterize (O'Donnell, et al., 2014a). Theory suggests that during periods of weak vertical stratification, the widest areas of the Sound should have strong lateral gradients (Valle-Levinson, 2008). What is known is that there is a substantial lateral density gradient in some sections of the Sound in spring and a very weak gradient in summer (Bennett, 2010); (O'Donnell & Bohlen, 2003). Sound water is persistently fresher in the southern portion of eastern Long Island Sound despite the discharge of the Connecticut River to the northern side of the eastern Sound (O'Donnell, et al., 2014a).

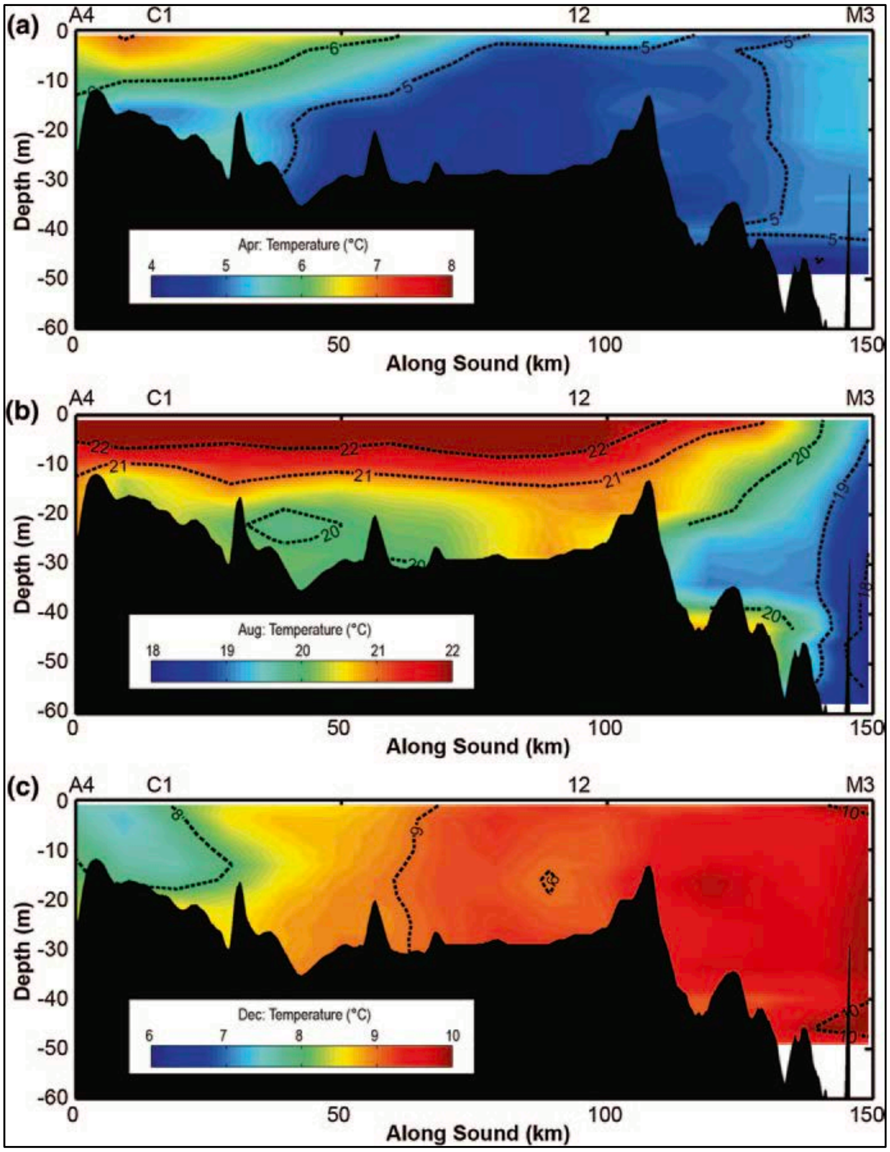
Wind-Driven Circulation

Like all water bodies, Long Island Sound responds to the frictional drag of local winds on the water surface. Strong wind events can set up wind-driven flows and generate surface waves. Although wind stress drives currents that are generally weaker than tidal currents, it is an important driving force for the net motions in Long Island Sound and has a marked influence on water properties attributable to upwelling, downwelling, and vertical mixing. In addition, these wind-driven flows can be particularly important to sediment transport because they are strongest when wind stress is greatest (during large storms or hurricanes) and when wave heights are also at their greatest. These conditions are ideal for the resuspension and transport of bottom sediments.



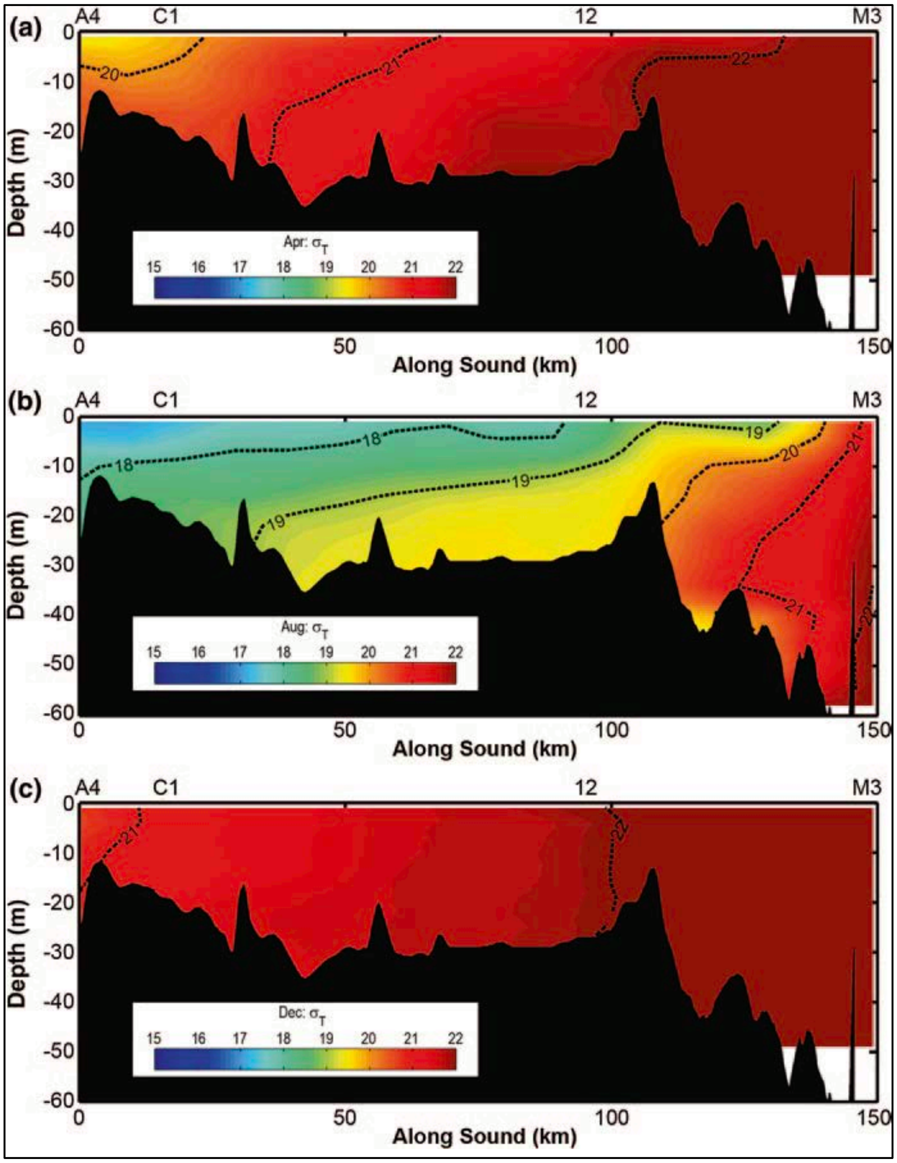
Source: O'Donnell, et al. (2014a); computed from CTDEEP data collected in April (a), August (b), and December (c).

Figure 4-8. Structure of the Salinity Distribution (psu) along the Axis of Long Island Sound.



Source: O'Donnell, et al. (2014a); computed from CTDEEP data collected in April (a), August (b), and December (c).

Figure 4-9. Structure of the Temperature Distribution (degrees Centigrade) along the Axis of Long Island Sound.



Source: O'Donnell, et al. (2014a); computed from CTDEEP data collected in April (a), August (b), and December (c).

Figure 4-10. Structure of the Density Distribution (ρT) along the Axis of Long Island Sound.

Wind-driven currents are manifest in several forms. Direct wind stress forcing, in shallow water, drives surface water in the general direction of the wind. In deeper water, near-bottom currents can flow opposite the direction of wind in response to sea surface slopes resulting from wind set-up (water 'piling up' along a shoreline boundary). Csanady (1973) observed downwind currents in shallow margins of the Sound in response to along-axis winds and an upwind counter-current in the deeper central regions.

Recent research points to this effect in deeper areas of western Long Island Sound. In the western regions of the Sound, where the bathymetric axial depression is well defined, there exists a strong deep flow opposite the wind direction (Signell, et al., 2000). If bathymetry gradients are shallow, such as in the Central Basin, this deep bottom flow is quite weak. During strong west-wind events (i.e., winds blowing from the west), a bottom flow toward the west occurs, opposite to the wind, which strengthens the westward density-driven flow. East winds, such as those generated by passing extra-tropical storms, result in an eastward bottom current response, opposite the westward density-driven flow, which serves to weaken the westward density-driven bottom flow. Data from the Eastern Basin have confirmed this pattern, which still results in velocities that are several times smaller than tidal current velocities (Whitney & Codiga, 2011).

Typical near-bottom currents alone rarely have enough energy to initiate the resuspension and transport of bottom sediment. However, when waves are large enough and have sufficient wavelength to impart energy to the seafloor, they can exceed the bottom shear stress value and resuspend sediments. By themselves, waves will not result in net transport because the to-and-fro wave motions are essentially closed ellipses, but when a mean near-bottom current velocity is superimposed on the wave velocities, sediment transport results.

Sediment Suspension and Transport

Dredged material particles may be transported horizontally in two ways. They may be carried by local currents while still in the water column immediately after placement, or they may be deposited on the seafloor and then periodically resuspended into the water column and transported by the currents.

Most of the dredged material to be placed in Long Island Sound consists of very fine sand to silt and clay. Low concentrations (2% to 5% of the dredged material) of the finest fraction of dredged material particles may persist for several hours in the water column as turbid plumes before depositing on the bottom (SAIC, 1994); (USACE, 2003).

Once the dredged material is deposited, current and wave energy affect its transport and dispersion. The deep basins of western and central Long Island Sound are covered with fine-grained deposits and have recorded net accumulation rates ranging from 0.01 to 0.05 inches per month (Kim & Bokuniewicz, 1991). These areas have low current-induced energy regimes, with tidal currents between 0.5 to 0.8 ft per second; weak wind-driven currents (less than 0.13 ft per second), density-driven currents (less than 0.13 ft per second) and tide-induced residual currents (less than 0.07 ft per second); and little or no wave energy except during very large storms (Signell, et al., 2000). The finest fraction of sediments entering the Sound may be deposited and then resuspended, transported, dispersed, and redeposited many times before ultimately being incorporated into permanent sediment deposits (SAIC, 1994).

The oscillatory motions beneath steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 98 ft (the average depth of the Western Basin, including the axial depression), peak wave-induced near-bottom orbital velocities calculated from linear wave theory would generate bottom orbital velocities from 0.3 ft per second for the 2-year storm to 0.7 ft per second for the 10-year storm (USACE, 2003). Velocities of this magnitude are not sufficient to cause appreciable erosion (Bokuniewicz & Gordon, 1980a). Model estimates indicate that bottom orbital velocities of 1.1 ft per second are required to mobilize 0.04 inch of non-cohesive sediments (USACE, 2003).

4.4.2 Open-Water Environment Oceanography

The physical oceanography of open-water site alternatives has been characterized in a series of studies (USACE (1996), USACE (2001), USACE (2003)). The results of these site-specific studies are consistent with more-recent regional measurement programs described above (e.g., Bennett (2010), Bennett, et al. (2010), O'Donnell & Bohlen (2003), Whitney & Codiga (2011)). Information on site characteristics was obtained from a study sponsored by the USACE and EPA in 2001 (USACE, 2001). That study combined an analysis of data from previous studies and a major field data collection program in the spring of 2001. The conditions at WLDS and CLDS described below are derived from these study results; the conditions at CSDS and NLDS are derived from DAMOS studies of these sites (USACE (1996) and Waddell, et al. (2001) respectively).

Western Long Island Sound Disposal Site

Currents – At the WLDS, the dominant flow direction measured in the spring of 2001 was nearly east-west and there was little flow normal to the dominant flow direction (USACE, 2001). Amplitude decreased with depth, and near-bottom amplitude was less than 0.7 ft·per second. During the two-month spring deployment period, 70% to 90% of the current variance was due to the tide, with nearly 90% of the near-bottom current variance in the direction of the long axis of the Sound due to tides (labeled as 'WLIS' in Figure 4-7). The year-long current meter deployment reported by Fredriksson & Dragos (1996) revealed periodic strong near-bottom flows to the west-southwest caused by the combining of the ebb tide with a west-southwestward flow associated with wind stress and, to a lesser extent, the density gradients. While near-bottom peak ebb and flood tides run from 0.7 to 1 ft·per second, flows directed to the west-southwest run as high as 1.3 to 1.5 ft per second for 2% of the time and 1.1 to 1.3 ft per second for 5% of the time, with flows as high as 1.6 to 1.8 ft· per second recorded on occasion. These results are consistent with the two-month measurement from the spring of 2001 of 1.4 ft·per second peak near-bottom current (6.6 ft above the bottom) and also with a month-long current meter deployment inside the boundaries of WLDS completed in January 1982 under the DAMOS program (Morton, et al., 1982). A current meter deployed in that study 4.9 ft above the bottom recorded a peak flood event of 1.5 ft·per second associated with winds in excess of 30 knots (50.6 ft·per second). Fredriksson & Dragos (1996) and Morton, et al. (1982) reported a net west-southwestward flow (long-term mean) of 0.05 to 0.18 ft·per second indicative of the density-driven estuarine circulation.

Waves – The wind fetch at WLDS is limited by the semi-enclosed nature of Long Island Sound, which limits the wave heights that can be developed at the site by winds from directions other than the northeast (along the axis of the Sound). Considering that winter storms can produce powerful winds from the northeast (nor'easters), the potential effect of waves generated by them must be taken into account despite the otherwise limited fetch for the site. Few wave measurements are available at or near WLDS. The two-month record of waves made in the spring of 2001 at a station within WLDS (USACE, 2001) recorded 6.5-ft high waves (significant wave height) with 4- to 6-second periods associated with a 19-knot wind event (winds from the east). Near-bottom peak orbital wave velocities measured at a 118-ft depth in the axial depression reached only 0.07 ft per second. In addition to this short-term measurement program, a 12-year record of wind data from the Buzzards Bay Tower was analyzed for the period July 1985 to February 1994 and May 1997 to March 2001 to develop wind climatology for the region (EPA, 2004). Using these data, wave height and period were determined for various wind conditions experienced in the Sound using a simple fetch-and-duration wave model (EPA, 2004).

The prevailing direction of waves in the region followed the prevailing wind directions, from the north and northwest in fall and winter (with occasional northeast events) and from the southwest in spring and summer. The data showed that a northeast storm with a return period of two years will generate waves of 9 ft with a 6-second period over the WLDS alternative site. Storms with a return period of 10 years will generate 11-ft waves with a 6.6-second period over the site. The short period relative to wave height is indicative of locally generated, fetch-limited waves. The waves reported from spring 2001, with a peak wave height of 6.5 ft, represent storms that can be expected several times a year (USACE, 2001).

Sediment Suspension and Transport – The oscillatory motions beneath steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 98 ft (the average depth of the WLDS alternative, including the axial depression), peak-wave-induced near-bottom orbital velocities calculated from linear wave theory for the 2- and 10-year storms would generate bottom orbital velocities of 0.3 to 0.7 ft·per second, respectively. Velocities of this magnitude are not sufficient to cause appreciable erosion (Bokuniewicz & Gordon, 1980a). Model estimates indicate that bottom orbital velocities of 1.1 ft·per second are required to mobilize 0.04 inch of non-cohesive sediments (USACE, 2003).

Central Long Island Sound Disposal Site

Currents – Surface, middle, and bottom currents were measured at the CLDS in the spring of 2001 (USACE, 2001). Average peak ebb and peak flood currents ran 0.7 to 1 ft·per second (depth-averaged), with the spring tides about 20% to 40% stronger. The dominant flow direction was nearly east-west, and there was little flow normal to the dominant flow direction. Amplitude decreased with depth and near-bottom amplitude was less than 0.8 ft·per second. During the two-month spring deployment period, 50% to 95% of the current variance was due to the tide, with 96% of the near-bottom current variance in the direction of the long axis of the Sound due to tides.

The two-month current meter deployment observed a peak near-bottom flood event of 1.5 ft·per second associated with winds in excess of 30 knots (50.6 ft·per second). Also observed was a net west-southwestward flow (long-term mean) of approximately 0.08 ft·per second indicative of the density-driven estuarine circulation.

Waves **–** The wind fetch at CLDS is limited by the semi-enclosed nature of Long Island Sound, which limits the wave heights that can develop at the site. This is particularly true for winds from directions other than the east and northeast (along the axis of the Sound). Considering that winter storms can generate powerful winds from the northeast (nor'easters), the potential effect of waves must be take into account despite the limited fetch. Few wave measurements are available at or near CLDS. A two-month record of waves made in the spring of 2001 at a station within CLDS recorded 5-ft high waves (significant wave height) with 4- to 6-second periods associated with a 19-knot (32 ft per second) wind event (winds from the east). Near-bottom peak orbital wave velocities measured at a 69-ft depth reached approximately 0.3 ft·per second. This, however, represents a very short record of potential wave activity. Therefore, the 12-year record of wind data from the Buzzards Bay Tower was analyzed as described for WLDS (EPA, 2004).

The prevailing direction of waves in the region follows the prevailing wind directions, from the north and northwest in fall and winter (with occasional northeast events) and from the southwest in spring and summer. The data show that a northeast storm with a return period of two years will generate waves of 8.0 ft with a 5.5-second period over the CLDS alternative site. Storms with a return period of 10 years will generate 10-ft waves with a 6.1-second period over the site. The short period relative to wave height is indicative of locally generated, fetch-limited waves. The waves reported in the spring of 2001, with a peak wave height of 5 ft, represent storms that can be expected several times a year (USACE (2001), EPA (2004)).

Sediment Suspension and Transport **–** The oscillatory motions beneath steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 68 ft, peak-wave-induced near-bottom orbital velocities calculated from linear wave theory for the 2- to 10-year storms would generate bottom orbital velocities of only 0.6 to 1 ft·per second. Velocities of this magnitude are not sufficient to cause significant erosion (Bokuniewicz & Gordon, 1980a). Model estimates indicate that bottom orbital velocities of 1.1 ft·per second are required to mobilize 0.04 inch of non-cohesive sediments (USACE, 2003).

Cornfield Shoals Disposal Site

Oceanographic studies have been conducted at the CSDS alternative by the University of Connecticut. In 1991, hydrodynamic data were collected by the university within the CSDS (USACE, 1996). Measurements were collected from mid-depth and near-bottom using fixed-point water velocity sensors. The mid-depth sensor was deployed from August to October 1991, and the near-bottom sensor was deployed from July to October 1991. Some additional data available from the region were presented in a technical report (USACE, 2003). Studies to support designation of an open-water site in eastern Long Island Sound conducted in 2014 included additional characterization of the current and wave fields in the vicinity of CSDS (O'Donnell, 2014b).

Currents – The mid-water and near-bottom current meters deployed at CSDS measured current direction and velocity from August 1 to December 12, 1991. In both the mid-water and the near-bottom data, the tidal/current direction was dominated by the semi-diurnal east-west component. The east-west directions for both mid-water and bottom currents were parallel to the axis of Long Sand Shoal near the mouth of the Connecticut River (MO5 in Figure 4-7).

The current velocities at CSDS were highest during the flood portion of the tidal cycle. Over the long term (monthly time scale), maximum mid-water velocities were about 3.9 ft per second on the spring tide and 2 ft per second on the neap. Near-bottom maximum velocities were about 2.6 ft per second on the spring tide and 1.3 ft per second on the neap. In all cases, these current velocities would be sufficient to erode fine to medium sands (USACE, 1996). For the near-bottom current, the flood tide velocities were highest. This resulted in a net westward trajectory for particles as they approached the bottom. With the tidal variability removed from the current meter data at the mid-water station, current vectors trended north and west. The combined net drift for the mid-water current was 305° true at 0.15 ft per second. For the near-bottom meters, removal of the tidal variability resulted in a south and west component with a combined net drift of 256° true at 0.27 ft per second.

Waves – No wave data were collected at CSDS in the programs reviewed above.

Sediment Suspension and Transport – Sediment transport was not modeled for the CSDS site as part of the 2003 study (EPA, 2004). However, during the current meter deployment at CSDS, two major storms passed over the area (USACE, 1996). Hurricane Bob passed over Long Island Sound on August 19, 1991, and produced maximum wind speeds of 45 knots. During the hurricane, the near-bottom current meter was on its side, and data were not obtained; the data from the mid-water meter showed that the mid-day flood velocity was reduced by more than half. The succeeding flood tide current was normal. The near-bottom current meter was operational between August 28 and September 26, 1991, and again between October 21 and December 12, 1991. At the end of October 1991, a major storm occurred that lasted 114 hours with sustained winds of 40 knots over October 30 and 31. The National Weather Service determined this to be a 100-year storm; therefore, the potential for erosion could have been high. During this "Halloween" storm, the current meters showed no change in current strength, yet change did occur in the net drift. The mid-water drift, normally 305° true, shifted to the west and then south for three days. The near-bottom current net drift, normally 256° true, shifted to the west. The combined effects of the October storm were to produce an offshore displacement in the mid-depth waters, and shoreward displacement of bottom waters, intensifying the rate of upwelling in the area.

Bathymetric and sediment profile imaging surveys at CSDS have documented bed-load transport of sand-size material and the persistence of consolidated fine-grained material placed at the site (USACE (1996), ENSR (2005a)).

New London Disposal Site

Measurements of currents and waves were collected for two seasons at NLDS (Waddell, et al., 2001). In late summer (September and October 1997), current velocity was measured 3.3 ft off the bottom. Bottom-mounted pressure measurements were used to characterize pressure conditions generated by local wind-wave conditions. Optical backscatter (OBS) observations were made 8 inches and 30 inches above the local bottom to estimate near-bottom suspended material concentrations and profiles. During the winter season (January and February 1998), when dredged material placement took place, this suite of instruments was supplemented with an acoustic doppler current profiler (ADCP) placed on the bottom in the northwest corner of NLDS, in approximately 59 ft of water and adjacent to the near-bottom current meter. The ADCP provided detailed current profiles between approximately 10 ft and 46 ft below the water surface. During a two-day cruise at the end of January 1998, a ship-based ADCP provided vertical velocity profiles along east-west and north-south transects across NLDS. During winter and summer deployments, wind velocity and atmospheric pressure measurements were obtained from a meteorological station maintained by the University of Connecticut at Avery Point located approximately 3 mi north of NLDS. More-recent data were also collected by O'Donnell (2014b).

Currents – Measurements showed the background near-bottom current speeds to be in the range of 0.07 – 0.5 ft per second, depending on the conditions. During the occasional larger wave events at NLDS, the maximum (instantaneous) wind-wave-induced bottom current speeds would be expected to be in the range of 0.33 – 0.7 ft per second, depending on wave height and period. In contrast, approximately 3 ft off the bottom, currents associated with the semidiurnal lunar (M2) tidal constituent varied regularly between 0.26 – 0.82 ft per second over the 12-hour, 25-minute tidal period. At 10 ft below the water surface, the M2 tidal current speeds varied between 0.26 ft per second and 1.5 ft per second.

In the northwest corner of the placement area, near-bottom current velocities (speed and direction) were measured at 56 ft below the water surface approximately 3 ft off the bottom (Waddell, et al., 2001). Maximum measured speed at this height was 2 ft per second directed toward the east-northeast (60°–90°). This direction class contained nearly 30% of the summer, near-bottom current measurements and all current speeds in excess of 1 ft per second. The mean current speed was 0.63 ft per second for the entire record, while the mean east/west vector velocity was 0.17 ft per second toward the east and the north/south mean vector velocity was 0.03 ft per second toward the north. Approximately 60% of the measured currents had speeds that were less than 0.66 ft per second.

Profiles of low-frequency currents showed that the current directions rotated counterclockwise with increasing depth below the water surface. A similar pattern was seen for the profile of average velocity vectors. Maximum current speed measured by the bottom-mounted ADCP (2.8 ft per second) was recorded near the water surface. At 3.3 ft above the bottom, the maximum measured speed was 1.8 ft per second, representing a strong low frequency current close to the water-sediment boundary.

Ship-based ADCP surveys showed that the magnitude and direction of currents over the placement site varied over a tidal cycle as well as between the near surface and near bottom (Waddell, et al., 2001). Generally, the bottom currents were oriented counterclockwise from the surface; however, at times there was little vertical direction difference. Spatial differences in near-bottom current speeds may reflect the influence of local bathymetry as well as variations in the influence that Fishers Island may have on flow in different portions of NLDS.

Waves – The NLDS placement site is generally protected from longer-period oceanic swell (wave energy); as a result, significant wave height was generally low. Local wave generation is limited due to fetch, in particular for wind from the northwest clockwise to the east-southeast. The longest potential fetch is for winds from the west-southwest blowing down the main longitudinal axis of Long Island Sound. During the late summer measurements, significant wind and wave events were limited in magnitude. Wind speeds were generally less than 33 ft per second. Similarly, local wind wave events (those that clearly stood out over the background) could be defined as intervals when significant wave heights exceeded 2 ft, a relatively low wave. While several such events occurred, significant wave heights were generally less than 3 ft with short periods.

During the winter deployment, significant wind speed events correlated well with decreasing local atmospheric pressure and the passage of fronts. Maximum wind speeds were seldom over 49 ft per second. Episodes when the significant wave height rose above the background were weak but generally correlated with local wind events associated with migrating atmospheric low-pressure systems.

Sediment Suspension and Transport – Generally, the OBS records did not show significant resuspension or local backscattering maxima in conjunction with local wave height increases. Approximately semidiurnal variations in the absolute value of the OBS signal correlated well over the 1.8-ft vertical sensor separation. Typically, the sensor closest to the bottom had slightly higher OBS values, which might be expected if a bottom gradient existed.

Maximum current speeds measured by the in-situ ADCP reached 1.8 ft per second at 3.3 ft above the bottom. Such relatively high speed currents near the bottom could have a substantial influence on the nature of local sediment transport, in particular for finer fractions. The twice daily M2 tidal currents can provide a mechanism for “winnowing” finer material so that coarser material and shell fragments tend to dominate the sediment-water interface. This build-up tends to insulate remaining fine material from bottom stress and hence “armor” or protect the remaining sediments from erosion (Waddell, et al., 2001). This would be particularly effective protection against storm-induced erosion because the measured wind-wave stress was generally so much less than the daily tidal excursion. The presence of armoring deposits over the surface of several historic and relic placement mounds at NLDS has been confirmed by numerous sediment-profile photography surveys (e.g., AECOM (2010)).

4.4.3 Nearshore/Shoreline Environment Oceanography

There is little specific information available to characterize the nearshore conditions.

4.4.4 Upland Environment Oceanography

Oceanography is not applicable to the upland environment.

4.5 SEDIMENT/SOIL QUALITY, CONTAMINANTS, TOXICITY, BIOACCUMULATION

The U.S. Department of Agriculture (USDA) defines terrestrial soil quality as its “fitness” and “function” to sustain biological diversity; to regulate water and solute flow; to filter, buffer, and degrade organic and inorganic materials; to cycle nutrients; and to provide physical stability and support (USDA, 2009). Aquatic sediment quality can be defined similarly, but with a different geohydrological setting. In summary, quality sediments and soils are free of contamination and serve ecological function. Some chemical components are essential for biological functioning at the microbial and macrofaunal level, others are inert to biological systems, and some chemicals may be taken up by aquatic life or bioaccumulate with adverse effects (e.g., mercury). The sediment condition can affect species diversity and abundance and can have food web implications.

Sediment and soil substrates occur across a spectrum of habitat types, and many intersect with dredging programs either at excavation or placement locations. In this respect, the affected environment considers coastlines and embayments, estuaries where dredging may occur, and offshore, coastal and upland areas where the material may be placed.

Sediments are a natural sink for particulates that settle from the overlying water column. Particulates may add a variety of chemical constituents to the accumulating sediment, either sorbed onto or incorporated within the particles. As sediment accumulates, biogeochemical processes proceed and sediment diagenesis takes place (Berner, 1980). Equilibrium partitioning theory suggests that rather than bulk sediment, the interstitial fluid chemistry can be the most important determinant of biological effect and that toxicity is directly proportional to interstitial water chemistry (Di Toro, et al., 1991). A common example resides in the binding of trace metals like mercury by sedimentary sulfide. In this case, the presence of highly toxic and bioaccumulative metals may have little or no effect on measured biological systems because it is tightly bound and essentially inert within the sediment matrix as an insoluble metal-sulfide. Acid-volatile sulfide (AVS) is a common measure of sedimentary sulfide, and these data are common in many program study areas.

Offshore areas tend to be more homogeneous, with lateral changes more gradual, in comparison to coastal areas where surface substrate is often more heterogeneous and lateral changes can occur over a relatively short distance. Coastlines are more easily reshaped, as evidenced by recent hurricanes (e.g., Hurricane Sandy), and material from dredging programs is increasingly used to implement coastal and nearshore restoration projects and to improve the resiliency of coastlines. In fact, all of the Harbor Estuary Programs situated within the program area are currently assessing or are developing plans to address climate change vulnerability (EPA, 2014a).

Addressing the quality of sediment and soil poses a significant challenge for several reasons:

- Sediments and soils are marked by a significant degree of natural variability and support a diverse range of habitats;
- Common (anthropogenic) contaminants may be naturally enriched in some areas; and

- Contaminant enrichment does not consistently result in a reduction in substrate functionality or biological impact.

For these reasons, sediment quality assessments often collect a wide range of environmental data types. An evaluation of particle size and organic carbon content (i.e., total organic carbon [TOC]) is an important first step in evaluating the sediment type. Sediment grain size is also related to the hydrodynamic environment in which the sediments are found; coarser-grained deposits are found in nearshore and higher-energy environments, while finer-grained deposits are found in deeper, lower-energy environments. Fine-grained sediments also tend to accumulate in protected coastal bays and harbors where tributaries flow into the Sound.

These characteristics of texture and TOC provide context for chemical/geochemical data and chemical "signatures," and for the biological species that may be present. Texture and organic content are important sediment characteristics. They provide context for further discussion of sediment chemical and biological indices and play a large role in the suitability of sediment as habitat for benthic organisms. They have a strong influence on the fate, transport, availability and uptake, and toxicity of contaminants. Runoff from watershed drainage, land use, and geology influence the composition of sediment. Toxicity testing and bioaccumulation bioassays can also contribute important insights in assessing sediment and soil quality, since some sediment components can often mitigate contaminant load and prevent biological uptake.

Many of these data types are available within the program area, particularly in the offshore placement areas which have been studied extensively by the USACE and the EPA (e.g., EPA (2004)). These alternative areas will be discussed in greater detail to provide a broad view of central Long Island Sound sediment conditions along an east-west axis.

Important studies and ongoing programs that provide a basis for existing conditions include the Long Island Sound Study (e.g., NEIWPCC (2012)); the National Status and Trends Program (NS&T), including the Mussel Watch and the Benthic Surveillance Program (e.g., Harmon, et al. (1998)); EPA's National Coastal Condition Assessment Program (EPA, 2008); and numerous other studies supported by the EPA, the USACE, and the U.S. Geological Survey (USGS) (e.g., EPA (2004); ENSR (2002), (ENSR, 2005b), (2007); AECOM (2009); Myre & Germano (2007); Knebel & Poppe, (2000); Mecray & Buchholtz ten Brink (2000), Mecray, et al. (2000), USGS (2013), Latimer, et al. (2014)).

4.5.1 General Long Island Sound Setting

Within Long Island Sound, sandy silt/clay dominates the areas of the Western and Central Basins of the Sound and in harbors on the north shore (Figure 4-3). Coarser silty sand and sand dominate the shoal complexes that separate the depositional basins and the Eastern Basin. Organic carbon and sediment grain size parameters are typically correlated with one another, and in Long Island Sound, the amount of sedimentary TOC decreases with increasing grain size, with an average of more than 1.9% dry weight (dw) in sandy clay/silt and less than 0.4% in sand (Hunt (1979); Poppe, et al. (2000)). In general, TOC content increases toward the west and from the shallow margins to the deeper parts of the Long Island Sound basin (Hunt (1979); Poppe, et al. (2000)). The highest levels (greater than 3% dw) were recorded in the deepest parts of the

Western Basin. Moderate levels (1 to 2% dw) were recorded in the Central Basin and in New Haven Harbor, and the lowest levels (<0.5% dw) were recorded in the Eastern Basin.

Again, fine-grained sediment is naturally enriched with metals relative to sandy sediments, trace organic compounds can be enriched to a greater degree when the corresponding TOC content is increased, and these general patterns hold true for the sediments of Long Island Sound. Based on these factors, the texture associated with dredged material also influences decision-making regarding suitability, depending on how it is used (e.g., habitat restoration, capping, etc.).

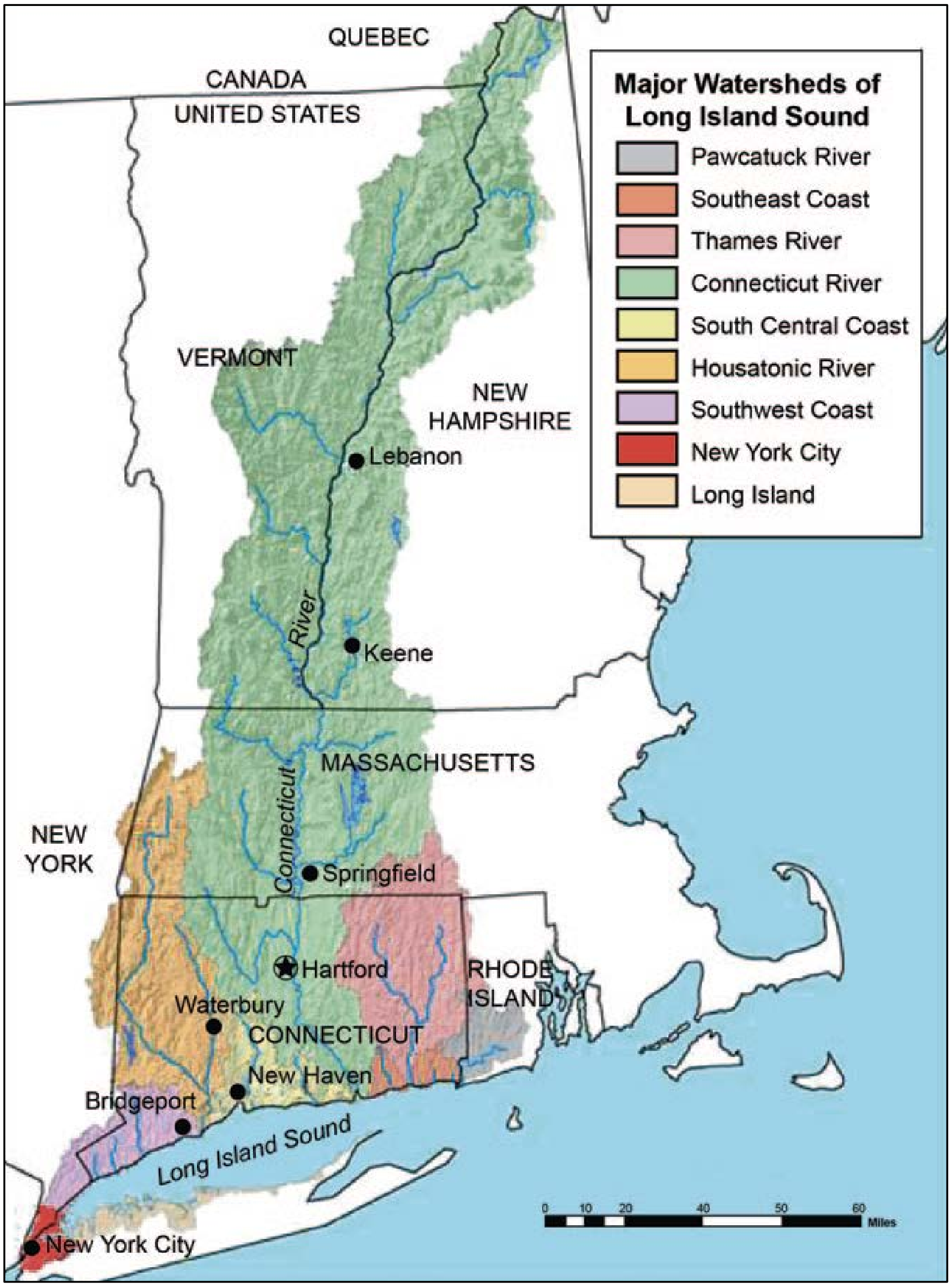
Long Island Sound Sediment Chemistry

Riverine inputs play an important role in the transport and distribution of sediments within the Sound. The primary rivers that enter Long Island Sound—the Housatonic, Connecticut, and Thames Rivers—flow from the north (Figure 4-11). Smaller coastal watersheds drain into Long Island Sound (the Southwest, South Central, and Southeast Coastal watersheds) (Figure 4-11). The East River, which is actually a tidal strait, forms the western end of Long Island Sound and passes through the metropolitan area of New York City. The East River connects to the Hudson River through the Harlem River to the north and southern Manhattan to the south. These primary rivers drain agricultural, urban, and industrial lands from a watershed that extends into Canada (Varekamp, et al., 2014). This watershed has a long history of industrial discharge, but the loss of most of these industries overseas and improvements in industrial practices required by water and air pollution regulations adopted since the early 1970s have in many cases reduced the load of industrial contaminants to Long Island Sound. However, residual historical contamination remains, particularly in industrialized harbors, nearshore areas, and upland areas. This residual contamination, combined with modern runoff from a densely populated region, continues to supply contaminants to Long Island Sound.

Severe storm events can also affect sediment contaminant loads. Based on results from core studies, a spike in contaminants occurred in flood deposits in central Long Island Sound following two hurricanes in 1995 (Varekamp, et al., 2014). Superstorm Sandy in October 2012 may have increased runoff and sediment transport in shallow regions and may have altered contaminant levels in various areas within the Sound.

Metals in Sediments

Metals affect biological function in different ways (i.e., are not equally toxic) and exist naturally at very different concentrations, ranging from parts-per-billion (ppb) mercury concentrations to parts-per-million (ppm) lead concentrations. Therefore, from a quality perspective, studies of metals in sediments typically focus on a subset of priority trace metals; furthermore, given the strong affinity/correlation between aluminosilicates and the heavy metals, sedimentary trends measured for a few often correlate to many of the other heavy metals.



Source: Latimer, et al. (2014).

Figure 4-11. Major Watersheds Draining to Long Island Sound.

Sediment quality guidelines (SQGs) are often used as a screening tool to conduct a first-level assessment of potential concern. These guidelines are statistically based on a wide range of biological effect measurements. They include low-probability-response values such as Effects Range-Low (ERL) values and concentrations with a higher probability of effect, such as Effects Range-Median (ERM) values (e.g., Buchman (1999)).

Table 4-3 provides an example of the range in concentrations (expressed in micrograms per gram [µg/g]) observed for nine metals within Long Island Sound surface sediments (within the upper

1 inch) and includes SQG values for comparison (ERL and ERM values). The sediment lead data associated with Table 4-3 is also provided graphically in Figure 4-12. In general, concentrations increase from lower levels in eastern Long Island Sound to higher levels in the more urbanized western Long Island Sound, which is consistent with many other studies in the area (e.g., Hunt (1979); Brownawell, et al. (1991); Mecray & Buchholtz ten Brink (2000); Mecray, et al. (2000); Mitch & Anisfeld (2010); Varekamp, et al. (2014)). Contaminant concentrations tend to be patchy within the Sound, varying among shoal complexes and in the central depression that runs from east to west through the Sound (Mecray, et al. (2003)).

Table 4-3. Long Island Sound Mean and Maximum Surface Sediment Metal Concentrations (0 to 1 inch)[1].

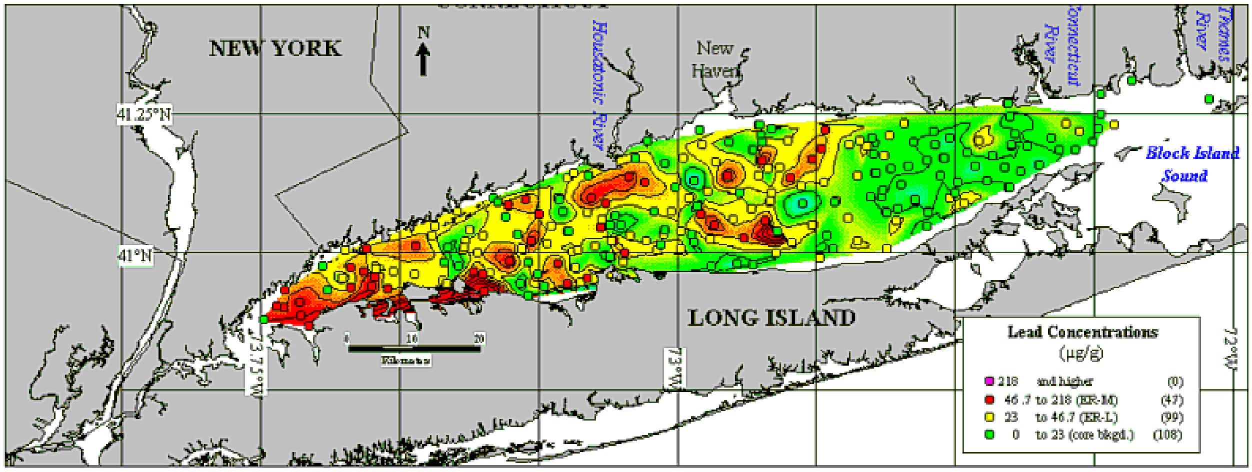
Concentration Values	Ag	Cu	Cd	Hg	Pb	Zn	Cr	Ni	As
	µg/g								
Mean	**1.5**	**117**	**2**	**0.7**	**83**	**160**	78	**26**	6
Maximum	**10.1**	**7720**	**35**	**17**	**3284**	**4800**	**2000**	**665**	**61**
Background	0.05	8	0.2	0.1	23	68	59	**25**	2.5
Mean EF	29.8	14.6	9.9	6.5	3.6	2.4	1.3	1.0	2.5
ERL	1.0	34	1.2	0.15	46.7	150	81	20.9	8.2
ERM	3.7	270	9.6	0.71	218	410	370	51.6	70

[1] Bolded values exceed ERL SQGs; underlined values exceed ERM SQGs (NOAA (1999)).
EF: enrichment factor

Metal enrichment factors (EFs) provide a possible way to understand if metal concentrations are enhanced above natural levels due to anthropogenic factors. Mecray & Buchholtz ten Brink (2000) reported EFs for metals based on mean values in surface sediment compared to background levels derived from sediment cores that sampled preindustrial sediments. Silver was the most highly enriched metal, followed by copper, cadmium, and mercury; in contrast, nickel was not enriched. Moreover, the distribution patterns of the most highly enriched metals could be associated with discrete pollution sources such as industry in the Housatonic River basin (copper, mercury, zinc, and chromium), urban sources in the East River (silver and mercury), and wastewater treatment facilities (silver) (Varekamp, et al. (2014)).

In general, silver, cadmium, copper, mercury, lead, zinc, and nickel mean concentrations exceed ERL values, but not ERM values within the Sound. Chromium, arsenic, vanadium, and barium concentrations were below corresponding ERL concentrations in this assessment (Varekamp, et al. (2014)).

Compared to national sediment metal concentrations, the median Long Island Sound sediment data (1996-2006) were generally higher (Table 4-3) (Mitch & Anisfeld, 2010). Another statistical benchmark calculated for the national dataset considers the statistical percentile, based on an ordering of samples by concentration. For example, samples with concentrations above the 85th percentile are within the top 15% nationally, on a concentration basis. Of the 11 metals measured for both western and central Long Island Sound, 8 had mean concentrations greater than the 1996 NS&T 85th percentile for metal samples. In the Eastern Basin, seven metals had mean concentrations that were above the 85th percentile.



Source: Mecray, et al. (2000).

Figure 4-12. Lead Distributions in Surface Sediments (0 to 1 inch) of Long Island Sound, 1996-1997.

The general pattern of high metal concentrations in Long Island Sound sediments is accentuated in harbors and embayments of Connecticut and Long Island (Varekamp, et al. (2014); Mitch & Anisfeld (2010); Breslin & Sañudo-Wilhemy (1999)). For example, harbors in the Western Basin have, on average, higher concentrations of copper and zinc than harbors in the Central Basin or Eastern Basin (Table 4-4) (expressed in milligrams per kilogram [mg/kg]). Most harbors have variable sediment characteristics and highly variable metal concentrations, although many of the harbors have similar mean values compared to the basins they influence. The maximum levels in coastal bays, notably for silver and mercury, were measured at much higher concentrations than the maximum levels measured in the basins (Mitch & Anisfeld, 2010). Copper and zinc tended to exceed ERL SQGs within most embayments and basins that represented fine-grained, depositional environments, but only the harbors tended to exceed ERM SQGs. The harbors with the highest contaminant concentrations have well-identified historical sources, and the higher ranges are typically associated with hot spots having fine-grained sediments and high organic content (Varekamp, et al. (2014)).

Organic Contaminants in Sediments

As with metals, biological sensitivities vary among trace organic compounds, and SQGs provide a useful tool for evaluating the potential significance of various sedimentary compound concentrations. In the case of trace organics, there is a strong relationship between compound concentrations and sedimentary TOC content, and screening SQG limits are often based on sediment TOC. With respect to the accumulation of organic compounds in biological tissues, trace organic compounds preferentially are partitioned to and accumulate in fatty (lipid) tissue.

Recent reviews of organic contaminants (PAHs, PCBs, and chlorinated pesticides) in Long Island Sound sediments have evaluated data compiled by the USGS for 1975-2000 (Mecray, et al. (2003); Varekamp, et al. (2014)) and from various sources between 1994-2006 (Mitch & Anisfeld, 2010). The data available for sedimentary organic contaminants are generally less than that available for metals.

Table 4-4. Comparison of Copper and Zinc Concentrations in Connecticut Harbors with Previously Published Data and SQGs.

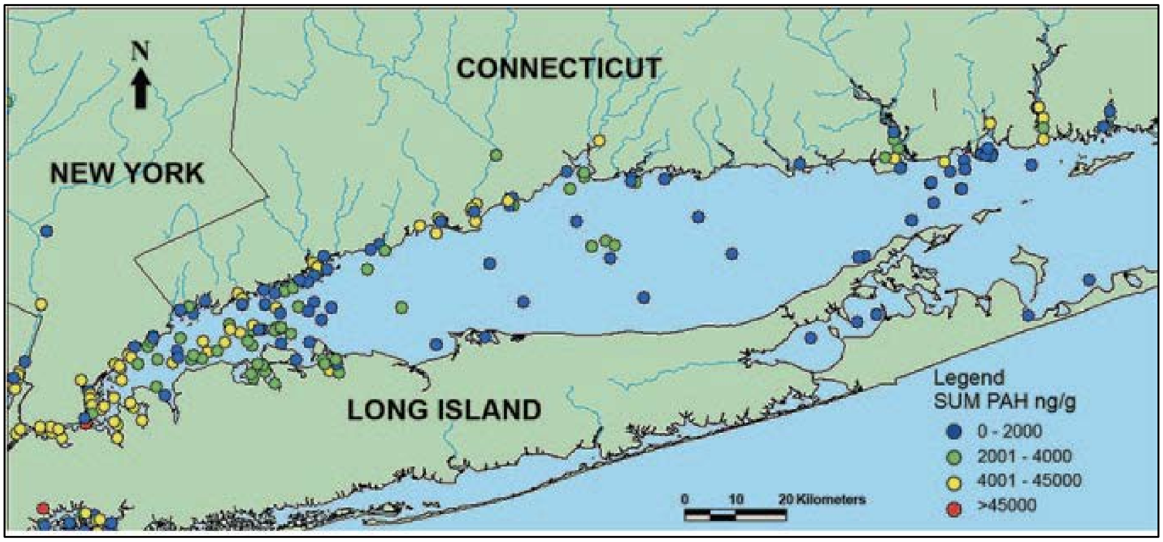
Harbor	Area	Stations	Copper (mg/kg)			Zinc (mg/kg)		
			Range	Mean	Median	Range	Mean	Median
New London	East	n = 35	3.2–**252**	**62**	**61**	10.0–**642**	**156**	**165**
Clinton	Central	n = 14	0.4–**49**	22	13	10.1–**247**	108	70
Branford	Central	n = 18	17.2–**148**	**67**	**67**	35.7–**274**	**159**	**156**
New Haven	Central	n = 128	6.3–**405**	**82**	**74**	7.5–**463**	**151**	146
Milford	Central	n = 11	19.9–**104**	**67**	**70**	37.0–**236**	147	**161**
Housatonic River	Western	n = 31	6.3–**685**	**146**	**93**	11.3–**517**	**159**	104
Bridgeport	Western	n = 26	18.5–**491**	**182**	**146**	5.6–**677**	**234**	**196**
Norwalk	Western	n = 30	6.9–**218**	**99**	**98**	33.0–**387**	**174**	**170**
Eastern Long Island Sound	-	n = 302	2.8–**96**	**53**	-	23.5–**186**	110	-
Central Long Island Sound	-	n = 323	8.6–**185**	**84**	-	43.3–**221**	137	-
Western Long Island Sound	-	n = 453	14.8–**216**	**116**	-	39.2–**315**	**183**	-
Natural Background	-	-	-	8	-	-	68	-

[1] Bolded values exceed ERL SQGs; underlined values exceed ERM SQGs (NOAA (1999)).

Source: Varekamp, et al. (2014).

In general, the concentrations of total PAHs (as the sum of 23 commonly measured compounds) were quite low in the Eastern and Central Basins compared to the corresponding ERL SQG, with the exception of three samples near the CLDS and those samples collected in harbors and embayments in Connecticut (Figure 4-13). Higher sediment PAH concentrations were measured in the Western Basin and bays and in embayments and harbors. If the NS&T Program sample set is treated statistically, then the concentrations associated with most of the samples collected from the Western Basin and bays fall above the 85th percentile (among the highest 15% nationally), and many exceeded the ERL (Long & Morgan, 1991). Furthermore, a few samples from the East River and Narrows exceeded the higher ERM SQG for total PAHs.

Mitch & Anisfeld’s (2010) compilation of more-recent (1994 through 2006) Long Island Sound bay and open-water sediment data (Table 4-5) found PAH trends similar to those reported from the USGS (1975-2000 data) (Mecray, et al. (2003); Varekamp, et al. (2014)), but with lower concentrations. Fewer stations contained PAH concentrations above the national 85th percentile, and the median PAH concentration for Western Long Island Sound (of 880 nanograms per gram [ng/g]) was lower than the earlier USGS finding (1975-2000 data compilation) (Mecray, et al. (2003); Varekamp, et al. (2014)). Although the median PAH concentration was highest in the Western Basin, the highest individual concentrations were measured in the Central Basin, followed by the Eastern Basin in this recent work, most likely in coastal bays and river estuaries in close proximity to sources and localized hot spots.



Sources: USGS data, 1975– 2000; all years combined, from Latimer, et al. (2014).

Figure 4-13. Total PAH Concentrations in Long Island Sound Surface Sediments.

Statistically, Mitch & Anisfeld (2010) found no significant difference in the medians of concentrations for PAHs between embayments and open water for Long Island Sound, although the maximum values within the dataset were much higher in embayment areas. This lack of significance may represent a sampling bias, since 52% of the analyzed sediments were collected from western Long Island Sound, where basin concentrations are higher than central and eastern offshore areas (see Figure 4-13).

PCBs in sediments collected from eastern and central Long Island Sound between 1975 and 2000 are distributed in a pattern similar to PAHs. On a total PCB basis, the sediment PCBs in these areas are generally below the corresponding PCB ERL SQG, with the exception of a few samples south of CLDS and in some nearshore areas and embayments (Mecray, et al. (2003); Varekamp, et al. (2014)). Some bay and river samples collected from the northern coast of Long Island Sound and in the Western Basin and bays contained total PCB concentrations that were above the corresponding ERM SQG (Varekamp, et al., 2014). The PCB content in one sample from the Mystic River and in samples from the East River were extremely high, exceeding 500 ng/g (Varekamp, et al., 2014).

Statistically, median PCB levels in the basins were similar to median PCB levels in the embayments, and the highest PCB levels occurred in the embayments. But again, a strong sampling bias toward the Western Basin exists, where sediment concentrations are higher than the Central and Eastern Basin offshore areas (Mitch & Anisfeld, 2010). The median PCB concentration in western Long Island Sound was, on a concentration basis, within the top 15% of samples analyzed nationally, exceeded ERL SQGs, and was an order of magnitude above the Eastern Basin median (Mitch & Anisfeld, 2010).

Table 4-5. Long Island Sound Sediment Organic and Inorganic Contaminant Concentrations, 1994–2006 (metals µg/g; organics ng/g dry)[1].

Contaminant	**Area of Long Island Sound**														
	Western					**Central**					**Eastern**				
	N	**10th**	**50th**	**90th**	**Mean**	**N**	**10th**	**50th**	**90th**	**Mean**	**N**	**10th**	**50th**	**90th**	**Mean**
Arsenic	366	ND	6.85	**12.2**	6.68	193	ND	4.98	**10.56**	5.69	268	ND	3.75	**11.2**	4.92
Cadmium	452	ND	*0.63*	***2.6***	***1.18***	311	ND	0.21	***2.16***	*0.92*	304	ND	0.2	***2.37***	*0.82*
Chromium	453	13.4	64	***110***	64.9	288	20.7	51.4	**108**	62	310	9.2	30.1	69.3	36.1
Copper	453	14.8	**89**	**216**	**116**	323	8.6	**51.7**	185	83.8	302	2.8	33.2	**96.3**	**52.5**
Lead	453	12.6	***57***	***162***	***87***	322	9.0	*37*	***85.9***	*45.6*	306	4.8	24.8	***82.2***	*43.9*
Mercury	454	0.02	***0.3***	***1.00***	***0.49***	300	0.02	***0.15***	***0.47***	***0.21***	302	ND	*0.12*	***0.56***	***0.24***
Nickel	451	7.4	**23**	***37.6***	**23.9**	306	6.8	19.4	***37***	**22.5**	303	5.6	15.2	**30**	18.1
Selenium	56	ND	ND	*5.3*	*1.3*	34	ND	0.2	*3.91*	*2.22*	26	ND	0.03	*2.12*	*0.74*
Silver	142	0.05	*0.54*	***2.05***	*0.97*	164	ND	0.31	***1.65***	*0.71*	60	ND	0.06	*0.6*	*0.25*
Tin	36	1.65	*5.54*	*9.8*	*5.88*	23	1.11	*2.94*	*5.34*	*6.77*	18	0.45	1.51	*7.95*	*2.99*
Zinc	450	39.2	***164***	***315***	***183***	305	43.3	113	***221***	*137*	299	23.5	82.2	***186***	110
DDTs	72	ND	**3.71**	***15.3***	**6.37**	39	ND	ND	**3.68**	**2.22**	30	ND	ND	**3.95**	1.29
PAHs	72	61.1	880	***4350***	*2370*	36	69.1	561	***10900***	*2860*	30	ND	463	***4610***	1810
PCBs	72	3.21	***36.5***	***174***	***162***	36	ND	2.75	***35.3***	***32.6***	30	ND	1.37	***31***	*15.2*

Sources: Mitch & Anisfeld (2010); Varekamp, et al. (2014).

[1] Values that exceed ERL SQGs are bolded; values that exceed ERM SQGs are underlined; values that exceed national 85th percentile are italicized; SQGs from NOAA (1999).

Chlorinated pesticides, such as dichlorodiphenyltrichloroethane (DDT), followed the same general decreasing trend from west to east as the other organic contaminants, with the highest means occurring in western Long Island Sound, followed by central, and then eastern, Long Island Sound (Mecray, et al. (2003); Varekamp, et al. (2014)). The mean DDT values in the western area of the Sound were more than double the mean in the central area. More than half of the DDT measurements made in central and eastern Long Island Sound were not detected. Several pesticides, along with PAHs and PCBs, exceeded the 1996 NS&T 85th percentile in the Housatonic River, the Mamaroneck, and Throgs Neck (Mitch & Anisfeld, 2010). The lack of comparable pesticide data prevented an assessment of temporal trends and comparison between bays and basins. Chlordane, a banned but persistent pesticide, was highest in urbanized areas of western Long Island Sound and did not show any significant decline from 1996 to 2006 (Yang, et al. (2007); Varekamp, et al. (2014)). Another recent analysis compared DDT, dichlorodiphenyldichloroethane (DDD), dieldrin, and dichlorodiphenylchloroethylene (DDE) in surface sediment and cores from 2005-2006 with archived sediments (1986-1989) (Yang, et al., 2012). These pesticides continued to be ubiquitous despite their ban more than two decades ago, and no significant decrease was observed.

Bioaccumulation

Since impacted sediments can contain chemicals that may accumulate in biological tissues, the quality of sediment is often examined from a biological uptake perspective, since once in the tissues of organisms, these chemicals can affect the organism directly as well as upper trophic level species that consume them. This section provides a summary of contaminants in the tissues of representative organisms (such as benthic invertebrates and fish) from Long Island Sound that either live in close association with the sediments or are likely to accumulate elevated tissue levels of these contaminants. Although the bioaccumulation of a contaminant by an organism may or may not result in detrimental impacts to the organism, it can be a risk indicator.

Contaminants in Mussel Tissue

NOAA has conducted the most comprehensive studies of tissue concentrations within Long Island Sound as part of the NS&T Mussel Watch and Benthic Surveillance Programs. Blue mussels have been collected from shoreline locations in the study area since 1986 and analyzed for the same suite of chemicals (and, more recently, for flame retardants) as part of the National Mussel Watch Program (Varekamp, et al. (2014); Kimbrough, et al. (2009); Kimbrough, et al. (2008); Robertson, et al. (1991)). Samples have been regularly collected at nine sites (Connecticut River, Sheffield Island, Housatonic River, New Haven, Hempstead Harbor, Huntington Harbor, Mamaroneck, Port Jefferson, and Throgs Neck; Varekamp, et al (2014)), and the Mussel Watch data from these nine sites have been used for Sound-wide evaluations (Varekamp, et al. (2014); Mitch & Anisfeld (2010)).

Within Long Island Sound, blue mussel contaminant levels measured by the Mussel Watch Program tended to be relatively low and constant overall, with some exceptions. Moreover, concentrations did not exceed human health or ecological effects thresholds for data encompassing 1994 to 2004 (Table 4-6; Mitch & Anisfeld (2010)). The contaminant concentrations for the majority of the program area samples were measured to be in the lower range for most of the measured contaminants. However, PAH values were notably elevated, with a median PAH value (436 ng/g dw) above the national median of 220 ng/g dw (Mitch &

Anisfeld (2010); Varekamp, et al. (2014); O'Connor & Lauenstein (2006)). Comparisons of mussel tissue from open water to mussel tissue from embayments cannot be made for these same time periods, because open-water samples were not collected under the Mussel Watch Program. These findings were consistent with the multivariate classification by Kimbrough, et al. (2008), in which a national dataset was clustered and classified as either low, medium, or high as a contaminant concentration. Most of the 2004-2005 station tissue metals data were classified as "low"; however, mercury, lead, and tin, along with several organic compounds, were within the medium contamination category. Lead and chlordane were in the high contamination category, although the New Haven and the Housatonic sites were not included.

Table 4-6. Blue Mussel (*Mytilus edulis*) Contaminant Concentrations Within Long Island Sound Embayments, 1994–2004.

Chemical Analyte[a]	N	Long Island Sound			NS&T 85th[b]	FDA[c]	EEV[d]
		10th	50th	90th			
As	43	4.75	6.44	8.84	15.0	602	88.2
Cd	46	1.12	1.83	2.82	2.82	28.0	21.0
Cr	46	0.899	1.57	3.24	3.58	91.0	82.6
Cu	46	7.76	10.5	***18.6***	11.6		67.2
Pb	46	1.58	2.68	***4.98***	3.86	11.9	83.3
Mn	46	20.4	35.4	***174***	50.2		
Hg	46	0.060	0.110	0.198	0.28	2.10[e]	1.40
Ni	46	1.20	2.06	3.06	3.08	560	26.6
Se	46	1.80	2.31	3.35	4.84		
Ag	46	0.040	0.116	***0.621***	0.442		10.5
Sn	46	0.000	0.103	0.353	0.41		
Zn	46	74.0	96.0	**136**	114		10619
Butyltins	46	11.0	18.7	39.9	40.4		
TChlordane	46	6.36	14.0	***31.7***	20.9	2100	448
Chlorpyrifos	37	ND	0.37	1.44	1.94		
DDT	46	20.8	43.5	***80.4***	59.3	35000	21000
TDieldrin	42	2.50	5.46	***14.4***	7.01	2100	30.6
TEndo	37	0.00	4.88	***10.9***	10.0		20.0
THCH	46	0.034	0.496	1.62	4.11		
Mirex	46	0.13	0.37	***1.59***	1.36		
PAHs	46	182	436	***1267***	953		70000
PCBs	45	92.3	155	315	534	700[f]	28000

Source: Mitch & Anisfeld (2010); *data source:* NS&T.

ND: not detected; EEV: Ecological Effects Value; FDA: U.S. Food and Drug Administration.

TChlordane = Total chlordane; TDieldrin = Total dieldrin; TEndo = Total endosulfan; THCH = Total HCH

[a] Metals µg/g dw; organics ng/g dw.

[b] 85th percentile of NS&T values nationwide in 1996; bold italicized values exceed NS&T national 85th percentile value.

[c] FDA Action Level for Crustacea and Mollusks.

[d] EEVs (EPA, 2004) have been corrected for moisture and assumed 85% tissue moisture.

[e] FDA/EPA fish tissue (including shellfish) consumption advisory criterion for methylmercury is 0.3 µg/g wet weight (ww) = 2.1 µg/g dw. Hg concentrations were interpreted as 100% methylmercury for all species (trophic levels three and above; EPA (2001a).

[f] CTDPH. Guidelines for PCBs (EPA, 2004).

Mussel tissues collected from 1996 and during the period of 2004-2007 were also tested for flame retardants as an emerging class of contaminants of potential concern (38 congeners of polybrominated diphenyl ethers [PBDEs]; Kimbrough, et al. (2009)). PBDEs were found to be widespread nationally and correlated with the human population density of the coastline. The ecological significance of this compound class is not well understood, but for this study samples were ranked as low (<1 ppb), medium, (1-270 ppb), or high (>270–8,202 ppb). In the period of 2004-2007, tissues from the Throgs Neck collection site contained the highest levels of PBDEs within Long Island Sound and ranked within the highest 15% nationally. Generally speaking, measurements collected from the nine Long Island Sound sampling sites were variable, but were classified within the medium to high concentration range.

Temporal Trends in Mussel Tissue Metals **–** Many authors have evaluated contaminant trends in mussel watch tissue data; Mitch & Anisfeld (2010) found mercury and arsenic to increase at Port Jefferson for the 1986 to 2004 dataset. Moreover, mercury increased in the Connecticut River tissue samples (excluding the New Haven and Housatonic sites), and chromium and manganese increased in Huntington Harbor, Port Jefferson, and Sheffield Island sites. The declines identified were tin (at two stations) and cadmium tissue concentrations in Hempstead Harbor. Transient spikes in levels of copper and silver were also noted for the nine stations. In the most recent NOAA report covering the period of 1986 to 2005, measured increases in arsenic and mercury were observed at the Port Jefferson site. No other trends were noted at any of the other Long Island Sound sites (Kimbrough, et al. (2008); Mitch & Anisfeld (2010)).

Trends in Mussel Tissue Organics **–** Nationally, organic contaminant levels are generally higher in areas of historic use and production. The PBDE tissue concentrations in Long Island Sound were also relatively constant from 1996 to 2004-2007. Nationally, both increasing and decreasing trends in PBDEs were evident in various locations. However, there was an overall increase in the "medium" clustering samples for PBDEs and a decrease in the "low" samples (Kimbrough, et al., 2009).

PAHs in mussel tissue have shown variable trends for Long Island Sound, although total PAH concentrations in mussels from the study area generally decreased from 1989 to 1997 (Varekamp, et al., 2014). After 1997, the data trended with an apparent increase, particularly in New Haven and in the Housatonic River, which both reached the maximum concentrations (~4,500 ng/g dw) observed during the 2004-2005 program. Since 2005, the levels at these two stations have declined but are still relatively high. Tissue PAH concentrations have increased during the period of 2002 to 2008 at the Mamaroneck and at the Connecticut River sites.

As a final note regarding mussel tissue as a sediment quality indicator, contaminant concentrations in these tissues relative to nearby sediments have only been weakly correlated (Mitch & Anisfeld, 2010). The weak link between sediment and tissue may be explained in part by low bioavailability of some of the metal contaminants due to high sulfide levels in sediments, variability in mussel uptake and excretion rates, and differences in time scales for contaminant accumulation (Mitch & Anisfeld, 2010), along with the fact that mussels generally live above, and not within, the sediment matrix. Despite the high sulfide levels that limit bioavailability of certain metals, lead did accumulate in the mussel tissue at Throgs Neck to levels that were considered high nationally.

Contaminants in Fish and Lobsters

In addition to the Mussel Watch Program, the NS&T National Benthic Surveillance Program (NBSP) determined the status of and long-term trends in the environmental quality of the nearshore waters of the United States from 1984 to 1992 (Harmon, et al., 1998). The program evaluated biological exposure to, and uptake of, organic contaminants and biomarkers such as enzymes that are active in the metabolism of contaminants in fish. This included the concentrations of organic and inorganic contaminants in the liver and bile of bottom-dwelling fish from coastal and estuarine waters of the United States that are found to be associated with seafloor sediments. In addition, the incidence of visible lesions in fish was recorded, and histopathological examination of selected liver, kidneys, fins, gills, ovaries, and testes was conducted. As a result of the prevalence of toxicopathic liver diseases, the NBSP expanded in 1987 to include measurements of biological effects due to contaminant exposure (NOAA, 2011). Methods, assays, and sampling sites varied over time as refinements were made and contaminated areas were identified and became the focus of the program (Harmon, et al., 1998).

A biomarker, cytochrome P450 monoxygenase (Cyp1a) activity, has been used in the program to assess exposure to PCBs, PAHs, and other organics in fish (Varekamp, et al., 2014). Winter flounder samples were collected at 22 sites in the northeast region from 1988 to 1994, and Cyp1a activity was typically detected throughout the region, indicating organic contaminant exposure (Collier, et al., 1998). No decreasing time trends were identified in these data (Collier, et al., 1998).

Other than the NS&T survey data collected from the designated placement sites (Section 4.2.2), there are only limited metals or organic contaminants in fish tissue data in Long Island Sound organisms. Monosson & Stegeman (1994) investigated Cyp1a activity in the livers of winter flounder, and a recent dissertation investigating Cyp1a activity (Romany, 2010) is summarized in Varekamp, et al. (2014). The fish tissue from Hempstead Harbor evaluated in the early 1990s had high concentrations of PCBs and the highest Cyp1a level of any fish in the northeastern United States study area. Romany (2010) found widespread exposure to organic contaminants in young winter flounder samples collected from Port Jefferson, Oyster Bay, Manhasset Bay, and Little Neck Bay in Long Island Sound, and Shinnecock and Jamaica Bay on Long Island's south shore in 2008 and 2009 (Varekamp, et al., 2014).

Several agencies (NYSDEC, CTDEEP, New York State Department of Health [NYSDOH], Connecticut Department of Public Health [CTDPH], and EPA) have collaborated to monitor PCBs in striped bass, bluefish, and additional species, and periodic sampling of striped bass and other species has continued since 1984. A review of the 2006-2007 survey results and earlier data by Skinner, et al. (2009) provides some spatial and temporal trends in PCB body burdens. No distinct spatial pattern in contaminant levels in striped bass and bluefish was detected by these authors, but temporally, levels of PCBs in striped bass have apparently declined by 82% from levels observed in 1985-1987. Lipid-normalized PCB levels for striped bass decreased from 59.31 μg/g in 1985-1987 to 29.19 μg/g in 2006-2007. No such change has been observed for bluefish. Skinner, et al. (2009) have concluded that ambient levels of PCBs in Long Island Sound have changed little over the past 30 years.

Striped bass, bluefish, weakfish, American eel, and lobster tissue were also tested for mercury as part of the 2006-2007 interagency effort (Skinner, et al., 2009), and concentrations have been correlated with the length of striped bass, bluefish, and weakfish. The highest mercury concentrations were observed in the northern area of central Long Island Sound, where the largest fish were found. Mercury levels in some large striped bass and bluefish caught in Long Island Sound during this period exceeded the U.S. Food and Drug Administration (FDA) human health action level of 1 mg/kg wet weight (ww) (Skinner, et al., 2009). Average mercury tissue concentrations ranged from 0.073 mg/kg ww in lobster to 0.365 mg/kg ww in striped bass. No clear spatial trends were found in a recent review of mercury in fish and shellfish from Long Island Sound (Varekamp, et al., 2014). Although available mercury data are limited, no significant difference was observed in the mean mercury concentrations in these fish between 2006-2007 relative to 1985 data by NYSDEC (Skinner, et al. (2009); Varekamp, et al. (2014)).

The hepatopancreas of lobsters (the tomalley, or soft green substance in the body cavity that functions as liver and pancreas) tends to accumulate contaminants, and in the 2006-2007 interagency sample set was found to contain relatively high concentrations of cadmium, indicating a potential health risk in this tissue (Skinner, et al., 2009).

Sediment Toxicity

The potential toxicity of sediments to aquatic organisms is evaluated with laboratory tests in which organism's representative of benthic infauna communities are exposed to sediments collected from the area under evaluation. Amphipods are commonly used and are relatively sensitive to a wide range of contaminants relative to other organisms.

A review of the published literature found few general studies that tested Long Island Sound sediments for potential toxicity, but the earliest system-wide study was conducted on sediment samples collected in 1990 and 1991 by the NS&T Program as part of its bioeffects program (Wolfe, et al., 1994). Sediments from three stations in each of 20 Long Island Sound coastal bays and from one station located south of the CLDS area were tested for sediment chemistry, benthic community structure, and toxicity as part of a Sediment Quality Triad (SQT) approach (Long & Chapman, 1985). An additional 11 stations from the open waters of Long Island Sound were tested only for sediment toxicity to amphipods.

Whole-sediment assays, conducted using the tube-dwelling amphipod *Ampelisca abdita*, showed that sediment toxicity was widespread in the 20 coastal bays. In contrast, the sediment collected in the open waters of the Sound had *Ampelisca* survival rates mostly above the survival threshold for significant toxicity (80% survival). Modest toxicity was found at the Throgs Neck, the CLDS, the Mattituck Creek, and the Block Island Sound sites (Wolfe, et al., 1994). The greatest sediment toxicity was observed at Manhasset Bay, followed by Oyster Bay, Little Neck Bay, Echo Bay, Cold Spring Harbor, Larchmont Harbor, Pelham Bay, the Housatonic River, and Bridgeport Harbor. The least toxic areas according to this study were observed to be Branford Harbor, Connecticut River, Southport Harbor, Milford Harbor, the Thames River, and Northport Harbor. The sample toxicity tended to co-vary with the contaminant concentrations and was affected by grain size and TOC content of the sediments. However, only a subset of the most toxic bays—Little Neck Bay, Manhasset Bay, Pelham Bay, and the Housatonic River—was considered to be the most contaminated based on sediment contaminant levels measured during the same study.

Two additional sediment toxicity tests, a bivalve (*Mulinia lateralis*) larvae survival and development assay and a microbial bioluminance toxicity assay that used solvent extracts from the sediments, were also conducted on the sediments. The data from these tests also suggested that sediments from all 20 bays were toxic. Of the 60 bay stations sampled, only 11 showed no toxicity in the three tests. Manhasset Bay had the most toxicity findings, with all three stations testing toxic for all three bioassays. Multiple positive toxicity test results were reported for all of the New York bays tested, which included Oyster Bay, Little Neck Bay, Echo Bay, Cold Spring Harbor, Larchmont Harbor, and Pelham Bay. The least toxic bays based on the toxicity tests were Branford Harbor and the Connecticut River, which each had only one toxic finding at a single station.

The toxicity of sediment samples is affected by grain size, contaminant concentrations, and the TOC content of the sediments. However, contaminant concentrations generally co-varied, which makes attribution of toxicity to specific chemicals difficult. The ratios of simultaneously extracted metal concentrations (SEMs) (i.e., those extracted under the same conditions as AVS) to AVS concentrations provide a means to assess the potential for toxicity from metals. SEM/AVS ratios in the early 1990 sediment study were generally at or below 1.0 (Berry, et al., 1996), indicating that these metals were not likely a primary source of the measured toxicity. However, statistical analysis indicated that the pesticide hexachlorobenzene likely affected the toxicity observed in samples from Centerport Harbor, Oyster Bay, and Larchmont Harbor, New York.

Toxicity tests have continued to be conducted as part of EPA's National Coastal Assessment (NCA) program. Results from 2000 to 2006 showed toxicity at 19 of the 310 Long Island Sound stations (Varekamp, et al., 2014). Whole sediment toxicity was identified primarily in nearshore areas, particularly in the embayments in Connecticut and New York. The frequency in the number of toxic sites also decreased in the later years of the study relative to earlier studies.

Summary of Sediment Contaminant Trends in Long Island Sound

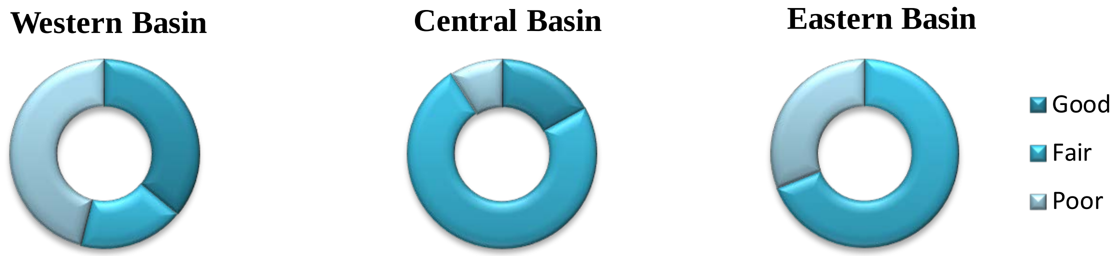
The general spatial distribution of sediment contaminants within Long Island Sound generally reflects a combination of sediment type (texture, TOC) and proximity to contaminant source within the Western, Central, and Eastern Basins of Long Island Sound and its embayments (Hunt (1979); Tedesco, et al. (2014)). Metal concentrations in sediment are typically enriched compared to background levels, and organic contaminants (PAHs, PCBs, and chlorinated pesticides such as DDTs) are evident. There is a general west-to-east gradient in concentrations in the open waters of Long Island Sound. The highest concentrations typically occur in the west, which is more heavily urbanized and industrialized and has more fine-grained sediments and less sand than the east. Moreover, the highest contaminant concentrations are found in the coastal bays and harbors of Long Island Sound near land-based sources; lower concentrations occur in the deeper, middle region of the Sound.

The changes in loadings to and transport within Long Island Sound are reflected in the concentrations of contaminants in sediment and biota. Sediment cores provide historical records that link the date of sediment deposition with sediment depth. Most of the cores analyzed to date show a decrease in metal concentrations between 1980 and 2010, the period of enhanced environmental control required by the CWA (Varekamp, et al., 2014). However, in the shorter term, no trends were evident in surface sediment metals concentrations between 1990-1992 and 2000-2002 (Mitch & Anisfeld, 2010). Similar to metals, PCBs did not change significantly, while the median PAH levels in surface sediments decreased by a factor of three in these NCA datasets.

Bioaccumulation results, however, vary by species, and spatial trends have been less obvious. Mussel tissue studies in the 1980s indicated a west-to-east gradient of decreasing contaminants; recent data suggest that bioaccumulation has become more varied (Varekamp, et al., 2014). Moreover, while metal concentrations in mussel tissue tended to decline at a few stations from 1986 to the mid-1990s, and organic contaminants generally declined, recently measured tissue levels appear to no longer be declining and may be increasing in localized areas for certain contaminants (Varekamp, et al., 2014).

PCBs and mercury tissue concentrations were above FDA action levels in only some of the large fish tested (Skinner, et al., 2009). Cadmium was also reported to have high levels in the hepatopancreas of lobster, which, along with chlorinated dioxins/furans and PCBs, contribute to health advisories. Specific enzyme activity in fish has also indicated general exposure to organic contaminants (Varekamp, et al., 2014). However, no significant changes in contaminant accumulation and exposure since the 1980s are evident in tissue data through the first decade of 2000 (Skinner, et al., 2009).

The Sound-wide sediment condition has also been evaluated by EPA and others (EPA (2008); NEIWPCC (2012)). In this analysis, quality indices associated with toxicity, sediment contaminant loads, and sediment TOC have been used as predictors of sediment quality. The results of this evaluation are shown in Figure 4-14. By this analysis, a large area (46%) of sediments in the Western Basin are considered to be in poor condition, while sediments within the Central Basin are in a much better condition, with 91% of the basin sediments ranked with either a good or fair scoring. Some decline in sediment condition was noted in the Eastern Basin, where two-thirds of the sediment has been rated to be in fair condition, and one-third rated to be in poor condition. These results generally confirm the conclusions drawn from the many datasets previously discussed.



Source: EPA (2008).

Figure 4-14. Sediment Quality in Long Island Sound's Western, Central, and Eastern Basin Areas.

4.5.2 Sediment Quality in the Open-Water Environment

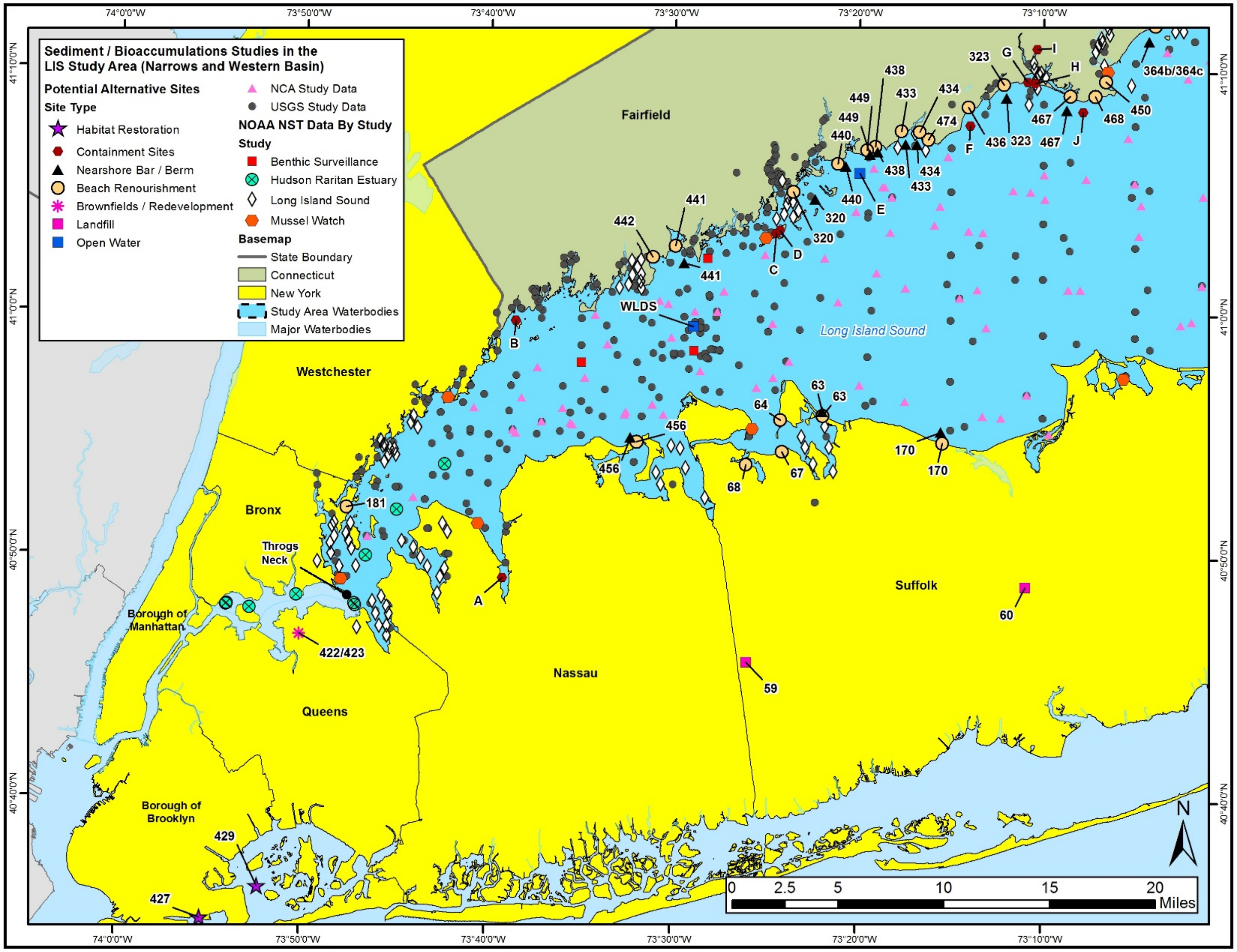
The sediments in the open-water environment of Long Island Sound have been sampled extensively over time by the major studies described above. Many of the sampling locations for these studies are located near the alternative sites being evaluated in this PEIS (Figure 4-15 through Figure 4-17). Table 4-7 presents some of those studies that have sampling stations within the vicinity of the unconfined and confined open-water alternative sites.

There are currently four unconfined open-water placement sites for dredged material in Long Island Sound: WLDS, CLDS, CSDS, and NLDS. WLDS, CLDS, and NLDS are located in largely depositional areas. CSDS is the only dredged material placement site managed as a dispersive site, where tidal currents transport material away from the placement location, primarily in an east-west direction. There is also one confined open-water placement alternative, near Sherwood Island in Westport, Connecticut.

Unconfined Open-Water Placement

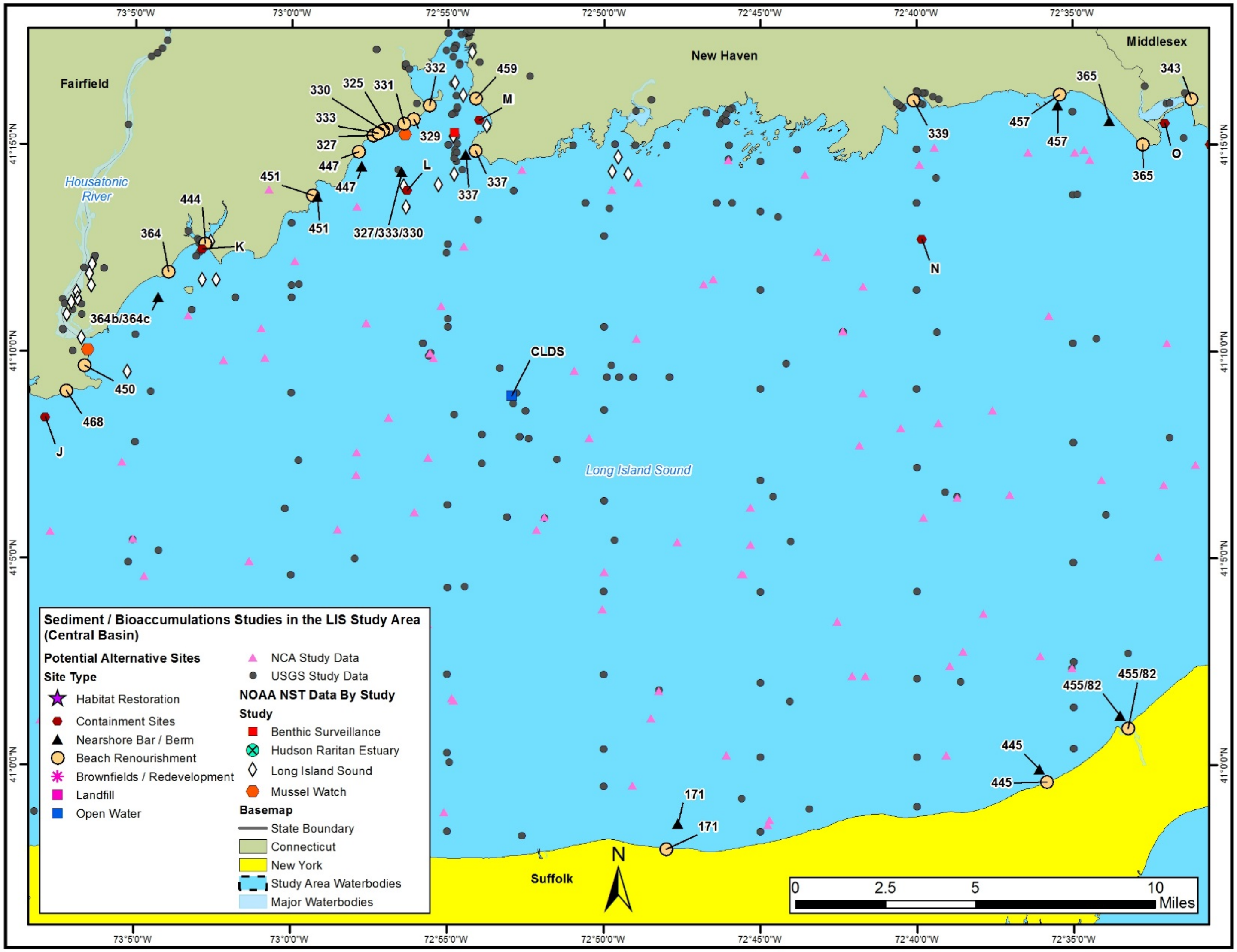
Detailed information is available from the offshore dredged material unconfined placement areas (e.g., ENSR (2002)). Although variable, the textures and TOC observed are generally consistent with the conditions in the broader Sound; the sediments at WLDS, CLDS, and NLDS are dominated by fine grained particles while the CSDS placement area in the Eastern Basin is characterized by coarser material. These observations are consistent with the physical oceanography discussed in Section 4.4, with significant tide-induced currents observed in the Eastern Basin and relatively weak currents observed in western and central areas of the Sound.

Three recent data compilations for Long Island Sound have been performed by the USGS, NOAA, and EPA. NOAA has compiled data through the NS&T Program, and EPA has gathered information to support the NCA program. Together, these programs have included numerous sampling locations within 1 mi of many of the unconfined open-water placement sites. The USGS compiled data from multiple studies over a 25-year period (1975-2000). Analytes include grain size, TOC, and a range of metal and trace organic contaminants. Not all studies included all analytes. The NS&T data included metals, PAHs, PCB congeners, and pesticides, in surficial sediments and soft tissues of bivalve mollusks or fish from 1986-2004.



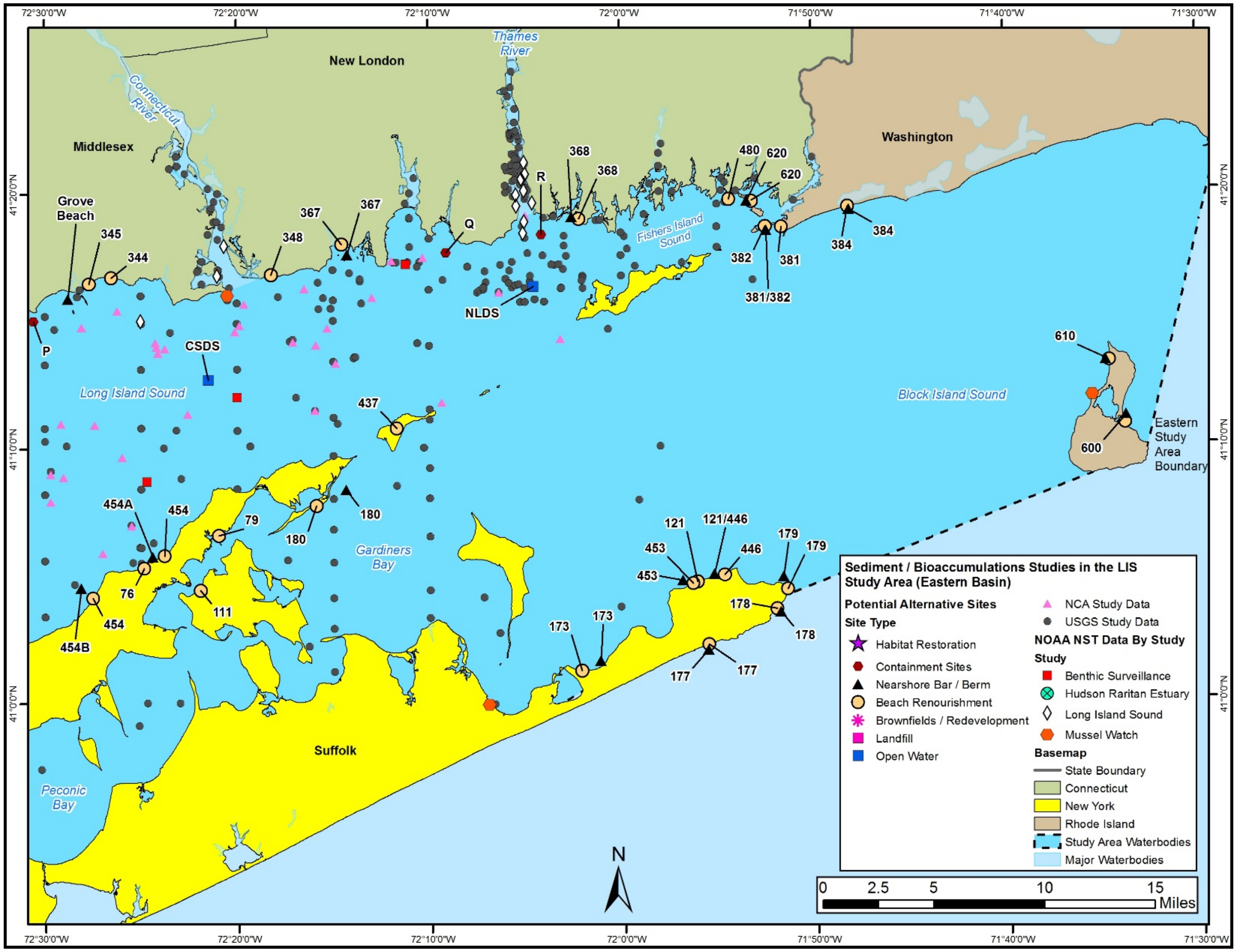
Sources: USGS (2013); EPA (2010a); NOAA (2014b).

Figure 4-15. Locations of Alternatives and Sediment Sampling Stations in Western Long Island Sound.



Sources: USGS (2013); EPA (2010a); NOAA (2014b).

Figure 4-16. Locations of Alternatives and Sediment Sampling Stations in Central Long Island Sound.



Sources: USGS (2013); EPA (2010a); NOAA (2014b).

Figure 4-17. Locations of Alternatives and Sediment Sampling Stations in Eastern Long Island Sound.

Overall, there were 85 stations from the USGS dataset within 1 mi of three of the unconfined open-water placement alternatives (WLDS, CLDS, and NLDS). No stations are located within 1 mi of CSDS, and a small set of stations from USGS and NCA have been sampled near the confined open-water alternative site (Site E) (Table 4-7).

Table 4-7. Sampling Stations Within 1 Mi of the Open-Water Placement Alternatives.

Alternative Type	Alternative ID	Sediment/Bioaccumulation Sampling Stations Within 1 Mi	USGS	NS&T	NCA
Unconfined Open-Water Placement	WLDS	32	X		
	CLDS	16	X		
	CSDS	None			
	NLDS	37	X		
Confined Open-Water Placement	E	4	X		X

The sediment quality conditions at WLDS, CLDS, CSDS, and NLDS are very well represented by multiple site-specific surveys conducted in 2000 and 2001. Surface sediment samples were analyzed for physical, chemical, benthic community, and toxicity evaluations (EPA (2004), Appendices F and H). The sampling locations for each site were defined to assess historic and recent placement areas in both near and farfield areas and included reference areas. The sediment chemistry data from these sampling efforts have been compared to other Long Island Sound data sets, to the NS&T dataset, and to biological effects values (Mitch & Anisfeld (2010); (NOAA (1999)). An SQT analysis (Long & Chapman, 1985) was also used to evaluate sediment quality, using indices developed from sediment chemistry, toxicity, and benthic community composition data.

Data on contaminant bioaccumulation at or in the vicinity of the placement sites can be found in Appendix H of the *Environmental Impact Statement (EIS) for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York* (EPA, 2004) and are summarized. Contaminants analyzed included metals, PCB congeners, PAHs, chlorinated pesticides, butyltins, dioxin/furans, radionuclides, and lipids in the tissue from fish, lobsters, worms, and clams, representing organisms that either live in close association with the sediments or are likely to accumulate elevated tissue levels of these contaminants. The most common large demersal species (i.e., winter flounder, scup) were collected in June and September 2000 to assess potential bioaccumulation. Migratory top predators (striped bass and bluefish) were caught in June and September to evaluate bioaccumulation within the waters of Long Island Sound as a whole. Lobsters were also collected in 2000 from within each of the four placement sites and from four reference areas that represented various habitat types along an east-west gradient within Long Island Sound. Clam and worm tissue were collected in July and August 2000 from NLDS and CLDS and their associated reference areas.

With the exception of PCBs, measured tissue concentrations collected from these surveys were below FDA limits for human health and within EPA’s acceptable risk range for carcinogenic and noncarcinogenic effects. Measured chemical concentrations for all chemicals in finfish tissue and lobster meat were approximately one to two orders of magnitude below the applicable FDA action/tolerance limits.

Most of the total PCB concentrations were also below the CTDPH threshold guidelines developed for fish consumption advisories (0.1 ppm, or 100 ppb) associated with recommendations for restricted consumption based on CTDPH's risk-based approach for winter flounder and lobster (Toal & Ginsberg, 1999). However, maximum concentrations of total PCBs in bluefish, striped bass, winter flounder, and scup were elevated above those levels at many locations. CTDPH has identified tissue concentrations of total PCBs as a Sound-wide issue (CTDPH, 2002). The most recent available advisory for 2012 includes striped bass, bluefish, and weakfish on the list for PCBs, while scup and flounder are no longer included, indicating levels below guidelines (CTDPH, 2012).

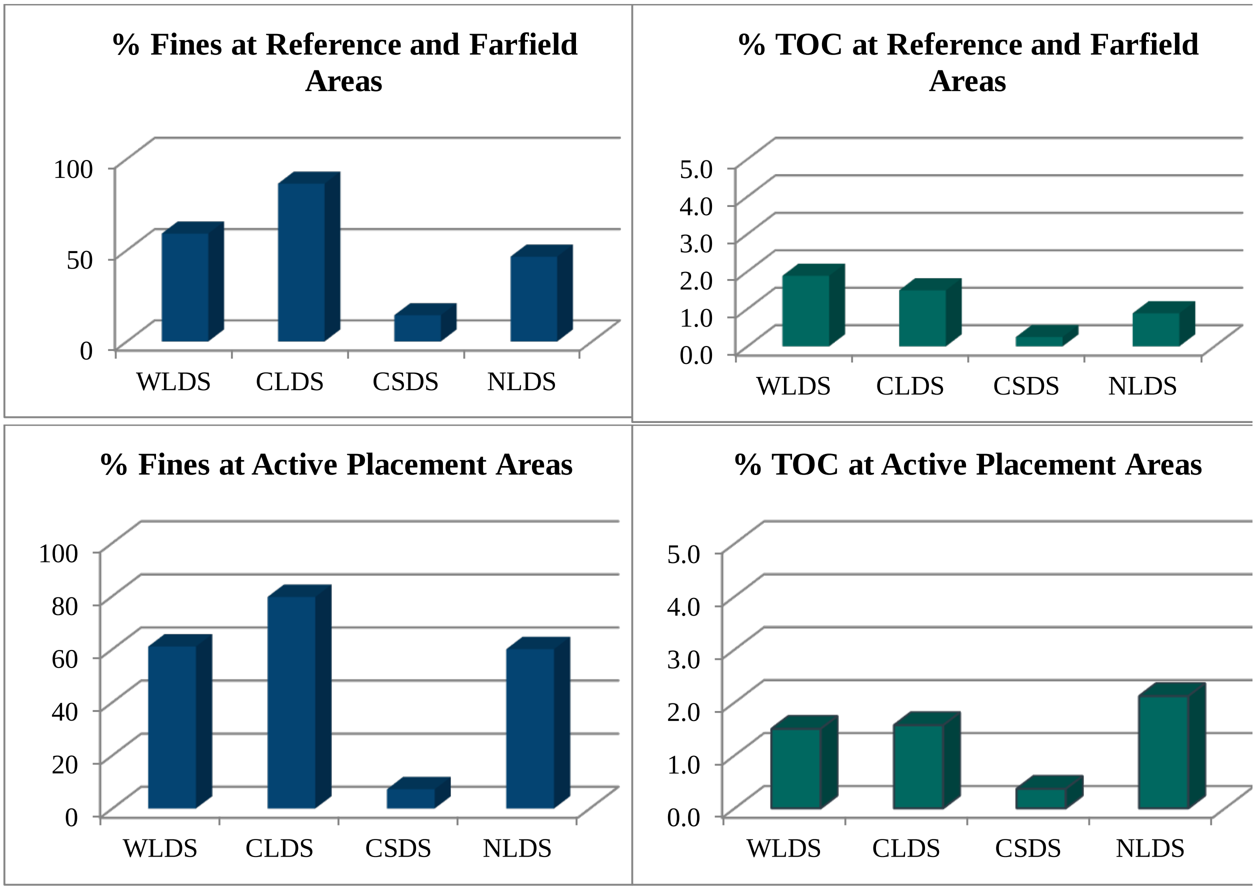
Similar results were noted based on the evaluation of carcinogenic and noncarcinogenic risk levels. Exposures of humans to chemicals in Long Island Sound are primarily associated with the consumption of fish and shellfish. In general, risks for this pathway were relatively low, with carcinogenic risks within EPA's acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$ and noncarcinogenic hazard quotients less than 1 for most chemicals, where a hazard quotient greater than 1 implies risk. Risks associated with PCBs were the exception. Noncarcinogenic risks for total PCBs were associated with hazard quotients greater than 1 for all species evaluated at all locations.

Risks were also estimated based on fish and lobster tissue concentrations modeled from measured clam and worm data using trophic transfer modeling with results comparable to direct measured results; that is, risks associated with fish and shellfish consumption were measured to be low for most contaminants, PCBs being the exception. However, this increased risk is currently managed through the issuance of fish and shellfish consumption advisories at the state level. The advisories warn the public of the potential risks associated with PCBs and recommends that consumption of certain fish species be limited to reduce exposure. Lobster hepatopancreas consumption advisories also exist for Connecticut and New York due to increased tissue contaminant concentrations.

Benthic invertebrate (i.e., clams, worms, lobster) tissue concentrations were also compared to available ecological effects values (EEVs) used by EPA New England to evaluate ecological risks associated with placed dredged material. These values represent tissue concentrations determined to be safe to aquatic organisms. Similar to the human health evaluation, risks to ecological receptors associated with elevated tissue concentrations appear to be very low. With the exception of copper in lobster tissue at WLDS and CLDS, all tissue concentrations were below the EEVs.

Sediment quality data collected from WLDS, CLDS, CSDS, and NLDS in 2000 and 2001 represent one of the most extensive datasets for the unconfined open-water alternatives (ENSR (2000), (2001a), (2001b), (2002)) and this sediment quality assessment is largely based on these (2000 and 2001) datasets. For these surveys, replicate (n=3) surface sediments (0 to 0.8 inches) were collected at active and historical placement areas, as well as at farfield and reference locations. Field experimental surveys performed within the CLDS area to evaluate the natural recovery of the seafloor following unconfined dredged material placement represent another important data source for discussing the quality of CLDS sediments (Myre & Germano (2007); AECOM (2013)).

Grain size and TOC data collected in 2000 and 2001 at the unconfined open-water placement sites are summarized in Figure 4-18. For comparison purposes, active placement areas have been plotted separately from reference and farfield locations. These data are generally consistent with the observations noted earlier. Finer grained sediments dominate the Western and Central Basins, and coarser material is prominent in the Eastern Basin, particularly at CSDS. Furthermore, from a sediment texture and TOC perspective, the active placement areas are relatively similar to farfield and reference areas at each site.


% Fines at Reference and Farfield Areas

% TOC at Reference and Farfield Areas

% Fines at Active Placement Areas

% TOC at Active Placement Areas

Figure 4-18. Grain Size and TOC Distributions at the Unconfined Open-Water Placement Alternatives.

Sedimentary metal concentrations measured at each of the unconfined open-water alternative sites (2000 and 2001 surveys) are summarized in Table 4-8. The fact that grain size and TOC content is generally consistent between active placement and reference areas provides some assurance that chemical measurements can be compared to a large degree without added data treatment (e.g., normalization). The data collection effort from 2000 and 2001 included the metals aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc. The trace metals silver, chromium, copper, cadmium, mercury, nickel, lead, and zinc are discussed here.

Table 4-8. Placement Site Station and Reference Area Averages for Metals in Sediment from February 2000.

Location	Ag	Cu	Cd	Hg	Pb	Zn	Cr	Ni
	μg/g							
WLDS[1]	**1.05**	**68.4**	**0.65**	**0.99**	**53.4**	119	47.1	19.5
WLDS REF	0.35	**37.5**	0.21	0.14	24.2	126	27.6	13.0
CLDS	**1.33**	**76.7**	**0.59**	**0.20**	44.6	140	80.0	**23.2**
CLDS REF	0.60	**44.6**	0.13	0.12	29.4	109	53.2	**23.7**
CSDS	0.04	2.78	0.06	0.01	4.07	16.97	5.63	5.77
CSDS REF	0.07	5.65	NA	0.01	6.53	20.36	8.58	8.12
NLDS	0.35	32.1	0.33	0.14	39.17	76.03	46.63	**21.23**
NLDS REF	0.02	9.7	0.07	0.02	11.88	37.13	14.18	8.53
ERL	1.0	34	1.2	0.15	46.7	150	81	20.9
ERM	3.7	270	9.6	0.71	218	410	370	51.6

>ERL = bold, > ERM = underlined (NOAA, 1999).

[1] Three replicates were averaged for each placement site and ref areas station (EPA (2004), Appendix F-1).

At the active WLDS, CLDS, and NLDS placement areas, the metals silver, copper, cadmium, mercury, and lead were elevated over reference conditions, and many of these metals exceeded ERL SQGs. Furthermore, mercury exceeded the higher ERM sediment guideline at the WLDS. However, AVS/SEM measurements were also included in the program, and based on sedimentary sulfides, only one WLDS replicate (n=3) from the active placement area exhibited limited sulfide relative to the metals (i.e., AVS/SEM <1), indicating that most of these metals probably exist as insoluble sulfides unavailable to resident organisms. In the cases of CLDS and NLDS, a few replicates exhibited limited sulfide content relative to metals; this occurred at historical placement areas, not at active placement areas (ENSR, 2001a).

An extensive set of sedimentary trace organic parameters was also measured during the 2000 and 2001 surveys; the set included PCBs, pesticides, PAHs, tributyltin (TBT), and dioxin/furan congeners. A subset of these data, total PAHs, total PCBs, and total DDT, are detailed in Table 4-9. In general, the concentrations observed occasionally exceed the lower ERL SQG, none exceed the higher ERM SQG, and are of the same magnitude as those observed Sound-wide by USGS and others (USGS (2013); Mitch & Anisfeld (2010)).

TBT concentrations were detected at much higher concentrations at the WLDS station (31 μg/kg) than at the two reference stations (average less than 1.0 μg/kg). Concentrations of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), which is used to represent dioxin and furan, were very low, with an average of 0.0009 μg/kg at the WLDS station and 0.00051 μg/kg at the reference areas.

Part of the sediment condition at CLDS has been affected by a field study that began in 1982. This study, termed the Field Verification Program (FVP), was performed jointly by EPA and USACE to evaluate the natural recovery of sediments following the unconfined placement of dredged material. In that study, 72,000 yd^3 of dredged material from Black Rock Harbor in Bridgeport, Connecticut, were placed in the northeast corner of the designated CLDS area to be monitored over time (SAIC (1995); Myre & Germano (2007)). The dredged material consisted of organic fine-grained sediment containing heavy metals, PAHs, and PCBs, which was demonstrated to have both acute and chronic toxicity (Morton, et al. (1984); Gentile, et al. (1988)).

Table 4-9. Placement Site Station and Reference Area Averages for Organic Contaminants in Sediment from February 2000.

Location	Number of Samples	Chemical and Physical Analytes				
		Total PAHs	Total PCBs	Total DDT	Fines	TOC
		ng/g dw			%	%
WLDS*	1	*3865*	***69***	**4.6**	**52.5**	**1.5**
WLDS REF	2	630	9	1.1	24.8	1.3
CLDS	1	1036	***59***	0.4	81.8	2.2
CLDS REF	2	783	*16*	0.8	92.4	1.9
CSDS	2	31	ND	ND	2.0	0.1
CSDS REF	2	112	ND	ND	9.7	0.4
NLDS	1	*1967*	***39.83***	**6.17**	**74.3**	**2.7**
NLDS REF	2	315	ND	ND	37.2	0.8
Western Long Island Sound Mean	72	*2370*	***162***	**6.4**	-	-
Western Long Island Sound 90th%		***4350***	***174***	***15.3***	-	-
Central Long Island Sound Mean	36 (39 DDT)	*2860*	***32.6***	**2.2**	-	-
Central Long Island Sound 90th%		***10900***	***35.3***	**3.7**	-	-
Eastern Long Island Sound Mean	30	1810	*15.2*	1.3	-	-
Eastern Long Island Sound 90th%		***4610***	***31***	**4.0**	-	-
ERL		4022	22.7	1.58	-	~1
ERM		44792	180	46.1	-	~1

>ERL = bold, > ERM = underlined, > 1996 NS&T national 85th percentile value = *italics*
Adapted from Mitch & Anisfeld (2010).
*Placement site and reference areas station were an average of three replicates per station.
Values compared to the mean and 90th percentile of Long Island Sound basin region sediment concentrations of organic contaminants 1994–2006.

In a 2005 survey of FVP sampling stations, contaminant concentrations at the FVP mound were observed to be slightly higher than at the corresponding reference area in cores collected in the outer mound flank (Myre & Germano, 2007), and several contaminants remained at levels above ERL or ERM SQGs. However, maximum contaminant concentrations at the FVP site were found to be less than the concentrations in the original dredged material. In a 2011 survey of the mound, the benthos and seafloor conditions were consistent with those at the reference areas, showing advanced recovery at the mound and no indication of impairment (AECOM, 2013).

As a direct measure of sediment quality, toxicity bioassays were performed using sediments collected during the 2000 survey (ENSR, 2000). The amphipod *A. abdita* was used to evaluate potential sediment toxicity at each of the unconfined open-water alternative sites. Coarse-grained sediment may confound the organism's ability to survive, since their habitat is typically fine-grained, but bioassay survival was very good in all sediments collected from each of the sites, including the more coarse-grained CSDS.

As a way to evaluate sediment quality more broadly, the SQT approach of Long & Chapman (1985) was applied to the 2000 and 2001 survey data sets. Underlying this analysis is a comparison and calculation of station-to-reference site ratios, which when near unity is an indication of low impact. In this final analysis, station-to-reference comparisons of organic chemical parameters (PCBs and PAHs) resulted in the largest excursions from unity, and chemical indices often exceeded 1, but despite these findings there was no apparent effect on either the resident benthic community or the organisms exposed to the sediment during toxicity bioassays. Based on this analysis, the sediment appeared to be in good condition at each of the open-water unconfined placement areas.

The accumulation of chemical residues in marine organisms was also examined during the 2000 and 2001 surveys. Striped bass, bluefish, scup, and winter flounder finfish were collected from the open-water sites where available and analyzed. Lobster specimens were available at WLDS and CLDS, and clam and worm tissues were also collected at CLDS.

Concentrations of chemical contaminants in finfish fillets were generally low in the samples collected from the open-water placement areas. The metals silver, cadmium, chromium, and nickel were all below reporting and/or detection limits in finfish tissue from WLDS, CLDS, CSDS, and NLDS.

Copper was often detected in at least one of the samples at WLDS, CLDS, and CSDS, but was lower than levels detected in non-placement site areas (maximum 0.651 µg/g). Mercury (as total) was detected in all of the samples and was notably higher in striped bass tissue samples from WLDS, CLDS, and NLDS, but the maximum concentrations measured at these sites, ranging from 0.211 to 0.483 µg/g, were much less than FDA's action limit of 1 µg/g set for methylmercury. Lead was below reporting limits at each of the unconfined open-water placement site study areas, except for winter flounder (0.102 µg/g) and scup (0.155 µg/g) samples at NLDS and a couple of non-placement (i.e., reference or farfield) site study areas.

At WLDS and CLDS, where lobster data were collected, metal contaminants were generally low or not detected in lobster muscle and were comparable to Long Island Sound reference areas collected (EPA, 2010b). Lobster hepatopancreas, commonly referred to as lobster tomalley, tends to concentrate contaminants, and higher concentrations of contaminants were found. Lead (0.136 mg/kg ww), nickel (53.8 mg/kg ww), and zinc (53.8 mg/kg ww) were highest at the WLDS compared to the CLDS and reference areas from the study. The rest of the metals were within the range of the reference areas. Copper was high in lobster tissue at WLDS and CLDS (574 and 1,010 mg/kg ww, respectively) and the reference areas (599 to 934 mg/kg ww), but lobsters and several other marine organisms have a copper-based blood system rather than the iron-based blood system common to most other animals, so the significance of these copper concentrations is unclear.

Metals results from clam (*Pitar morrhuana*) and worm (*Nephtys incise*) tissue collected in 2000 from CLDS (only) were variable but similar between placement and reference areas. In fact, cadmium, lead, and mercury were measured at higher concentrations at the corresponding reference location relative to the placement area.

Several classes of organic parameters were analyzed in the tissues collected in 2000 from the open-water placement areas, including PAHs, PCBs, and dioxin/furans. In the case of trace organic compounds, the lipid content of the organisms is of critical importance given the preferential partitioning that occurs by organic compounds into fatty tissue. As such, the organisms that naturally contain higher lipid content (striped bass and bluefish) tended to contain the higher concentrations of organic contaminants when detected.

Overall, the concentrations of contaminants measured in these (2000 survey) studies were within the range of other published tissue studies from Long Island Sound. Total PAH concentrations were generally within the range of 1 to 10 µg/g when detected and calculable; Total PCBs were detected only at WLDS and CLDS finfish. PCB concentrations in bluefish and striped bass samples were measured in the 300- to 400-µg/g range and in the 60- to 120-µg/g range for scup and winter flounder. When detected at any of the four placement sites, dioxin as 2,3,7,8-TCDD was measured in the 3- to 6-ng/g concentration range.

At WLDS and CLDS, organic contaminants were generally low in lobster muscle and comparable to other Long Island Sound reference areas. The dioxin and furan compounds 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-TCDF), heptachlorodibenzo-*p*-dioxin (HpCDD), and octachlorodibenzodioxin (OCDD) were detected in muscle tissues collected from these sites at very low concentrations (EPA, 2010b).

In lobster hepatopancreas, the concentrations of organic chemicals were higher than the corresponding measurements within the lobster muscle, and the tissue levels from WLDS and CLDS were generally comparable to Long Island Sound overall. PCB levels were one to two orders of magnitude greater in the hepatopancreas than in muscle tissue (1,848 µg/kg and 2,0262 µg/kg ww, respectively) and dioxin concentrations, as 2,3,7,8-TCDD, were measured with concentrations in the range of 2.08 to 4.25 ng/kg at these sites.

Finally, with respect to the clam (*Pitar morrhuana*) and worm (*Nephtys incise*) tissue data collected in 2000 from CLDS, the concentrations of trace organics were typically higher at the CLDS area than at its reference. One of the sampling stations was from the uncapped FVP mound, established to monitor natural recovery following dredged material placement. Total PAHs and total PCBs were higher in the worm and clam tissue at CLDS relative to the reference area, which is expected based on the known contaminants in sediments placed at the FVP at CLDS decades ago. This difference is greater in the worms (non-selective deposit feeders) than clams (filter feeders). Worms would have greater potential exposure to the sediments based on feeding mechanism. Most of the individual dioxin and furan congeners were not detected in both species at any locations sampled. Pesticide concentrations in clams were comparable from the reference area and at CLDS.

Confined Open-Water Placement

The Sherwood Island Borrow Pit (E) alternative is a potential 100-acre confined open-water placement site approximately 1/2 mi offshore of Sherwood Island State Park, Westport, Connecticut. The existing borrow pit is approximately 30 ft deeper than the surrounding area, which has average depths of -20 ft MLW. There are four samples (USGS and NCA) within 1 mi of this alternative (Table 4-7 and Figure 4-15).

4.5.3 Sediment Quality in the Nearshore/Shoreline Environment

Coastal embayments and shorelines have been shown to have great variability in physical properties and to have the highest contaminant levels , most notably in Connecticut rivers and bays and in the western region of Long Island Sound that have fine-grained sediments. Dredging of navigational channels, marinas, and shipping berths has removed sediment and associated contaminants in the bays and harbors of Long Island Sound over time, which in turn may reduce contaminant levels in these locations and the potential for transport to nearby areas (depending on the local hydrodynamics). Many of the shoreline alternatives appear to be in areas with higher sand content, which would be an important consideration in the suitability evaluation. Due to the proximity of some of the CAD cell and CDF alternatives to areas with known contaminant sources and sediment hot spots, site-specific alternatives evaluations will be needed for specific projects.

The following sections provide generalized information for nearshore and shoreline alternatives and identify sources of information that offer more site-specific data.

The USGS grain size information used to identify possible placement alternatives can be found in the geological setting section (Section 4.2.3). USGS TOC data (Poppe, et al., 2000) could also be evaluated for site-specific information. USGS, NS&T, and NCA datasets were analyzed for proximity of sampling stations to the nearshore/shoreline alternatives (Table 4-10). The locations are shown in Figure 4-15 through Figure 4-17.

Confined Placement

In-harbor CAD cells

The three CAD cell alternatives are located in the central and western areas of the sound. Contaminants have been identified as a potential concern in coastal bays in this area, notably near New Haven Harbor, Bridgeport, and the Housatonic River (Varekamp, et al., 2014). CAD cells that require excavation of the sediment would need to be evaluated on a project- and alternative-specific basis.

Table 4-10. Sediment Quality Data Available for the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Sediment/Bioaccumulation Sampling Stations within 1 Mi	USGS[2]	NS&T[3]	NCA[4]
Nearshore/ Shoreline Environment	In-Harbor CAD Cell	G	45	X	X	
		H	45	X	X	
		M	18	X	X	
	Island CDF	B	27	X		
		L	10	X	X	
		N	None			
		P	5	X		
		Q	None			
		R	13	X	X	
	Shoreline CDF	A	10	X		
		C	21	X	X	
		D	16	X	X	
		F	1	X		
		I	15	X	X	
		J	None			
		K	17	X	X	
		O	13	X		
	Nearshore Bar Placement/ Nearshore Berm Sites[1]	177	None			
		178	None			
		179	None			
		121/446	None			
		453	None			
		173	None			
		180	2	X		
		454A	11	X		
		454B	1	X		
		455/82	None			
		445	None			
		171	None			
		170	4	X		
		63	1		X	
		456	None			
		441	10	X		
		320	3	X	X	
		440	None			
		449	5	X		
		438	7	X	X	X
		433	7	X	X	
		434	7	X	X	
		323	3	X		
		467	None			
		364	5	X		X
		451	None			
		447	None			
		327/333/330	8	X	X	

Table 4-10. Sediment Quality Data Available for Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Sediment/Bioaccumulation Sampling Stations within 1 Mi	USGS[2]	NS&T[3]	NCA[4]
		337	40	X	X	
		457	4	X		
		365	None			
		GP	21	X		
		367	5	X		
		368	3	X		
		381/382	None			
		384	None			
		600	None			
		601	None			
		620	2	X		
	Beach Nourishment	323	2	X		
		433	5	X	X	
		434	5	X	X	
		436	3	X		
		365	None			
		457	4	X		
		364	6	X	X	
		444	14	X	X	
		451	4	X		
		337	41	X	X	
		320	29	X	X	
		441	15	X		
		442	17	X	X	
		450	14	X	X	
		447	None			
		438	4	X		
		440	None			
		449	5	X		X
		181	5	X	X	X
		453	None			
		63	1		X	
		456	10	X		
		454E	1	X		
		454W	1	X		
		455/82	None			
		384	None			
		367	None			
		368	6	X		
		171	None			
		173	None			
		177	None			
		178	None			
		179	None			
		170	4	X		
		180	2	X		
		445	None			

Table 4-10. Sediment Quality Data Available for Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Sediment/Bioaccumulation Sampling Stations within 1 Mi	USGS[2]	NS&T[3]	NCA[4]
		446	None			
		343	12	X		
		474	5	X	X	
		339	38	X		
		459	14	X	X	
		348	None			
		480	10	X		
		467	None			
		468	None			
		325	7	X	X	
		327	7	X	X	
		329	12	X	X	
		330	7	X	X	
		331	12	X	X	
		332	18	X	X	
		333	7	X	X	
		344	None			
		345	21	X		
		121	None			
		64	None			
		67	None			
		68	3	X		
		111	None			
		76	10	X		
		79	None			
		381	None			
		382	None			
		437	None			
		600	None			
		601	None			
		620	None			

[1] Generally placed along the ~15-ft depth and high relief mounds.

[2] The USGS dataset includes multiple studies from 1975 to 2000. Analytes include grain size, metals, PAHs, PCB congeners, butyltins, and pesticides. Additional analytes include carbon (inorganic, organic, and total), nitrogen, ammonia, AVS, volatiles, chemical oxygen demand, cation exchange capacity, and total solids, water weight, radionuclides. Not all studies included all analytes.

[3] The NS&T data included metals, PAHs, PCB congeners, and pesticides, in surficial sediments and soft tissues of bivalve mollusks or fish from more than 300 coastal sites nationwide from 1984 to 2012. Additional analytes include but are not limited to butyl tins, carbon, fluorescent aromatic compounds, organochlorines, perfluoro compounds, PBDEs, dioxins, furans, grain size, and sewage markers. Not all studies included all analytes.

[4] The NCA data included grain size, metals, PAHs, PCB congeners, butyl tins, and pesticides, dioxins, and furans. Additional analytes include, but are not limited to, water content, nutrients (magnesium, calcium, phosphorus), alkanes, and carbon (inorganic, organic, and total). Not all studies included all analytes. 2000 to 2006 (Environmental Monitoring and Assessment Program [EMAP] data covered the time period 1990 to 1993).

Island CDFs

The six Island CDF alternatives were identified in three regions of Long Island Sound. Each is located along the northern shore of Connecticut. There appears to be high variability in the potential levels of contamination from site to site and each site would need to be evaluated individually.

Shoreline CDFs

The eight shoreline CDF alternatives include Hempstead Harbor in New York and locations along the northern shore of Connecticut. High variability in the potential levels of contamination from one site to the next is possible; therefore, these sites would need to be evaluated on a site-specific basis.

Beneficial Use

Nearshore bar/berm placement

The many nearshore bar and berm alternatives are located in diverse areas with variable contamination concentrations. Many of these areas would be expected to have high sand contents and generally lower contamination levels.

Beach Nourishment

The beach replenishment alternatives were identified as having medium- to coarse-grain sand. Sands tend to have very low contaminant levels due to their lower affinity for chemical contaminants.

4.5.4 Soil Quality in the Upland Environment

Generally speaking, soils in the program area, as in the entire northeast, have often been appreciably altered by human activity. In many cases, soil ecological function has been reduced or lost. This is largely true for many of the upland alternative sites, which include existing landfill facilities, a former airport, and eroded beaches and marshlands.

Nonetheless, the upland dredged material placement projects are largely considered to be ecologically beneficial ways to use these sediments. However, each of these alternatives will be guided by a construction design and/or permit that requires that the material used meet physical and chemical specifications. In addition, many of these alternatives will require that the material be dry. Potential dewatering sites have been identified for the program area (USACE, 2010a).

Landfills Placement and Cover/Capping

The landfills identified as potential dredged material placement alternatives are all currently permitted, operating facilities. Contaminated soils have been identified at one landfill site (Alternative 60), but the remedial investigation and corrective action have been completed. Similar concerns do not currently exist at the other landfill alternatives (Alternatives 59, 61, 251, and 272). Each identified upland alternative has limited information available and would require a project-specific review to determine final suitability of dredged material quality for use. One landfill (Alternative 59) accepts fill material; the remaining landfill facilities may accept materials suitable for site capping or cover provided the material meets site specifications (Table 4-11).

Brownfields and other Redevelopment Sites

Reconstruction projects that can benefit from dredged material have been planned at the former Flushing Airport (Alternative 422/423), located in Flushing, New York. Specific soil or groundwater contamination at the site has not been identified, but an environmental assessment (EA) has not been performed. The Brownfield alternative 422/423 (Flushing Airport) projects are required to use clean fill for wetlands and uplands restoration (NYSDEC, 2010a). For restoration, fine-grained dredged materials can be used beneficially to further the site restoration goals, provided the material meets the associated design and use regulatory criteria. The site is situated above a sole-source aquifer, so marine dredged material sources would also need to consider salt content, among the other chemical constituents.

Habitat Restoration, Enhancement, or Creation Sites

Jamaica Bay is a highly urbanized estuary with several (capped) landfills, municipal wastewater treatment plants, and combined sewer overflows (CSOs) along its perimeter (Benotti, et al., 2007). Soil and sediment contamination has been identified in and near Jamaica Bay (CARP (2007), although direct marsh loss poses one of the greatest threats to the Jamaica Bay ecosystem. The bay receives wastewater from four municipal wastewater treatment plants, which, along with sea-level rise, have contributed to significant marsh loss (JBRS, 2001). The habitat restoration projects are located near Jamaica Bay (Alternative Sites 427 and 429). The alternatives have used, and can continue to use, dredged material from regional navigation projects to rebuild and expand these beach and wetland areas. Rebuilding these marshlands may counter the loss in ecological function of the bay that has occurred over the past half century.

Table 4-11. Upland Environment Soil Resources.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	Sand and gravel[a]
	Landfill Cover/Capping	60	Available area for increased vegetation[a]
		61	Area for increased vegetation[a]
		251	Area for increased vegetation[a]
		272	Area for increased vegetation[a]
	Brownfields & Other Redevelopment	422/423	Ecosystem habitat[a]
	Habitat Restoration / Enhancement or Creation	427	Barrier beach/local storm surge protection[a]
		429	Ecosystem habitat[a]

Sources: NYSDEC (2015); CTDEEP (2014d); USDA (2014); USACE (2014a).

[a] Project-specific assessments will be necessary for each of these alternative sites if they are used for placement.

4.6 WATER QUALITY

4.6.1 General Long Island Sound Setting

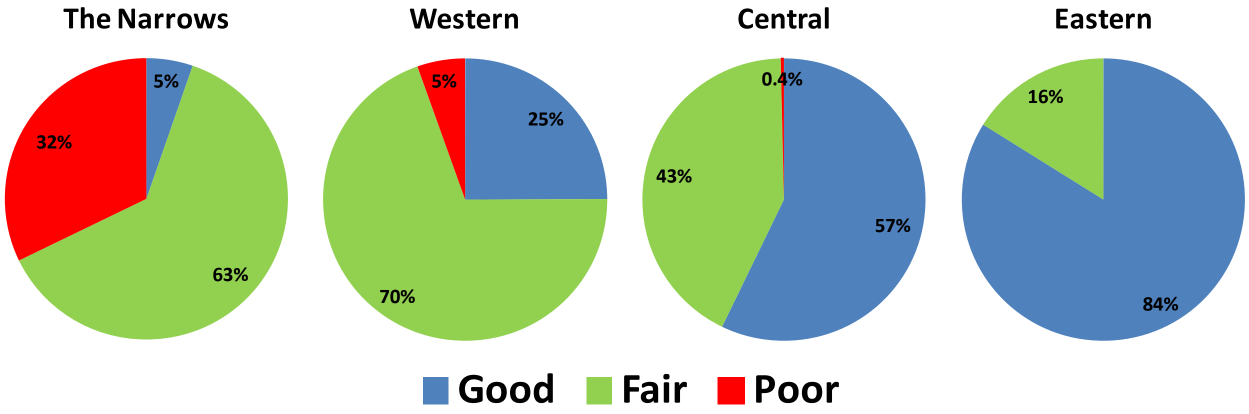
Marine Water Quality in the Study Area

This section describes the water quality (temperature, turbidity, nutrients, biomass/chlorophyll, DO, pH, pathogens, and toxic contaminants) of Long Island Sound in general, with a focus on inshore-to-offshore gradients. This discussion relies on the numerous Sound-wide studies and long-term monitoring efforts (HydroQual (1996); NYSDEC and CTDEP (2000); Latimer, et al. (2014), and references therein), rather than any site-specific water quality information. Information specific to alternative sites is limited in both time and space, and, when available (sporadically), the data provide only a snapshot in time. The long-term monitoring and other Sound-wide studies (including seasonal, inter-annual, and spatial variations) provide a more complete understanding of water quality in this region.

Concerted efforts to identify and quantify water quality problems in Long Island Sound began in the early 1970s. At that time, problems related to impaired surface water quality of Long Island Sound triggered the closing of approximately 25% of shellfishing beds in New York state waters. Bathing beaches were also closed because of high bacteria counts. Eutrophication of marine waters in bays due to nutrient loadings, alteration of salinity regimes as a result of decreased stream flow and reduced groundwater seepage, and discharge of inadequately treated wastewater and untreated stormwater runoff directly into Long Island Sound surface waters also degraded the water quality of the Sound (Wolfe, et al., 1991). These concerns stimulated a number of studies by academic and government institutions, resulting in an extensive body of water quality data generated by many monitoring programs dating back more than 30 years. The EPA sponsored the largest of these studies, the Long Island Sound Study, which began in 1985 when Congress funded EPA to conduct studies of the pollution problems facing Long Island Sound and to develop a comprehensive management plan for improved management of the Sound. The Comprehensive Conservation and Management Plan for Long Island Sound (EPA, 1994) was approved in September 1994. Key water quality issues identified by the Long Island Sound Study include low DO, toxic contamination, pathogens, floating debris, and the health of living organisms of the Sound (EPA, 1998). In 2000, a Total Maximum Daily Load (TMDL) was established for the Long Island Sound Study that seeks to reduce nitrogen loading to the Sound to reduce hypoxia and help meet DO water quality standards (NYSDEC and CTDEP, 2000). While loadings of nutrients, pathogens, and contaminants to Long Island Sound have been reduced dramatically since the early 1970s, Long Island Sound is still considered an impaired water body. A comprehensive review of historical and more-recent data (Latimer, et al., 2014) sheds new light on a number of these issues by examining how they have been addressed in the last decade and how well the system has responded to the remedies. Most of the data discussed in this section have been collected as part of the Long Island Sound Study over the last 30 years.

EPA’s NCA developed a water quality index that is used to qualitatively compare conditions in coastal waters across the United States (EPA, 2012). The water quality index is based upon five parameters: dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) in surface waters, chlorophyll in surface waters, DO in bottom waters, and water clarity as measured using a Secchi disk. Good water quality is defined as water containing low concentrations of nitrogen, phosphorus, and chlorophyll *a*; high concentrations of DO; and high water clarity. Fair water quality conditions are defined based on a range of threshold values: DIN greater than or equal to 0.1 to 0.5 milligrams per liter (mg/L); DIP greater than or equal to 0.01 to 0.05 mg/L; chlorophyll *a* greater than or equal to 5 to 20 µg/L; DO less than or equal to 5 to 2 mg/L; and Secchi depth less than or equal to 3.6 to 2.3 ft. Nutrient and chlorophyll values higher than the maximum thresholds and DO and Secchi depths lower than the minimum thresholds are indicative of poor water quality for the NCA index.

As with many conditions in the Sound, water quality improves from west to east. The average water quality in the Narrows over the 20-year period of 1991-2010 is best described as fair (63%), with a relatively high percentage of readings (32%) that fell in the poor category (Figure 4-19). The percentage of good readings increases from a minimum of 5% in the Narrows to about 25% in the Western Basin and 84% in the Eastern Basin. Similar trends of improving water quality from the Narrows in the west to the Eastern Basin are discussed below for each of the parameters included in the water quality index.



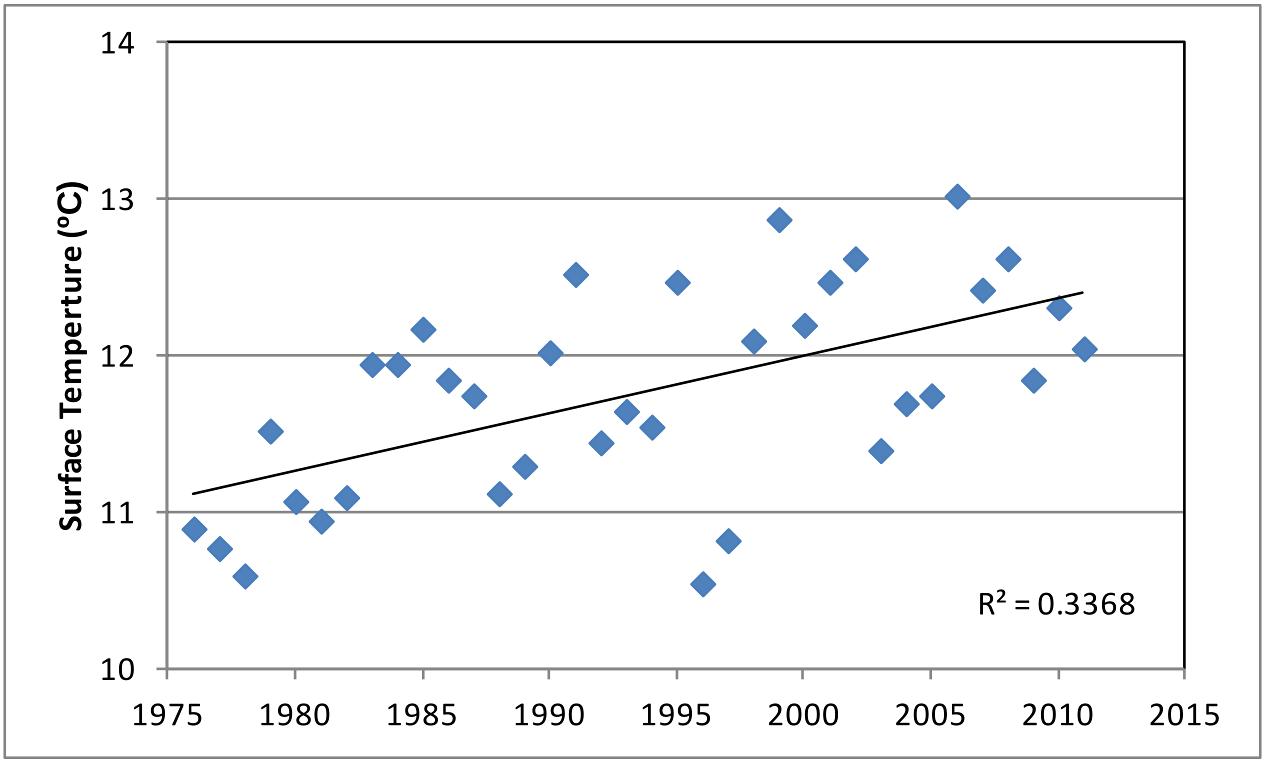
Source: EPA (2014b)

Figure 4-19. EPA's NCA Water Quality Index.

Temperature

Long Island Sound experiences a wide range of temperatures over an annual cycle (USACE, 1998). During more than 18 months of Long Island Sound Study surveys in 1988 and 1989, temperatures ranged from less than 2°C (36°F) in the central Sound (March 1989) to greater than 24°C (75°F) (August 1989) (HydroQual, 1996). However, temperatures tend to be quite uniform vertically and horizontally in the winter and spring. In the summer and fall, temperatures tend to increase from east to west, with the exception of colder water near the mouth of the Connecticut River (Reid, et al., 1979). Vertical temperature gradients show a progression from unstratified (i.e., constant temperature from the surface to the bottom) winter conditions to stratified conditions (warmer water on the surface) in the summer and a return to unstratified conditions in the fall (usually completed by the end of September). The Long Island Sound Study surveys showed a typical temperature gradient of 3 to 5°C from top to bottom during the summer (HydroQual, 1996). The stratification of the water column hinders the mixing of surface waters with bottom waters and is a dominant factor controlling duration and intensity of low oxygen conditions in Long Island Sound bottom waters in the summer months (Latimer, et al., 2014).

A recent analysis of long-term temperature data sets from the 1940s to the 2000s showed that surface water temperatures in central Long Island Sound have warmed about 1.6°C from 1948 to 2012 (~0.03 °C per year; Rice, et al. (2014)). Long Island Sound Study data from Millstone Environmental Laboratory have also shown a steady increase in seasonal temperatures, with the most pronounced change observed during the winter months (January-March) (EPA, 2014b). The data from this nearly 30-year time series show how variable annual mean temperature can be in the Sound, but they also corroborate the other findings–that there has been a clear increase in surface water temperatures over the past few decades (Figure 4-20). The continued increase in water temperatures in the Sound will have unknown and potentially profound impacts on its biota, the ecosystem, and its functions.



Source: EPA (2014b).

Figure 4-20. Annual Mean Surface Water Temperature (°C) at the Millstone Environmental Laboratory (1976 to 2011).

Turbidity

Organic and inorganic particulate matter in the water column is measured as total suspended solids (TSS) in milligrams of solids per liter of water. The term "turbidity" is often used when referring to TSS; however, turbidity is more correctly defined as an optical property of water referring to the blockage of light as it passes through water. The higher the levels of particulate matter, the higher the turbidity. In general, turbid water interferes with recreational use and aesthetic enjoyment of water (EPA, 1976). Higher turbidity also lowers water transparency, increasing light extinction (a measure of the penetration of light through water) and reducing the depth of the euphotic zone. This decreases primary production and decreases food for fish and shellfish. Thus, turbidity plays an important role in the productivity of phytoplankton and the distribution of aquatic plants (e.g., submerged aquatic vegetation [SAV]) in Long Island Sound. Direct or indirect measures of turbidity are most often made in the spring and summer, the most biologically productive seasons in Long Island Sound.

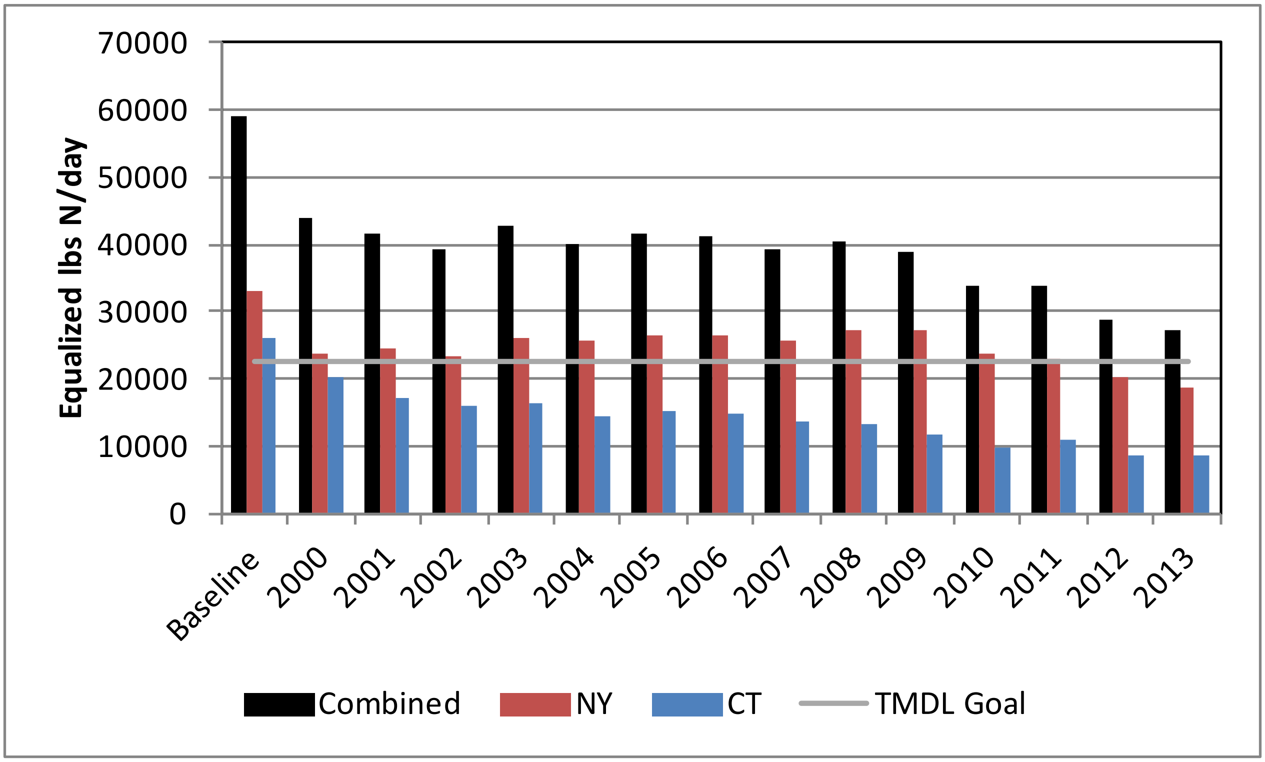
Field measurements of water transparency are most often made with a Secchi disk, a round disk painted with black and white markings that is lowered into the water until it is no longer visible. Secchi disk measurements can be converted to extinction coefficients using the relationship $ke = 1.7/SD$, where ke is the light extinction coefficient and SD is the water depth at which the Secchi disk is no longer visible. The Long Island Sound Study 1988 to 1989 field study found that turbidity and extinction coefficients decreased eastward (water transparency increased) in the Sound and were lowest in the Eastern Basin. In the East River, light extinction coefficients were consistently high, generally ranging from 1.0 to 1.5 per meter (corresponding to a euphotic zone depth of 3 to 4.5 meters) (HydroQual, 1996). For western Long Island Sound, O'Shea & Brosnan (2000) report summer mean Secchi depths from 1986 to 1999 corresponding to light extinction coefficients of 0.9 to 1.9 per meter. In the Eastern Basin, extinction coefficients were consistently near 0.4 per meter, which corresponds to a euphotic zone depth of about 11 meters (HydroQual, 1996).

Nutrients

Nutrients include the organic and inorganic forms of nitrogen, phosphorus, and silica. These exist in aquatic environments in both dissolved and particulate form. In Long Island Sound, nitrogen is the primary limiting nutrient for algal growth (if this nutrient is increased, plant growth will increase). Nutrients have been measured in Long Island Sound for over 60 years. The Long Island Sound Study has measured nutrients more or less continuously throughout the Sound since the mid-1980s (HydroQual (1996); EPA (1998); CTDEEP (2013a); Latimer, et al. (2014)).

The significant sources of nitrogen and phosphorus to Long Island Sound include municipal and industrial wastewater treatment plants, CSOs, nonpoint sources (runoff from land use activities), and atmospheric deposition directly to water surfaces (NYSDEC and CTDEP, 2000). Loading of silica to the system is primarily due to non-anthropogenic sources via influx of offshore waters and directly to the system from rivers due to erosion and weathering. A nitrogen TMDL was developed for Long Island Sound in 2000 in an effort to address the hypoxia problems in the Sound (NYSDEC and CTDEP, 2000). The TMDL seeks to reduce nitrogen loading to the Sound by 58.5%. Best management practices and other efforts are being used to decrease nonpoint sources and atmospheric deposition, but the primary effort is focused on improving treatment technologies at wastewater treatment plants (WWTPs) in the region. WWTPs in New York and Connecticut discharging into Long Island Sound and its tributaries have reduced their nitrogen load by more than a third since 1990, from a baseline value of 210,000 pounds (lbs) N/day to an average of 135,000 lbs N/day (CTDEEP, 2011a).

The Long Island Sound Study uses an indicator called 'point source nitrogen-trade equalized loads' that normalizes the nitrogen loads based on locations in the Sound where the load is discharged. The current circulation in the Sound tends to retain materials in the system. The residence time for nitrogen loads is longer in western Long Island Sound than in eastern Long Island Sound, which communicates directly with offshore waters. Thus, nitrogen loading to the western Sound will have more of an impact to water quality (and ultimately hypoxia) than discharges farther east. There have been substantial decreases in nitrogen loading from both New York and Connecticut since the TMDL took effect (Figure 4-21). Over the last couple of years, equalized loading has been reduced to about half that of the baseline value. Unfortunately, as noted in Section 4.5, a large reservoir of nutrients and organic carbon in the sediments of Long Island Sound continues to fuel bacterial respiration in the bottom waters (i.e., releases nutrients from the sediments to the water column seasonally), which in turn continues to contribute to periods of hypoxic conditions in parts of the Sound.



Source: EPA (2014b).

Figure 4-21. Summary of In-basin Equalized Nitrogen Loading (pounds per day).

The Long Island Sound Study sampling program measured concentrations of ammonia (NH_3), as well as different forms of nitrogen such as nitrate + nitrite (NO_x), particulate organic nitrogen (PON) and total nitrogen (TN) either directly or by difference (HydroQual, 1996). Generally, the highest concentrations of each form of nitrogen were found in the East River and western Long Island Sound, with concentrations diminishing toward the east (HydroQual, 1996). In the East River, mean TN was highest in the winter months (~2.2 mg/L) and was generally less than 1.5 mg/L in other seasons. While a trend towards diminishing concentrations was observed to the east, the concentrations of TN in the Western, Central, and Eastern Basins were similar, all generally ranging between 0.2 and 0.5 mg/L. No systematic difference in the concentrations of nitrogen species was observed between surface and bottom waters. Anderson & Taylor (2001) found NH_3 to be the dominant nitrogen species in western Long Island Sound and, while concentrations were highly variable, they observed both NH_3 and NO_x increasing relatively constantly from July through October 1993. Some variability was accounted for by rainfall events. Anderson & Taylor (2001) observed no systematic vertical gradients in nitrogen species.

The 1989 to 1999 Long Island Sound Study sampling program measured dissolved inorganic phosphorus (DIP, also referred to as orthophosphate-PO_4) and total phosphorus (TP) in Long Island Sound waters. Concentrations of both DIP and TP are the highest in western Long Island Sound and decrease toward the east (HydroQual, 1996). Monthly average TP concentrations ranged from 0.16 mg/L in the East River to 0.03 mg/L in Block Island Sound. DIP concentrations ranged from 0.14 mg/L in the East River to 0.02 mg/L in Block Island Sound. Temporally, TP and DIP displayed distinct cyclical variations, with concentrations increasing beginning in late spring, reaching a maximum in late summer, and declining through autumn and winter before reaching a minimum in early spring (HydroQual, 1996).

Dissolved silica is an important nutrient required by unicellular plants such as diatoms, in which particulate silica is generally in a form not available for immediate algal uptake or is bound in siliceous organisms such as diatoms. The Long Island Sound Study measured both dissolved and particulate silica. As for other nutrients, the highest concentrations of dissolved silica were found in the East River and diminished in an easterly direction, although the trends were not as significant as those observed for nitrogen and phosphorus species (HydroQual, 1996). Monthly averages of dissolved silica ranged from about 0.5 to 2.2 mg/L in the East River to about 0.2 mg/L in Block Island Sound. Seasonally, concentrations in the western Long Island Sound rose from late spring to peak in late summer, then declined to near zero concentration in early spring. The more easterly regions of Long Island Sound exhibited similar seasonal patterns (HydroQual, 1996). The seasonal fluctuations are also due in part to uptake of nutrients by plants such as phytoplankton and macroalgae.

Biomass (Organic Carbon/Chlorophyll)

The spatial distribution and temporal variability of chlorophyll (a measure of phytoplankton biomass) in Long Island Sound are discussed in Section 4.7. This subsection simply summarizes the chlorophyll results along with information on the inputs of anthropogenic organic carbon, as both of these impact bottom water DO levels and the phytoplankton biomass serves as the direct link between high nutrient/eutrophic conditions and hypoxia. As observed for nitrogen, there is a strong gradient of decreasing chlorophyll from west to east across the Sound. The highest levels are consistently observed in the Narrows in association with high nitrogen loading (Latimer, et al., 2014). In addition to the nutrient load from the WWTPs and rivers, there is also an organic carbon load (both particulate and dissolved). The biological oxygen demand (BOD) from these organic materials shows a similar trend, with higher BOD to the west and near river mouths. The steps taken since 2000 to reduce the nutrient load from WWTPs has also decreased loading of BOD. However, the reduction in nutrients has not as yet led to a decrease in chlorophyll levels (see Figure 4-27), nor have the areal extent or duration of the hypoxic events changed significantly (see details in next section).

Dissolved Oxygen

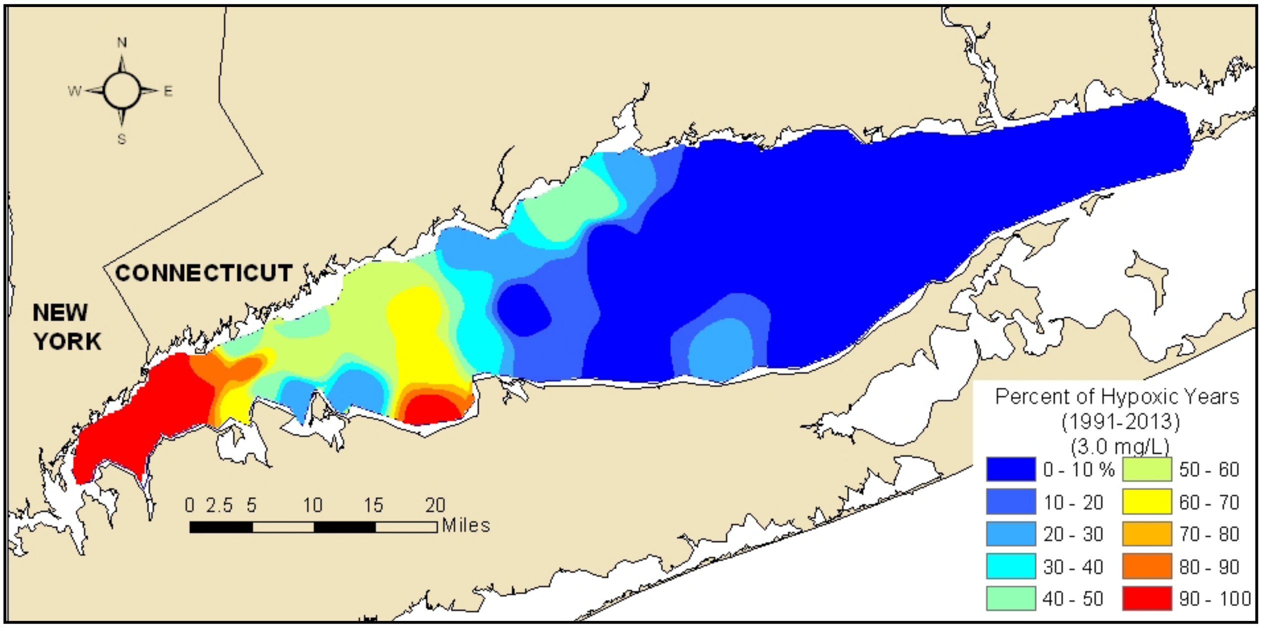
DO, an important gauge of water quality, indicates the ability of the water body to support a well-balanced aquatic faunal community. Additionally, DO in the water column, particularly in bottom waters, prevents the chemical reduction and subsequent leaching of iron and other elements from sediments and is required for the biochemical oxidation of ammonia in natural waters (EPA, 1976). In estuaries, DO concentrations can range from saturation (the highest amount of DO which the water can hold at equilibrium) to 0 mg/L (anoxia). Saturation varies with water temperature and salinity, but is about 7.5 mg/L when water temperature is 22 °C, a typical summer temperature in Long Island Sound. Hypoxia, or low DO concentrations, has been identified as the most pressing priority problem in Long Island Sound. Both the states of New York and Connecticut have established state water quality standards for DO for various water quality classifications (see text box). The Long Island Sound Study has defined the onset of hypoxia as 3 mg/L (EPA, 1990).

The primary pollutant contributing to hypoxia in Long Island Sound is nitrogen. As previously discussed, nitrogen is the limiting nutrient for algal production and leads to the generation of organic carbon that eventually sinks into the bottom waters and depletes oxygen when consumed by bacteria. Organic carbon loads to Long Island Sound also contribute directly to hypoxic events (NYSDEC and CTDEP, 2000). There is no evidence of a persistent DO gradient associated with sediment oxygen demand (i.e., the biological and chemical processes that use oxygen in sediments) once the bottom water DO has begun to be depleted. That is, sediment oxygen demand is dependent upon water column DO concentrations and does not exacerbate hypoxic events (Welsh & Eller, 1991). Hypoxic occurrences have been recorded in the Western Basin of Long Island Sound during the summer months each year since sampling began in 1986 (EPA, 1998) (Figure 4-22).

State DO Water Quality Standards

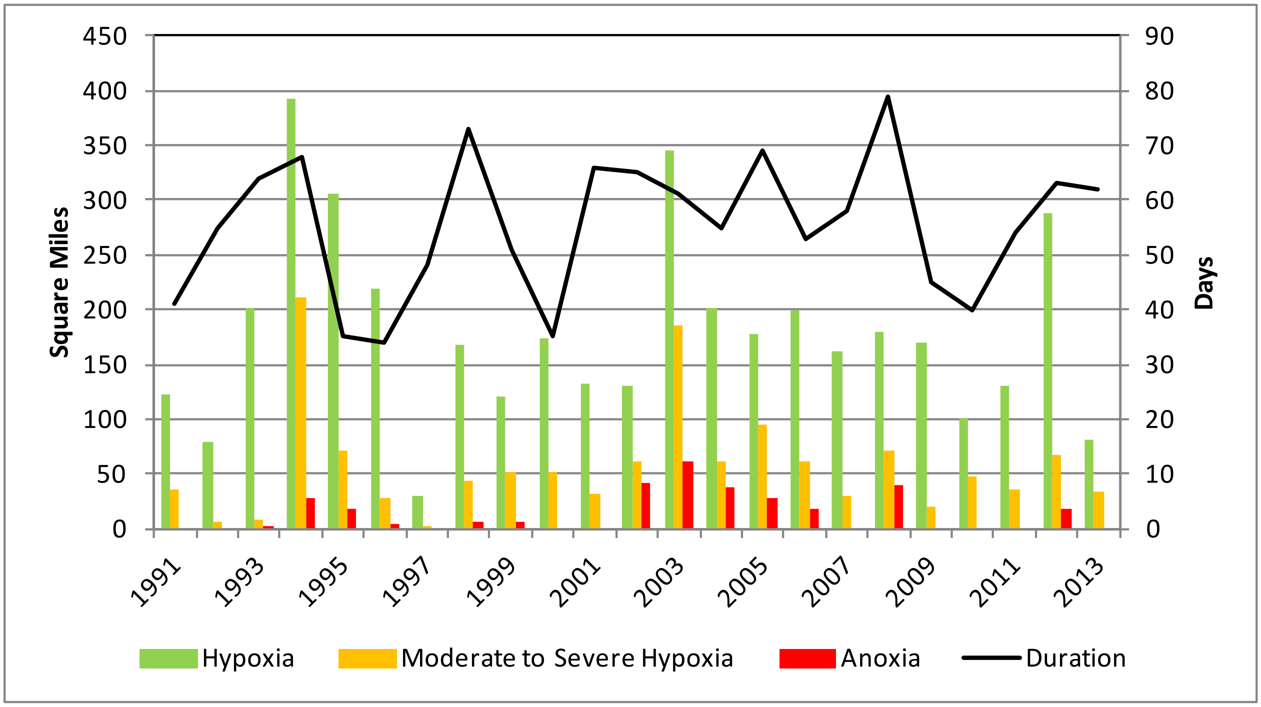
As required by the Clean Water Act (Section 303), the states of Connecticut and New York have adopted DO water quality standards for coastal and marine surface waters. The states have set criteria or water quality goals for water resources depending upon the water's class and/or designated use(s). DO should not be less than 5.0 mg/L at any time (New York and Connecticut water quality standard) for the following: protecting marine fish, shellfish, and wildlife habitat; harvesting shellfish for transfer to approved areas for purification prior to human consumption; primary contact (swimming) and secondary contact (navigation); and recreation (i.e., Class SB Waters) (CTDEP (2002); NYSDEC (1999)). DO should not be less than 6.0 mg/L (Connecticut water quality standard) or 5.0 mg/L (New York water quality standard) at any time for shellfish harvesting for direct human consumption (Class SA Waters) (CTDEP (2002); NYSDEC (1999)). In 2000, a TMDL was developed to reduce nitrogen levels by 58.5% from a 1990 baseline to meet DO water quality standards.

Natural variations in weather and physical factors have affected the size of the hypoxic area, the duration of the event, and the degree to which the DO concentrations have fallen. Generally, hypoxia events span a period of 40 to 80 days (Figure 4-23). The occurrences can start as early as mid-June and can end mid- to late September (EPA, 1998). Hypoxia steadily develops through the summer as bacteria consume the supply of phytodetritus (debris from dead phytoplankton) and other organic material descending to bottom waters as well as the existing historic organic carbon in the sediments. Hypoxic conditions propagate from near the East River in an easterly direction, reaching well into the Central Basin of the Sound, in concert with increasing seasonal stratification (Torgersen, et al., 1997). Intermittent mixing events can ventilate bottom waters during the summer; eventually, DO is restored during fall turnover of the water column, returning to well-mixed conditions (EPA (1998); Anderson & Taylor (2001)).



Source: : EPA (2014b).

Figure 4-22. Frequency of Hypoxia in Long Island Sound Bottom Waters.



Source: EPA (2014b).

Figure 4-23. DO Levels in Long Island Sound.

Evaluations by Lee & Lwiza (2008) of meteorological and physical oceanographic data highlight the importance of wind strength and predominant direction on the establishment and intensity of hypoxia in the Sound. Their analysis of CTDEP data from 1995-2004 showed a significant correlation between bottom DO concentrations and density stratification in the shallower waters (less than 49 ft) in western Long Island Sound. At deeper stations in central Long Island Sound and farther east, this relationship is not significant. Hypoxic volume was weakly correlated to a combination of summer wind speed, spring total nitrogen, spring chlorophyll *a*, and maximum river discharge (multiple regression had $r^2 = 0.92$). However, the weakest variable was the total nitrogen; when it was excluded from the multiple regressions, the r^2 only dropped to 0.84 (Lee & Lwiza., 2008). Modeling efforts have also shown how important climatic processes and wind-induced mixing are in controlling the evolution of summertime hypoxia in western Long Island Sound (Wilson, et al., 2008).

pH

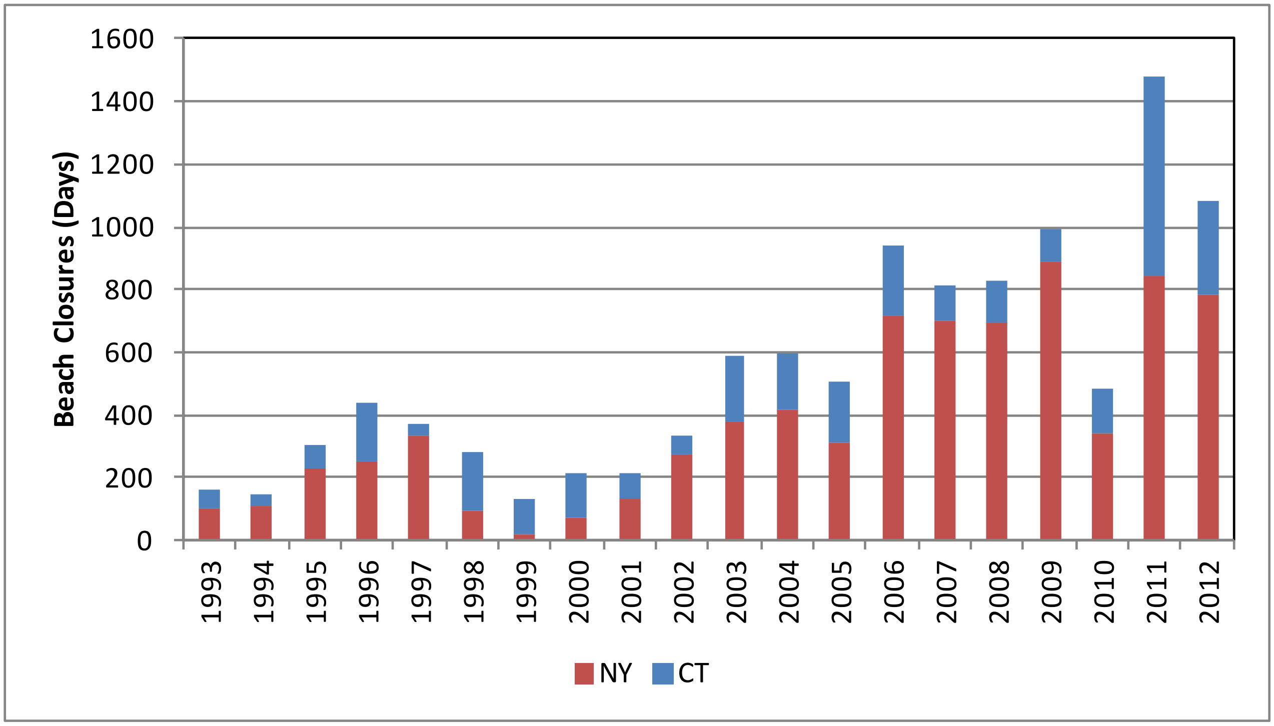
As discussed above, excessive nutrient loading into coastal ecosystems promotes algal productivity, and the subsequent microbial consumption of this organic matter lowers oxygen levels and contributes toward hypoxia. A second, often overlooked consequence of microbial degradation of organic matter is the production of carbon dioxide and reduction in pH associated with that process. The overall acidification of the ocean has become a major focus of climate change research as the increasing carbon dioxide concentrations in the atmosphere have been somewhat mitigated by carbon dioxide being transferred into the oceans and decreasing pH levels. In coastal waters, this is further exacerbated under eutrophic conditions and has been linked to elevated mortality in larval finfish and shellfish (Talmage & Gobler (2010); Baumann, et al. (2012)). This suggests that acidification, which has been intensified by climate change (Doney, et al., 2009), may be currently altering the ability of coastal waters such as Long Island Sound to support robust fisheries. Current, high-quality pH data for the Sound are limited; however, in the coming years, pH measurements will become more and more prevalent in coastal monitoring programs.

Pathogens

Pathogens are bacteria and viruses that, when ingested or contacted by humans, cause illnesses or diseases such as gastroenteritis, cholera, typhoid fever, salmonella, or hepatitis A. Pathogens that concentrate in the fecal waste of infected humans or warm-blooded animals enter Long Island Sound through both point and nonpoint pathways. Specific sources of pathogens include improperly treated or untreated sewage discharges from CSOs, sewage treatment plant breakdowns, stormwater runoff, waterfowl and animal wastes, septic systems, inadequately treated sewage discharges from boats, and illegal connections to storm drain systems (EPA, 1990). There are no practical tests for pathogens in the environment, so coliform bacteria (i.e., total coliform bacteria, fecal coliform bacteria, and *Enterococcus*) are often used as surrogates (i.e., indicators). The sources of fecal coliform bacteria to Long Island Sound in 1986 included urban runoff (47%), rivers and upstream sources (52%), and sewage treatment plants (1%) (EPA, 1990). The open waters of Long Island Sound are not often tested for indicator bacteria; rather, waters near beaches or other recreational areas and near shellfish beds are most often tested for these bacteria. A survey of 240 monitored beaches along Long Island Sound (131 in Connecticut and 109 in New York) from 1993 through 2000 showed no significant increasing or decreasing trends in the number of pathogen-related beach closure days (EPA, 2001b). However, more-recent data through 2012 shows a clear and steady increase in beach closure days since 2000 (Figure 4-24).

There are a few important factors to note when examining the trend in beach closure days. The most important is that, during the early 2000s, there was a change in indicator bacteria from using fecal coliforms to enterococci. An EPA study (1986) of appropriate indicator bacteria found that fecal coliforms were not reliable predictors of human illness. In contrast, enterococci were very good predictors of illness in all fresh and marine recreational waters. In 2000, the EPA Beach Act recommended use of enterococci, and by 2004 the use was promulgated for our nation's coastal waters. This switch to the more robust enterococci indicator not only tied beach closures more closely to potentially infectious pathogens, but also likely resulted in an increase in the number of beach closures.

Additionally, the main environmental factor influencing beach closures is rainfall and the associated runoff (direct runoff, via rivers, or via combined stormwater and sanitary outfalls). For instance, the highest numbers of beach closure days were observed in 2011; this was likely due to the impact of tropical storm Irene (August 2011) and other storms. Inter-annual changes in the number of summer storms and rainfall will continue to instill variability into this indicator of pathogens in Long Island Sound. If climate change forecasts for more frequent tropical storms and an overall increase in precipitation are correct, the numbers of days that the beaches are closed will likely continue to trend upward and be variable from year to year.



Source: EPA (2014b).

Figure 4-24. Number of Beach Closure Days at New York and Connecticut Beaches

Toxic Contaminants

Toxic contaminants in the water column are almost always found at trace levels and, therefore, are usually measured indirectly. That is, contaminants are measured in biota that may have bioaccumulated (i.e., taken up or concentrated) the pollutants from the water column (for example, the NS&T Mussel Watch project (NOAA, 2014c), or measured in sediments (see Section 4.5). Thus, there are limited data on dissolved or particulate contaminants in Long Island Sound.

Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL does not imply accuracy of precision of the quantitative measurement, but protects against incorrectly reporting the presence of a compound at low concentrations in cases when noise and actual analyte signal may be indistinguishable. The MDL is designed to control against "false positives" (reporting detection of a substance when none is actually present) at the 99% confidence level in an ideal matrix. Reporting a false positive at the MDL concentration in a sample that does not contain the analyte should be rare (≤1%). Therefore, a signal that represents the presence of a substance in a sample at the MDL concentration is not likely to be false (Oblinger Childress, et al., 1999).

One source of contaminant data for Long Island Sound is studies conducted in support of dredged material testing. EPA collected and analyzed site water from near the CLDS in January 2000 and the CSDS in September 2001 (EPA, 2004) as part of testing conducted to determine the suitability of sediments dredged from harbors in Connecticut for placement. The data from these analyses show that all ambient metals levels were below applicable water quality standards. The pesticides and PCBs evaluated were not detected with the exception of endosulfan sulfate at CLDS and methoxychlor at CSDS. However, measured concentrations of these compounds were below applicable water quality standards. Similarly, low-molecular-weight PAHs (i.e., the two- and three-ring PAHs, which exhibit some water solubility) were detected at CLDS, but all measured concentrations were found to be below applicable water quality standards. The higher-molecular-weight PAHs were not found above the method detection limits (MDLs) (EPA, 2004). It should be noted that the MDLs for many of the pesticides were historically well above the water quality standards.

A recent review of literature on metal and organic contaminants in the Sound (Mitch & Anisfeld, 2010) summarized available data since 1994. Their findings confirm the relatively low concentrations of metal contaminants presented above. Dissolved metal concentrations in waters from across the Sound were well below Connecticut and New York water quality standards for the eight metals for which there was sufficient data (cadmium, copper, iron, lead, mercury, nickel, silver, and zinc). Reported levels of copper, nickel, and zinc were the only ones that even approached the same order of magnitude as the water quality standards (Mitch & Anisfeld, 2010). Spatial trends from west to east were observed, the strongest of which was for lead and silver. Levels of those two metals were much higher in the East River than in western Long Island Sound, though there was little variation from western to eastern Long Island Sound. Lead and silver are closely associated with WWTP effluent and likely signal the high loading of effluent into the East River. Mitch & Anisfeld (2010) noted that dissolved concentrations of cadmium, copper, nickel, and zinc tended to decrease from western to eastern Long Island Sound, while concentrations of iron and mercury increased. They attributed the trend of increasing iron concentrations to riverine inputs from the Connecticut River, while the mercury increase was ascribed to a decrease in adsorption by organic material (i.e., less organic material in the water column and sediments to the east means less mercury can be adsorbed; therefore, more remains in the water column). Mitch & Anisfeld (2010) also note that there have been substantial decreases in metal concentrations in western Long Island Sound since 1994, with mean lead, mercury, silver, and zinc levels decreasing by 6%, 18%, 25%, and 29%, respectively. They do not attribute this to any specific factor, but it is consistent with improved source reduction and WWTP upgrades. It should be noted that general decreases in metal and organic contaminants in WWTP and industrial effluents and nonpoint source discharges has led to decreased loadings of these contaminants to coastal waters and sediments (Mitch & Anisfeld, 2010). Thus, the newly deposited sediments in the harbors are not as contaminated today as they were decades ago.

Summary

The primary threat to water quality in Long Island Sound is nutrient loading to the system. Recent efforts to reduce the load from wastewater discharges have reduced the load of nitrogen by about 50% compared to 1990 levels. Surprisingly, as the TMDL-induced efforts are approaching the prescribed maximum nitrogen loading limit, the extent and duration of hypoxia remains unchanged. The onset of hypoxia is dependent upon temperature and stratification, while the persistence (extent and duration) is influenced by both bacterial utilization of organic material and meteorology (wind ventilation events). The loading of new organic material to the bottom waters is likely brought about by decreases in nitrogen levels (though current levels may still be above those necessary to limit primary production), but any reduction in loading is more than compensated by the historic accumulation of organic matter in the sediments. Climate change likely plays a role in the variability, spatial extent, and severity of Long Island Sound hypoxia by changes in winds, rainfall, and even the pH on a local and regional scale.

Upland Water Quality in the Study Area

The upland portions of the study area include surface water (lakes, ponds, rivers, and streams) and groundwater resources. Each of the three states within the study area has developed a classification system to characterize water resources under state regulatory programs. In addition, the EPA has identified sole-source aquifers in the study area as those groundwater resources that supply 50% or more of an area’s drinking water with no viable alternative sources. These aquifers are considered a priority resource for protection and conservation.

New York

All waterbodies in New York are given a water quality classification based on criteria established under New York State’s Environmental Conservation Law, Title 5 of Article 15. Those classifications are defined in New York Codes, Rules, and Regulations (NYCRR), Chapter X - Division of Water Resources, Part 701 and predate the Federal CWA. Streams and waterbodies classified as Class C or above (Classes N, AA-S, A-S, A, and B) are collectively considered protected waterbodies in New York.

> **Class N**: Source water for drinking and food processing, primary and secondary contact recreation, and fishing. Also suitable for fish, shellfish, and wildlife. No discharges or flow alteration allowed that will impair the receiving waters.

Class AA-S: Source water for drinking and food processing, primary and secondary contact recreation, and fishing. Also suitable for fish, shellfish, and wildlife. No discharges, flow alteration, nutrient inputs, or turbidity increases allowed that will impair the receiving waters.

Class A-S: Source water for drinking and food processing, primary and secondary contact recreation, and fishing. Also suitable for fish, shellfish, and wildlife. This classification may be given to international boundary waters.

Class AA: Source water for drinking and food processing, primary and secondary contact recreation, and fishing. Also suitable for fish, shellfish, and wildlife. These waters meet or will meet NYSDOH drinking water standards with approved disinfection treatment.

Class A: Source water for drinking and food processing, primary and secondary contact recreation, and fishing. Also suitable for fish, shellfish, and wildlife. These waters meet or will meet NYSDOH drinking water standards with approved coagulation, sedimentation, filtration, or disinfection treatment.

Class B: Suitable for primary and secondary contact recreation and fishing. Also suitable for fish, shellfish, and wildlife.

Class C: Suitable for fishing and fish, shellfish, and wildlife.

Class D: Suitable for fishing and fish, shellfish, and wildlife, but natural conditions such as intermittent stream flow may limit these uses.

In addition to these classifications for surface waterbodies, the State of New York also categorizes its groundwater resources in fresh and saline categories.

Class GA: Fresh groundwater that is suitable source for potable water supply.

New York State maintains a database of water quality, the degree to which certain uses are supported, and identification of potential threats to water quality through the Waterbody Inventory/Priority Waterbodies List. This program assesses each basin in the State on a five-year rotating basis. The basins within the study area include the Atlantic Ocean/Long Island Sound Basin and the Lower Hudson River Basin. Portions of these basins are highly developed, and water quality suffers from urban runoff, municipal wastewater, failed septic systems, dredged material placement, groundwater/surface water intrusions, thermal discharges, and contamination from past industrial activities. These sources have led to water quality impairments from nutrients, pathogens, reduced DO, temperature, turbidity, metals, and organic contaminants (NYSDEC (2011); NYSDEC (2008)).

Connecticut

There are three classes of inland surface waters in Connecticut based on the guidance developed under Section 22a-426 of the Connecticut General Statutes (CGS)and Section 303 of the Federal CWA. These classifications are intended to establish the general uses for each waterbody and to determine the allowable discharges, alterations, and development.

Class AA: Drinking water supply, recreational use, agricultural use, industrial supply, and habitat for fish and wildlife. Discharges are limited to those from public or private drinking water treatment systems, dredging, dewatering, and clean water discharges.

Class A: Drinking water supply, recreational use, agricultural use, industrial supply, navigation, and habitat for fish and wildlife. Discharges are limited to those from public or private drinking water treatment systems, dredging, dewatering, and clean water discharges.

Class B: Recreational use, agricultural use, industrial supply, navigation, and habitat for fish and wildlife. Allowable discharges include public or private drinking or wastewater treatment systems, industrial cooling waters, dredging, dewatering, and clean water discharges.

The State of Connecticut also classifies its groundwater resources into four categories.

Class GAA: Existing or potential public drinking water supply without treatment. Discharges limited to treated domestic sewage and agricultural wastes.

Class GA: Existing private or potential public and private drinking water supply without treatment. Discharges limited to treated domestic sewage and agricultural wastes.

Class GB: Industrial cooling or process water, not suitable for human consumption without treatment. Discharges limited to treated domestic sewage and agricultural wastes.

Class GC: Special permitted uses including lined landfills. Discharges restricted to certain waste facilities dependent on permit requirements.

In addition, CTDEEP identified aquifer protection areas through its Aquifer Protection Program. This program identifies areas that contribute groundwater to a high-yield public water supply well field to promote land-use regulations and protect the drinking water supply. The program is limited to public water supply well fields that serve populations of 1,000 people or more.

The State of Connecticut includes five major watershed basins: Thames, Connecticut, Central Coastal, Housatonic, and Western Coastal. The state compiles the Connecticut Integrated Water Quality Report to monitor the health of these waters every two years. Major impairments to water quality in the state stem from urban stormwater runoff, CSOs, municipal wastewater treatment plants, failed septic systems, flow alteration, and former industrial discharges.

Rhode Island

The RIDEM Office of Water Resources implements the water quality standards program in the State of Rhode Island according to Chapters 46-12 and 42-17.1 of the Rhode Island General Laws. The classifications are summarized in the Section 305(b) State of the State's Waters Report (RIDEM, 2012a) and include four classifications for freshwater.

Class AA: Drinking water supply, primary and secondary contact recreation, fish consumption, and habitat for fish and wildlife. These waters also have excellent aesthetic value.

Class A: Primary and secondary contact recreation, fish consumption, and habitat for fish and wildlife. Suitable for use as industrial process and cooling water, hydropower, agriculture, and navigation. These waters also have excellent aesthetic value.

Class B: Primary and secondary contact recreation, fish consumption, and habitat for fish and wildlife. Suitable for use as industrial process and cooling water, hydropower, agriculture, and navigation. These waters also have good aesthetic value.

Class B1: Secondary contact recreation, fish consumption, and habitat for fish and wildlife. Suitable for use as industrial process and cooling water, hydropower, agriculture, and navigation. These waters also have good aesthetic value.

The RIDEM Office of Water Resources also classifies the groundwater resources of the state into four categories:

Class GAA: Known or presumed to be suitable for drinking water supply without treatment and located within one of the three groundwater resource priority areas.

Class GA: Known or presumed to be suitable for drinking water supply without treatment but not located within one of the three groundwater resource priority areas.

Class GB: May not be suitable for drinking water supply without treatment due to a known degradation.

Class GC: May not be suitable for drinking water supply due to certain waste disposal practices.

Water quality impairments noted in the State of Rhode Island List of Impaired Waters include biodiversity, nutrients, pathogens, mercury, and total toxicity due to wastewater treatment plants, stormwater outfalls, septic systems, and agricultural and urban runoff (RIDEM, 2012b). These impairments have led to observed effects in Rhode Island waterbodies such as excess algal growth, taste, odor, color, chlorophyll *a*, sedimentation, and noxious aquatic plants (RIDEM, 2012b).

4.6.2 Open-Water Environment Water Quality

There are clear gradients in some water quality parameters from west to east across the Sound. These are primarily driven by higher nutrient loading rates in the western end of Long Island Sound. As noted in Section 4.6.1, these high nutrient loads lead to increased phytoplankton biomass and in turn lower bottom water DO in the Narrows and western Long Island Sound compared to eastern Long Island Sound. Hypoxia starts earlier, lasts longer, and is more severe in the westernmost reaches of the Sound and shows a decreasing trend in severity and duration as it progresses eastward. Therefore, hypoxia is expected to be most severe at WLDS, least severe at NLDS, and moderately severe at alternative sites CLDS, CSDS, and confined open-water Site E (Sherwood Island Borrow Pit). The levels of pathogens in the open water are not known, but they are expected to be very low and consistent across the Sound. Dissolved contaminant levels are well below water quality standards for metals and for those organics that have been quantified. There are some spatial trends in the dissolved metal concentrations, but since they are all very low there is little to distinguish the open-water alternative sites.

All three states in the study area have water quality goals for their respective marine surface waters and have established water quality criteria for key parameters (CTDEEP (2012b); NYSDEC (1999), (2008); and RIDEM (2010)). These goals and criteria are associated with various water quality classifications that vary slightly from state to state (Table 4-12). The highest classification for marine waters in each of the states is the SA classification, which includes the most sensitive water uses (e.g., harvesting of shellfish for human consumption).

Although lower water quality classifications (i.e., SC and SD in New York) exist, all of the open-water alternative sites are located in SA-classified waters (Table 4-13; Figure 4-25). Physical, chemical, and biological criteria have been established as parameters of minimum water quality necessary to support these surface water use classifications. The water quality goals and applicable criteria for each state in the study area are listed in Table 4-12 for reference.

4.6.3 Nearshore/Shoreline Environment Water Quality

None of the water quality studies cited in Section 4.6.1 included water quality information specific to the nearshore environment. However, there were clear gradients in water quality parameters from west to east across the Sound. Nutrient loading and ambient concentrations tended to be higher in western Long Island Sound and decreased to the east. This was also the case with phytoplankton biomass. The combination of shallower depths (see Figure 4-2) and higher organic matter loading to the sediments leads to an earlier occurrence, higher frequency, and more intense hypoxia in the western Sound than farther to the east. These gradients could reasonably be expected to be present along the nearshore/shoreline alternatives from west to east, although there are no data available to readily confirm this trend across alternative sites.

The nearshore and shoreline sites fall into either SA- or SB-classified waters (Table 4-14; Figure 4-25). The main difference between SA and SB waters is the ability to directly market harvested shellfish for human consumption (SA) or need for the shellfish to be depurated prior to consumption (SB). Physical, chemical, and biological criteria have been established as parameters of minimum water quality necessary to support these surface water use classifications. The water quality goals and applicable criteria for each state in the study area are listed in Table 4-12 for reference.

Table 4-12. Marine Water Quality Classifications and DO Numeric Criteria.

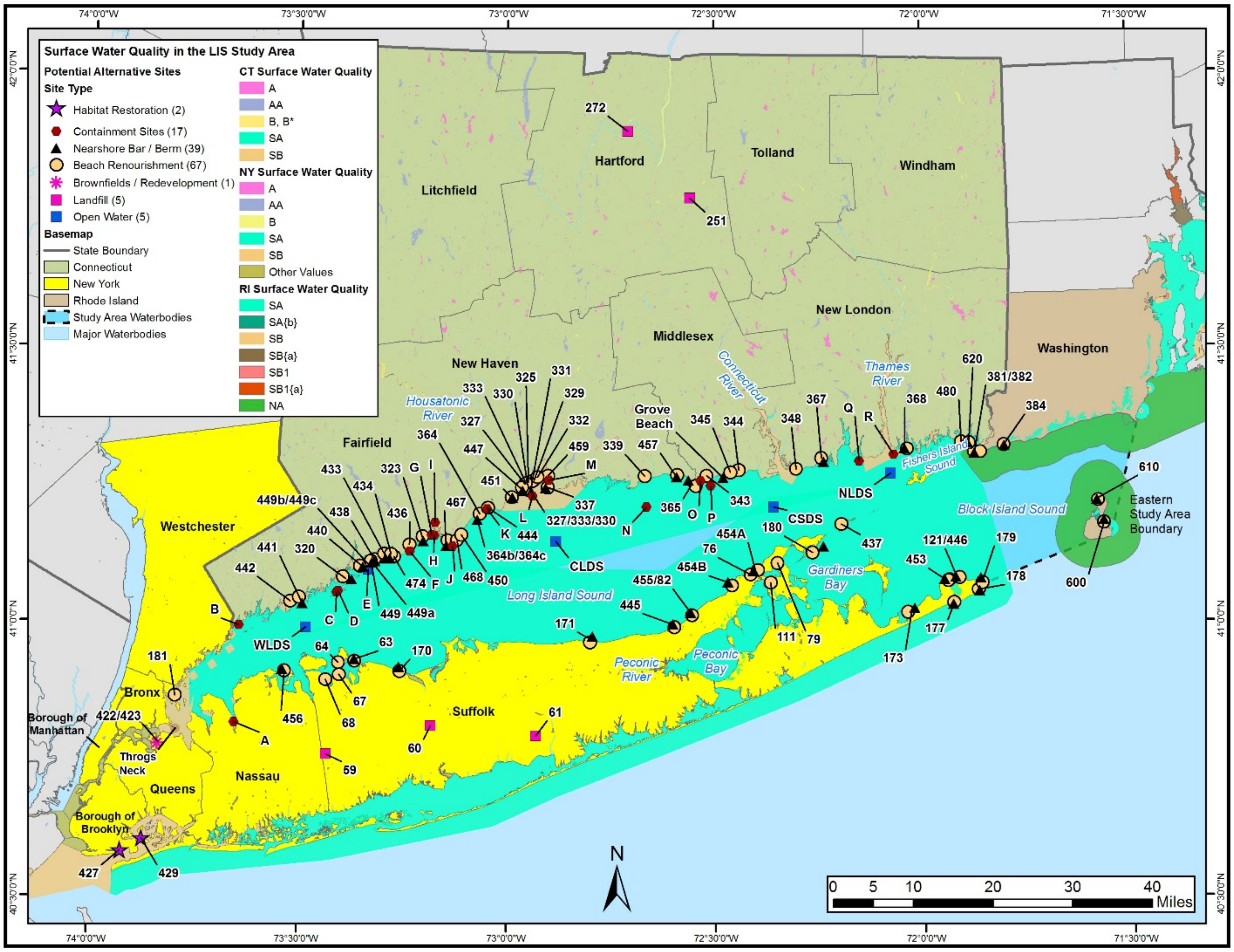
Marine Classification	Connecticut[1]	New York[2]	Rhode Island[3]
SA	• habitat for marine fish, other aquatic life and wildlife; • shellfish harvesting for direct human consumption; • recreation; • industrial water supply; and • navigation	• shellfishing for market purposes; • primary and secondary contact recreation and fishing; and • suitable for fish, shellfish, and wildlife propagation and survival.	• shellfish harvesting for direct human consumption; • primary and secondary contact recreational activities; • fish and wildlife habitat; • suitable for aquaculture, navigation and industrial cooling; and • good aesthetic value.
SB	• habitat for fish and other aquatic life and wildlife; • recreation; • navigation; and • industrial and agricultural water supply.	• primary and secondary contact recreation and fishing; and • suitable for fish, shellfish, and wildlife propagation and survival.	• primary and secondary contact recreational activities; • shellfish harvesting for controlled relay and depuration; • fish and wildlife habitat; • suitable for aquaculture, navigation, and industrial cooling; and • good aesthetic value.
SA and SB Numeric DO Criteria	• DO o Acute: not <3.0 mg/L o Chronic: not <4.8 mg/L with cumulative periods of DO in 3.0-4.8 mg/L range[1]	• DO o Acute: not <3.0 mg/L o Chronic: not <4.8 mg/L daily average o may fall <4.8 mg/L for a number of days based on formula[4]	• Stratified waters o surface waters: DO not <4.8 mg/L more than once every three years, except as naturally occurs o bottom waters: levels protective of Aquatic Life Uses • Mixed waters o DO >4.8 mg/L o If DO <4.8 mg/L, the waters shall not be: ▪ <3.0 mg/L for >24hrs consecutive during recruitment season; ▪ nor <1.4 mg/L for >1 hour more than twice during the recruitment season; ▪ nor shall they exceed the cumulative DO exposure levels[3]

[1]CTDEEP (2012b); [2]NYSDEC (1999); [3]RIDEM (2010); [4]NYSDEC (2008).

Table 4-13. Water Quality Classifications in the Open-Water Environment.

Environment	Alternative Type	Alternative ID	Water Quality Classification		
			CT	**NY**	**RI**
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS, CLDS, CSDS, NLDS	SA	NA	NA
	Confined Open-Water Placement	E	SA	NA	NA

NA = not applicable



Sources: RIGIS (2013); CTDEEP (2011b); NYSDEC (2010b).
Note: All RI seawaters not assigned to a category in the map above (i.e., “NA”) shall be considered to be Class SA (RIDEM, 2010).

Figure 4-25. Surface Water Quality Classifications in the Long Island Sound Study Area.

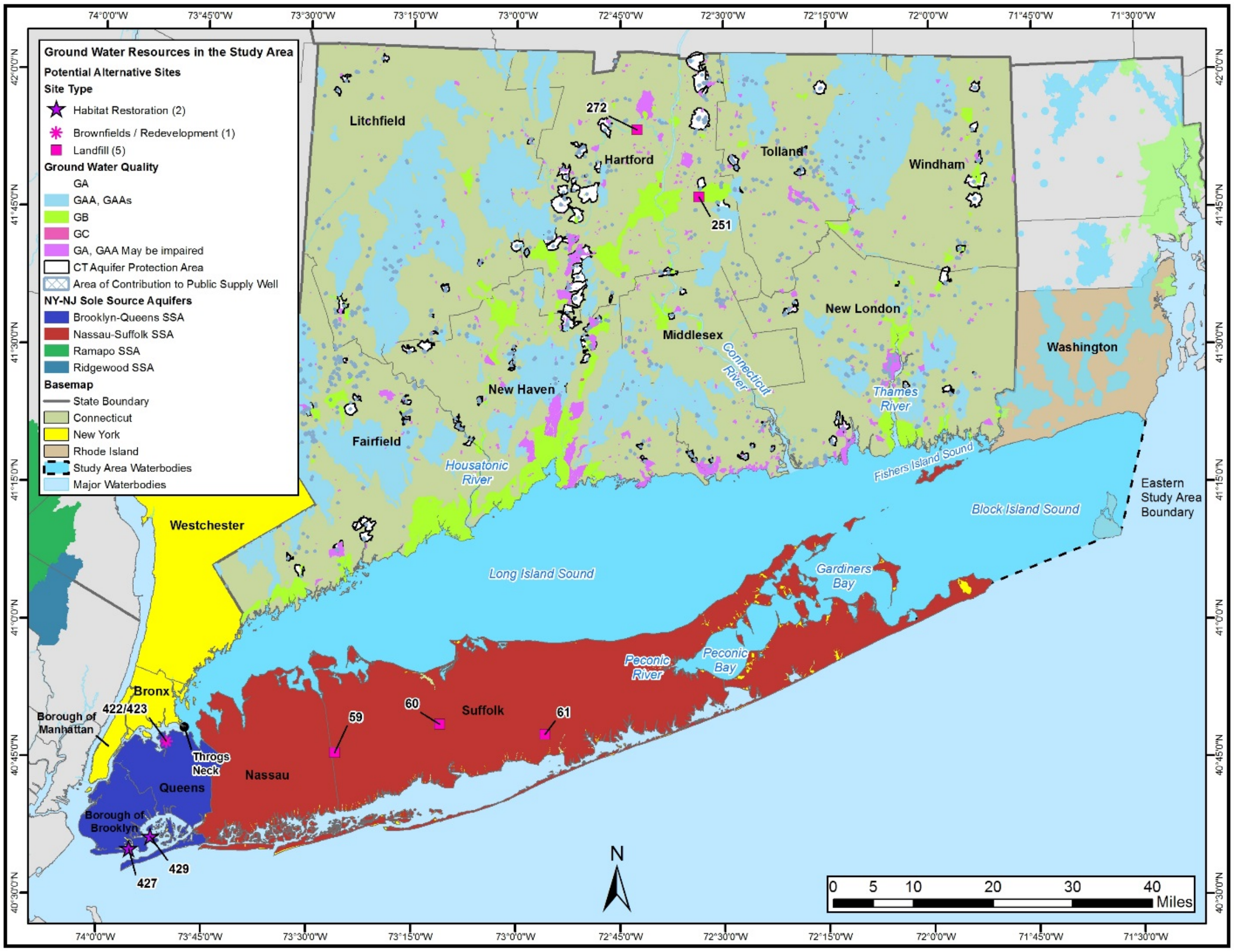
Table 4-14. Water Quality Classifications in the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Water Quality Classification		
			CT	NY	RI
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G, H, M	SB	NA	NA
	Island CDF	B, N, P, Q	SA	NA	NA
		L, R	SB	NA	NA
	Shoreline CDF	A	NA	SB	NA
		C, D, F, J, O	SA	NA	NA
		I, K	SB	NA	NA
	Nearshore Bar Placement/ Nearshore Berm Sites	177, 178, 179, 121/446, 453, 173, 180, 454A, 454B, 455/82, 445, 171, 170, 63, 456	NA	SA	NA
		441, 320, 440, 449, 438, 433, 434, 323, 467, 364b/364c, 457, 365, GP, 367, 368	SA	NA	NA
		451, 447, 327/333/330, 337	SB	NA	NA
		381/382, 384, 600, 610, 620	NA	NA	SA
	Beach Nourishment	339, 343, 344, 345, 323, 433, 434, 436, 365, 457, 320, 442, 438, 440, 449, 367, 368, 467, 468, 474	SA	NA	NA
		325, 329, 451, 337, 447, 327, 330, 331, 332, 333, 348, 364, 441, 444, 450, 459, 480	SB	NA	NA
		453, 63, 64, 67, 68, 76, 111, 456, 454E, 454W, 455/82, 437, 171, 173, 177, 178, 179, 170, 180, 445, 446, 121, 79	NA	SA	NA
		181	NA	SB	NA
		384, 381, 382, 600, 610, 620	NA	NA	SA

NA = Not applicable

4.6.4 Upland Environment Water Quality

Based on surface water classification datasets from New York, Connecticut, and Rhode Island, there is potential for certain surface water resources to occur near the Landfill Placement, Landfill Capping/Cover, Brownfields/Redevelopment, and Habitat Restoration sites. In addition to surface waters, several of these sites are also located within sole-source aquifers or groundwater resource areas (Figure 4-26). No specific Upland CDFs or Innovative Technology sites have been identified to date. If a location were to be identified within the Long Island Sound study area, the water resources would need to be investigated at that time. Surface water and groundwater resources present within 1 mi of each resource are presented in Table 4-15.



Source: RIGIS (2012); CTDEEP (2013b); CTDEEP (2012c); EPA (2007a).

Figure 4-26. Groundwater Resource Areas in the Study Area.

Table 4-15. Water Quality Resources in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	Nassau-Suffolk Sole-Source Aquifer[1]
	Landfill Cover/Capping	60	Nassau-Suffolk Sole-Source Aquifer[1]
		61	Nassau-Suffolk Sole-Source Aquifer[1]
		251	CT Class A and B Surface Waters[2] CT Class GB Groundwater[3] Aquifer Protection Area - Manchester Water Department[4]
		272	CT Class A Waters[2] CT Class GB Groundwater[3]
	Brownfields & Other Redevelopment	422/423	NY Class C Waters[5] Brooklyn-Queens Sole-Source Aquifer[1]
	Habitat Restoration/ Enhancement or Creation	427	NY Class SB Water (marine)[5] Brooklyn-Queens Sole-Source Aquifer[1]
		429	NY Class SB Water (marine)[5]

Sources: [1]EPA (2007a); [2]CTDEEP (2011b); [3]CTDEEP (2013b); [4] (CTDEEP, 2012c); [5]NYSDEC (2010b).

4.7 PLANKTON

This section provides a general description of the phytoplankton and zooplankton of the greater Long Island Sound area. The available plankton data are not specific to the various open-water or nearshore alternative sites; rather, the data apply to the entire Sound. As with the water quality data discussed in Section 4.6, the plankton data reveal clear temporal and spatial trends that may be relevant to dredging operations and placement activities.

Early studies of plankton in Long Island Sound were conducted as part of general oceanographic studies. These studies evaluated various aspects of the phytoplankton (Riley & Conover, 1967) and zooplankton (Deevey, 1956). More-recent studies run the gamut from very detailed studies of various aspects for certain species or groups of species (e.g., Kudela & Gobler (2012); Hattenrath, et al. (2010)) to more routine monitoring that provides general descriptions of phytoplankton biomass (as measured by chlorophyll) and community structure patterns Sound-wide or in specific parts of the Sound (Capriulo, et al. (2002); Goebel, et al. (2006); Liu & Lin, (2008), Dam, et al. (2010); Rice, et al. (2014); Latimer, et al. (2014)). Site-specific studies have not focused on plankton community structure at the four open-water alternative sites or at the numerous nearshore/shoreline alternative sites evaluated in this PEIS. Therefore, this discussion focuses on general aspects of the Sound-wide community as they apply to the open-water alternative sites.

4.7.1 General Long Island Sound Setting

Plankton form the base of the marine ecosystem’s food chain. They are small, free-floating or weakly swimming organisms that drift through the water column. They play a crucial role in transferring carbon and nutrients up to higher trophic levels.

Phytoplankton are single-celled plants that produce organic carbon via photosynthesis. The level of primary production (as this process is called) varies based on the availability of light and nutrients. In the temperate waters of Long Island Sound, there is a clear seasonal signal (light- and temperature-related) to phytoplankton primary production, and the rates of production are enhanced due to the high rate of nutrient loading to the system (see Section 4.6). Parts of Long Island Sound, but especially western Long Island Sound, are eutrophic, with very high nutrient loading to the system that leads to elevated rates of production. Ultimately, increased transfer of organic material to the sediments occurs, often leading to hypoxic conditions in this system.

Zooplankton range in size from small (less than 50 micrometers [µm]), single-celled, microzooplankton to larger, multicellular, macrozooplankton. The zooplankton serve as the first trophic transfer—often referred to as secondary production—from phytoplankton to larger pelagic or benthic organisms. The mechanisms followed for this transfer are important to the development and understanding of how an ecosystem’s fisheries and other larger organisms function. Changes to zooplankton community structure and abundance are likely to have ramifications higher up the trophic ladder.

In general, the plankton community in the study area appears to be consistent with that expected for the mid- to north Atlantic (Capriulo & Carpenter (1983); Peterson (1983); Anderson &

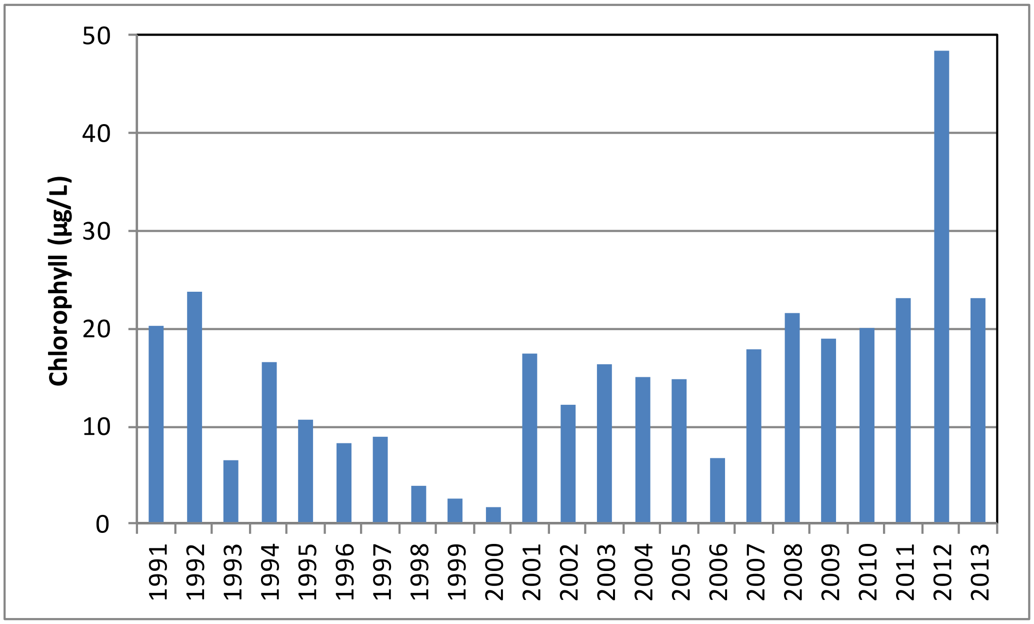
Taylor (2001); Capriulo, et al. (2002)). One of the primary environmental factors affecting the nature of the phytoplankton and zooplankton communities in Long Island Sound is the seasonal stratification of the water column. The water column is well-mixed from fall through early spring, but increased freshwater runoff and increasing water temperatures cause buoyant, warmer water to become layered over denser, colder water during late spring, summer, and early fall. This stratification results in seasonal changes in the distribution and abundance of the plankton community.

Phytoplankton

Phytoplankton cycles in Long Island Sound revolve around seasonal blooms in early spring, summer, and fall. These algal blooms occur when environmental factors stimulate phytoplankton growth to levels that exceed the removal of cells by death and grazing. Diatoms typically bloom in the spring (February and March), dinoflagellates dominate the bloom in the summer (June and July), and diatoms again dominate the bloom in the fall (September and October) (Conover (1956); Capriulo & Carpenter (1983); Liu & Lin (2008)).

Phytoplankton are typically evenly distributed throughout the water column before the onset of seasonal stratification. They receive nutrients from several sources, including the sea floor (Peterson, 1983). After stratification, nutrients are locked below the pycnocline (the density gradient set up by the differences in temperature and salinity between the surface and bottom layers), and phytoplankton populations decline as the nutrients they require are used and not replenished above the pycnocline. Occasional summer blooms may occur if increased tidal mixing during new moon phases (Peterson, 1983) or disturbance of bottom waters by storms (Anderson & Taylor, 2001) breaks down the stratification barrier and releases nutrients into the photic zone (zone within which light penetrates and photosynthesis occurs). Fall blooms occur following turnover of the stratified waters typically by late September.

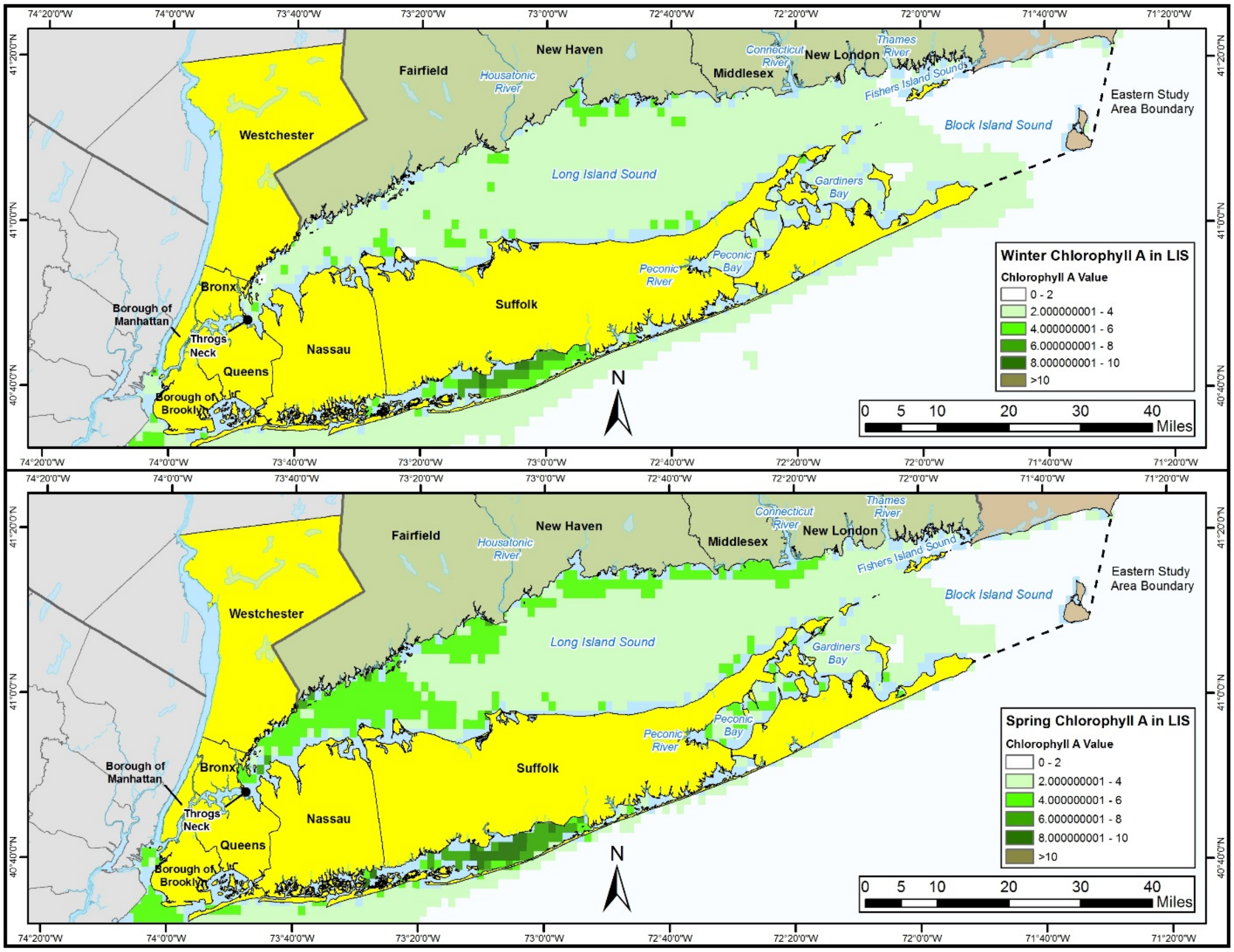
One indicator that the Long Island Sound Study measures (EPA, 2013a) is the winter/spring peak monthly mean chlorophyll concentrations at monitoring stations in western Long Island Sound (Figure 4-27). This winter/spring monthly mean can peak any time from February to April and is used to compare this important seasonal bloom across years. Typically, the winter/spring bloom exhibits the highest chlorophyll concentrations and phytoplankton abundances of each year. From 1991 to 2000, there was a clear decrease in the magnitude of the peak, suggesting that decreases in nutrient loading may have had an effect on phytoplankton and primary production. Further data, however, confirmed that this was a short-lived trend; from 2001 to 2013, levels increased and remained relatively high, peaking at nearly 50 micrograms per liter (µg/L) in 2012. The factors contributing to the decreasing trend in the 1990s and the seemingly more historically consistent and higher levels since 2000 continue to be the focus of much research, but these trends clearly indicate that phytoplankton biomass and abundance are variable in Long Island Sound.



Source: EPA (2014c).

Figure 4-27. Winter/Spring Bloom Period Peak Monthly Mean Chlorophyll.

Spatial trends in chlorophyll concentrations have also been well documented. The Long Island Sound Study dataset includes chlorophyll measurements at 20 stations from the Narrows across to eastern Long Island Sound. As discussed in Section 4.6, there is a strong gradient of decreasing DIN concentrations from west to east across the Sound. Annual mean chlorophyll concentrations at the western Narrows stations are consistently three to five times higher than those measured in eastern Long Island Sound (Dam, et al., 2010). However, unlike the gradient in nitrogen that consistently shows a relatively strong decrease from the Narrows to western Long Island Sound to central Long Island Sound, the annual chlorophyll levels are more variable spatially; the only consistent difference is between the most extreme western and eastern ends of the Sound. A review of seasonal satellite chlorophyll fluorescence imagery shows just how consistent phytoplankton biomass is across the Sound (Figure 4-28). These plots display the seasonal means for winter (January-March) and spring (April-June) over 9 years from January 1998 to June 2006. These plots not only highlight the clear differences between the extreme western and eastern portions of the Sound, but also show how similar levels are across the rest of the Sound. Importantly, the graphs suggest that there may be more of an inshore-to-offshore gradient in chlorophyll levels than a west-to-east one.



Source: The Nature Conservancy (2010).

Figure 4-28. Winter (January-March) and Spring (April-June) Seasonal Mean Chlorophyll Fluorescence (1998 – 2006).

Phytoplankton abundance and species identification data have not been collected as frequently as chlorophyll concentrations, but individual studies indicate that trends in abundance are similar to those discussed for chlorophyll. As with chlorophyll, phytoplankton abundance typically peaks in the winter/spring with a secondary peak in the fall, both of which are associated with diatom blooms of various species (Conover (1956); Harris & Riley (1956)). Work in the early 1990s and 2000s has shown maximum phytoplankton abundance occurring in the summer—still dominated by diatoms with elevated abundances of dinoflagellates and unidentified microflagellates (Capriulo et al. (2002); Liu & Lin (2008)). Spatially, phytoplankton abundance shows similar trends with chlorophyll: significant differences between the western and eastern ends of Long Island Sound, with the highest numbers being observed concomitant with the high nutrient levels in the Narrows.

Overall, the phytoplankton community in the Sound is dominated by diatoms (61%), with dinoflagellates (26%) as subdominants that peak in abundance in the summer. Much of the remaining phytoplankton consists of other smaller species (chrysophytes, raphidophytes, chlorophytes, cryptophytes, and other unidentified species (unpublished data from S. Lin as reviewed in Latimer, et al. (2014)). The predominance of diatom species suggests that eutrophication has not impacted the entire Sound, though it has been posited that the variations in dominant diatom species spatially across the Sound are a potential response to eutrophication (Cloern (2001); Latimer, et al. (2014)).

One of the main focuses of phytoplankton research is on harmful algal blooms (HABs) as they pose both direct human health risks and potentially severe economic impacts. About 2% of the approximately 4,100 known phytoplankton species are capable of causing HABs such as brown or red tides (Smayda, 1997). HABs have generally increased in prevalence since the 1980s (Anderson & Garrison, 1997) and are of concern because of the devastating effects they can have on other marine organisms and humans. It is not clear what has caused the apparent increase in HAB frequency and severity of impacts, but studies point to an array of potential interrelated factors including climate change, eutrophication, and invasive species (Smayda (1997); Hattenrath, et al. (2010)).

Brown tides caused by the bacteria *Aureococcus anophagefferens* have been reported from Narragansett Bay to Long Island (Peconic Bay and bays along the south shore), but have not yet occurred in Long Island Sound, although the bacterium has been found in small numbers (Bricelj & Lonsdale (1997); Greenfield & Lonsdale (2002)). Brown tides caused by this species can have serious effects on the ecosystems in which they occur by reducing light levels available to plants such as eelgrass (*Zostera marina*) and by severely reducing growth and causing high mortalities in bivalves such as mussels (*Mytilus edulis*) and bay scallops (*Argopecten irradians*) (Bricelj & Lonsdale, 1997).

Historically, red tides have been relatively infrequent in Long Island Sound and were limited in toxicity and observed in isolated embayments (Anderson & Garrison, 1997). However, the frequency and magnitude of such blooms have increased over the past few years in some of the Sound’s more eutrophic estuaries and bays (Hattenrath, et al. (2010); Kudela & Gobler (2012); Hattenrath, et al. (2013)). For example, the dinoflagellate *Alexandrium fundyense*, which produces a saxitoxin that is responsible for the majority of paralytic shellfish poisoning (PSP) along the northeast coast, has been observed in the embayments along the Sound since at least the early 1980s (Anderson, et al., 1982). However, it wasn’t until 2006 that *A. fundyense* blooms led to high PSP toxicity and the closure of shellfish beds in the Sound (Northport-Huntington Bay). These blooms have since become an annual occurrence in these waters, and evidence suggests that the increased frequency and magnitude may be related to nutrient loading to the Bay (Hattenrath, et al., 2010).

A. fundyense is just one of many HAB species that have gotten the public’s and researchers’ attention in the last few years. For example, the dinoflagellate *Dinophysis acuminata*, which is associated with diarrhetic shellfish poisoning (DSP), was reported in high densities in Northport-Huntington Bay from 2008 to 2011 (Hattenrath, et al., 2013). This species bloomed in such high densities in 2011 that DSP toxin levels exceeded FDA action levels for the first time on the east coast of the United States. These occurrences are not just limited to embayments in the western Sound. *A. fundyense* blooms have become annual problems from Northport Bay to Narragansett Bay and many embayments in between. In 2004, another HAB dinoflagellate, a species of the genus *Cochlodinium* that produces ichthyotoxins that can kill many marine organisms, was first reported in Peconic Bay and has formed large, annual blooms from 2004 to 2011 (Kudela & Gobler, 2012).

In the context of this PEIS, *A. fundyense*, like many dinoflagellates, has a resting life stage where it forms cysts that lie dormant in the sediments. As highlighted by Anderson, et al. (1982), who documented the presence of *A. fundyense* cysts in five embayments in 1982 (and are likely present in more today [D. Anderson, personal communication, April 22, 2014]), the potential for this organism to spread via natural advection and human activities (including dredging and placement) should be monitored closely.

Zooplankton

Unlike phytoplankton, there are no analogous ancillary measurements like chlorophyll that are relatively easy to measure for zooplankton. Thus, even fewer studies have been conducted to characterize zooplankton in Long Island Sound, and less is known about this portion of the food web for the Sound. The primary resources available are from studies conducted in Long Island Sound in the 1950s (Deevey (1956); Conover (1956)), 1979-1980 (Capriulo & Carpenter, 1983), 1980s (Peterson, 1986), 1990s (Capriulo, et al. (2002)), 2000s (Dam & McManus (2009); Dam, et al. (2010)), and most recently 2010-2011 (Rice, et al., 2014). The data from these various surveys were primarily collected within central Long Island Sound, and the studies were often limited in focus. Since 2000, work conducted as part of the CTDEEP monitoring program is more comprehensive both temporally and spatially. For this PEIS, these data have been combined to summarize the zooplankton community in the Sound and highlight any trends that may be of interest pertaining to potential dredging and material placement for this portion of the affected environment.

Zooplankton are divided operationally and functionally into microzooplankton (35 to 200 µm) and mesozooplankton (greater than 200 µm). The microzooplankton consist primarily of ciliates, including tintinnids, other heterotrophic ciliates, and *Myrionecta rubra* (Latimer, et al., 2014). The Long Island Sound mesozooplankton group is dominated by copepods (80% to 90%) (Deevey (1956); Dam & McManus (2009)). There is some crossover between the micro- and mesozooplankton designations; for example, copepod nauplii and other smaller copepodite stages are small enough to fall in the microzooplankton size class but are functionally associated with the mesozooplankton copepods.

Capriulo & Carpenter (1980), (1983) studied the abundance and feeding biology of microzooplankton in Long Island Sound. These are primarily protozoans such as tintinnids. Capriulo and Carpenter (1983) found 28 species of tintinnids in the Sound and found that the highest diversity occurred from September to April. Tintinnid abundances ranged from 268 to 12,600 individuals per liter, with the highest numbers occurring in July and August. Occasionally, rotifers were also abundant. Capriulo and Carpenter (1983) concluded that tintinnids, by virtue of their high abundances and ingestion rates, were important herbivores in Long Island Sound. They emphasized, however, that because tintinnids feed more efficiently on small phytoplankton, they did not directly compete with copepods, which are significant grazers on larger organisms (often including these tintinnids). The relative importance of the traditional phytoplankton-to-copepod food web vs. the microbial loop (bacteria/nanoplankton to microzooplankton to copepods) is an intense area of study in the Sound and has been cited as one reason why the decrease in nutrient loading has not had a major impact on hypoxia (Capriulo, et al. (2002); Dam, et al. (2010)).

The broad range of water temperatures (0 to 77°F) in Long Island Sound induces seasonal dominance of distinct boreal (winter–spring) and warm-water (summer–fall) copepod communities, both containing species adapted to the reduced and variable salinity of estuarine waters (Deevey (1956); Peterson (1986)). The numerically important species in Long Island Sound are few *(Acartia hudsonica*, *Temora longicornis*, and *Pseudocalanus minutes* in winter–spring; and *Acartia tonsa*, *Paracalunus crassirostris*, *Centropages* sp., and *Oithona* sp. in summer–fall) and there has been little change in the dominance of these species since the 1950s (Deevey (1956); Latimer, et al. (2014)).

Peterson (1985) offered observations indicating that the zooplankton community in Long Island Sound is a relatively distinct, closed system that differs from communities in nearby Block Island Sound or Narragansett Bay. The closed nature of the system probably contributes to the retention of plankton species within Long Island Sound. Before stratification occurs, two copepod species dominate separate aspects of the zooplankton community. The most abundant species is *A. hudsonica*, whereas the species with the highest biomass is *T. longicornis* (Peterson, 1985). *Pseudocalanus* is the third most influential taxon. In Block Island Sound, the dominant taxa are the copepods *Centropages*, *Pseudocalanus*, and *T. longicornis*, while *A. hudsonica* is uncommon, likely due to its high salinity intolerance. In Narragansett Bay, *A. hudsonica* dominates in biomass and numbers, and the other two species have only minor roles in the community.

The spring assemblage described by Peterson (1985) is replaced during the summer as temperatures warm (to 62°F in bottom waters and to 68°F in surface waters) by one consisting of three other copepod species: *Acartia tonsa*, *Oithona similis*, and *Paracalanus crassirostris* (Peterson, 1985). All three of these species occur in the Sound throughout the year, but historically have not been abundant during the winter and early spring. The seasonal patterns in these winter-spring and summer-fall dominant species have changed little since the 1950s. The lone exception has been a recent change in the duration of *Acartia tonsa* presence (Dam & McManus, 2009). Typically, this species was present from June to December, but in recent years (2008 to 2010) it has remained in the Sound from June till April, perhaps in response to warmer winter temperatures.

A recent analysis of long-term temperature data sets and changes in zooplankton community structure from the 1950s to the 2000s in Long Island Sound has shown some significant changes. Surface water temperatures in central Long Island Sound have warmed 0.03°C/year from 1948 to 2012 (Rice, et al., 2014). This warming has been correlated with significant decreases in the size of the dominant *Acartia* sp. (*tonsa* and *hudsonica*) and an increase in the relative percentage of the small copepod *Oithona similis*. These changes are consistent with predictions of what the impact of climate change would be on marine ectotherms such as copepods (Daufresne, et al. (2009); Dam (2013)).

Although the zooplankton community structure has remained relatively consistent over the past 60 years, there have been clear decade-by-decade differences in abundance. Comparisons of annual mean zooplankton abundance indicate that levels were significantly lower in 2002-2004 than in 1952-1953, but that there were no significant differences between 1952-1953 and 2008-2009 or 2002-2004 and 2008-2009 (Latimer, et al., 2014). Zooplankton abundances in the 2000s were generally higher than in the 1990s, but this may have more to do with sampling locations than any real differences, though the low zooplankton abundances in 1990s were concomitant with low phytoplankton biomass. Overall, even with the limited number of datasets, there appears to be a great deal of variability in zooplankton abundance in Long Island Sound.

In summary, unlike water quality parameters phytoplankton researchers have not observed any significant changes in zooplankton community structure from the nutrient-, biomass-rich Narrows and western Long Island Sound to the lower-nutrient waters of central and eastern Long Island Sound (Capriulo, et al. (2002); Rice, et al. (2014)). There are, however, consistent west-east spatial differences in zooplankton abundances in the Sound (Capriulo, et al. (2002); Dam & McManus (2009)). The zooplankton community structure may remain unchanged, but abundances consistently decrease three- to five-fold between the extreme western and eastern stations (Latimer, et al., 2014). The coincident decrease in phytoplankton biomass/abundance and zooplankton abundance from west to east suggests that the zooplankton are food-limited in Long Island Sound. Moreover, the consistent zooplankton community structure within the Sound and elevated abundances in western Long Island Sound suggests that eutrophic conditions in western Long Island Sound are not adversely impacting the zooplankton community.

4.7.2 Plankton in the Open-Water Environment

Most of the recent studies of Long Island Sound plankton have involved detailed studies on various aspects for certain species (or groups of species) rather than on a description of community structure patterns Sound-wide (or in specific parts of the Sound). Therefore, site-specific information is not available to describe the communities at each alternative site. However, because the primary environmental determinants of the community structure are temperature and the seasonal stratification of the water column, it is assumed that the general description would apply to conditions at each alternative site. For example, Capriulo, et al. (2002) found little difference between the zooplankton communities off the shore of Milford, Connecticut, and those off the shore of Stamford, Connecticut. Thus, it is assumed that the plankton community at each alternative site is similar to that described for the Sound in general, and that the primary factor controlling fluctuations in these populations is the seasonal stratification of the water column and food availability (nutrients/phytoplankton biomass).

4.7.3 Plankton in the Nearshore/Shoreline Environment

There have not been any recent studies specifically examining the phytoplankton or zooplankton communities at any of the nearshore/shoreline alternative sites. These sites are located within the shallow coastal waters of the Sound, where the primary factors controlling fluctuations in plankton communities are water temperature, nutrient abundance, water column turbulence, stratification, and the presence of predators. There are clear gradients in some water quality parameters and plankton from west to east across the Sound. These are primarily driven by higher nutrient loading rates in the western end of Long Island Sound. As noted above, these nutrients lead to increased phytoplankton biomass and, in turn, zooplankton abundance in the Narrows and western Long Island Sound compared to eastern Long Island Sound. Plankton community structure, however, is quite consistent across these gradients in nutrients, biomass, and abundance. Thus, the plankton species and community structure at these nearshore alternatives should be similar to open-water communities in each region of the Sound.

There is limited information on the plankton communities in individual embayments; most of the data have been collected during studies focused on HABs. These more highly eutrophic embayments have seen an increase in the frequency and magnitude of HABs in recent years, often resulting in closings of shellfish beds until the HAB bloom is over and the shellfish are safe to eat. *Alexandrium fundyense* is one of the dinoflagellate species responsible for red tide blooms in the Sound. Otherwise, the information about plankton communities in general gives no reason to conclude that the plankton community at each alternative site differs from that described for the open waters of the Sound.

4.7.4 Upland Environment

Plankton is not applicable to the upland alternative sites.

4.8 BENTHIC RESOURCES

The interface between the water column and sediment supports an extensive community that is often used as an indicator of ecosystem stress or recovery status. Known as the benthic infauna community, it consists of invertebrate organisms that live on or within the sediment, typically inhabiting the upper 4 inches. Benthic infauna are an important component of the food web, providing a food source for megafauna such as lobster and other motile species such as fish and crabs. These megafauna are discussed in Sections 4.9 (Commercial and Recreational Shellfish Resources) and 4.10 (Fish). Benthic infauna also plays an important role in geochemical and physical processes such as sediment reworking, chemical flux, and sediment resuspension. Benthic invertebrate community structure is used to provide a measure of ecological condition; it is particularly useful for evaluating impacts from anthropogenic activities that result in disturbance to the seafloor.

The structure of benthic communities is influenced by water depth, sediment grain size and organic content, DO, sediment transport regimes, and hydrodynamics. The general condition of the benthic community in Long Island Sound has been described in several key studies conducted in the 1950s, 1970s, and 1980s. In addition, in recent years, a significant number of studies have been conducted under the USACE DAMOS program relative to the impacts of dredging and dredged material placement at designated sites within the Sound. These data provide a generalized picture of the benthic condition in the Sound, provide a baseline from which to assess future conditions, and allow for management of dredged material disposal at these sites. Taken together, they illustrate some recurring dominant patterns that are discussed in this section.

Benthic community analysis relies on sediment collections from grab samplers that collect a discrete portion of the sediment, typically a 1.1-ft^2 or 0.4-ft^2 area with depths of 0.8 to 4 inches. The sediment is evaluated to determine the number (abundance) and type (species when possible) of organisms present. The abundance data are typically treated statistically to develop ecological parameters that are used to describe the condition of the infaunal community (Figure 4-29).

The analysis of a benthic sample begins by identifying and counting the organisms present in the sample. The data resulting from this task are very difficult to understand and interpret by themselves. Therefore, ecologists have developed many univariate parameters that essentially condense the full set of species data into a single number. These parameters range from simple calculations, such as the number of species in a sample, to more complex derivations, such as rarefaction analysis. However, because there is no single metric that can adequately characterize a sample, several are used in ecological evaluations. The parameters described below are among the more common ones used by marine ecologists to characterize samples, and therefore to characterize communities.

Abundance — measured as the number of infaunal organisms identified in a defined sample size or area; the actual number of organisms counted is often extrapolated to the number per square meter by dividing the count by the sample area.

Species — represents the number of species identified in the sample; this value cannot be extrapolated to the number per square meter.

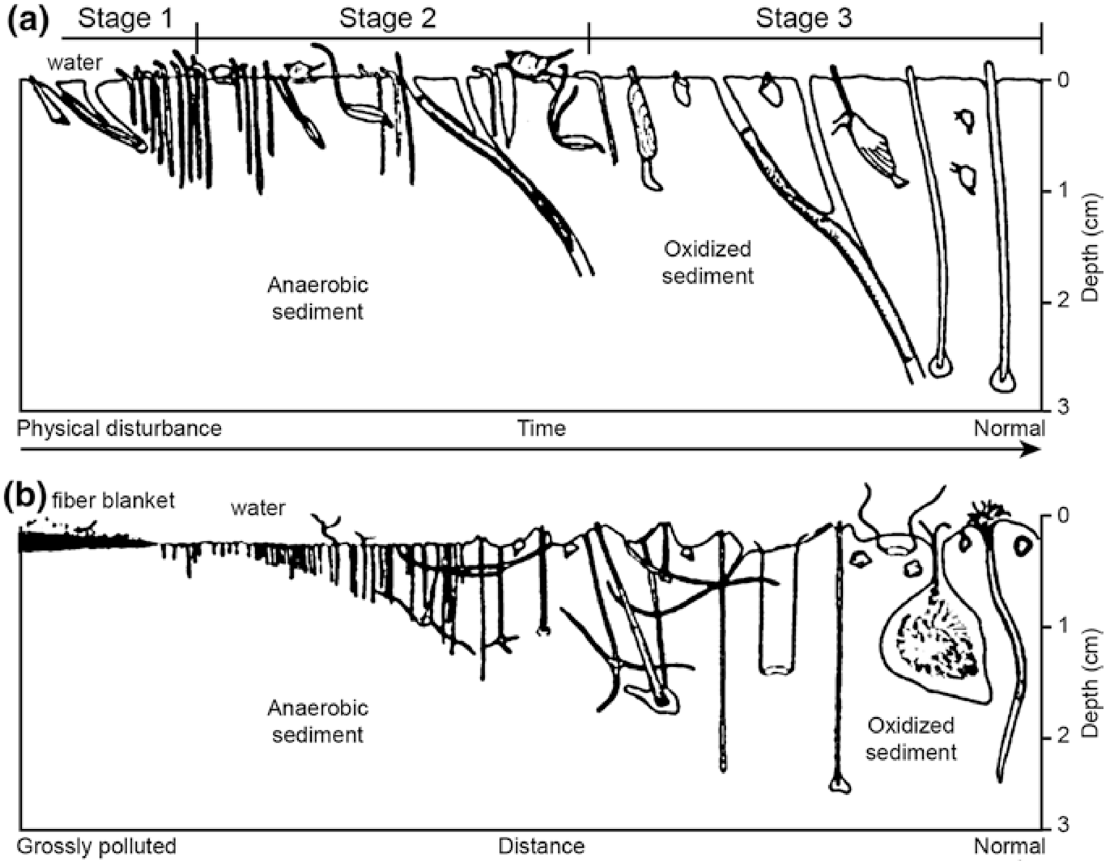
Shannon-Weiner Diversity (H′) — a measure of species diversity that estimates the uncertainty associated with predicting the species identity of an organism randomly selected from a sample. H' is 0 when there is only one species in the sample and is at a maximum when all species in the sample have the same number of individuals. Generally, maximum H' values for marine infaunal communities are between 6.0 and 7.0 for very diverse deep-sea communities. Maximum values for southern New England communities are generally less than 5.0.

Sanders-Hurlbert Rarefaction — provides a measure of diversity that can be compared among samples having unequal numbers of individuals. The species estimate is calculated for several randomly selected subsamples of *n* individuals taken from the original sample. The estimates are graphed as continuous curves plotting the number of species expected [ES (*n*)] on the Y-axis and the sample size (i.e., number of individuals from the original sample (*n)* described above) on the X-axis. These curves provide a visual comparison of diversity among samples of different sizes. More diverse samples will have a higher number of species expected for a given sample size than less diverse samples, resulting in “taller” lines.

Evenness — a measure of the distribution of the abundance of the organisms in a sample among the species in that sample. The index ranges from 0 to 1 and is at the maximum value when all species in the sample have the same number of individuals. Pielou’s J’ is a measure of evenness.

Figure 4-29. Ecological Parameters Used to Characterize Infaunal Communities.

While the early studies in the Sound relied on grab samples, infaunal sorting and identification, and calculation of the parameters described above, technological developments in the 1980s, specifically the Remote Ecological Monitoring of the Seafloor (REMOTS®) criteria used to analyze sediment profile images described by Rhoads & Germano (1982), provided the potential for more rapid assessment of benthic conditions and communities. The method has been refined in the years since it was developed and is generally referred to as sediment profile imagery (SPI). Modern benthic studies routinely include SPI as a cost-effective method for rapid assessment of benthic conditions. SPI does not provide a full community analysis (i.e., individual organisms are not identified or counted), but it does provide data that describe general infaunal ecosystem health. In SPI analyses, several physical parameters are also described, and communities and habitats are described in terms of successional stage (Figure 4-30). The staging convention is useful in assessing ecosystem recovery following a physical disturbance and has become central to many survey designs that are focused on monitoring the response of the seafloor to sediment placement events.



(a) Model of soft-sediment succession proposed by Rhoads, et al. (1978), in which disturbance is followed by recolonization of stage 1 species consisting of opportunistic species which live in the upper few centimeters of the sediment. Eventually, a “climax” stage 3 community is reestablished consisting of deeper-dwelling, more long-lived type species. The successional model stages have similarities to responses of infauna along an organic pollution gradient as proposed by Pearson & Rosenberg (1978) shown in (b).

Figure 4-30. Comparison of Soft-Sediment Successional Model Stages with Responses of Infauna.

4.8.1 General Long Island Sound Setting

The study of benthic habitat and benthic communities in Long Island Sound began in 1953 with the work of Howard Sanders (1956). Since then, several large-scale studies have been conducted, primarily in the 1970s and 1980s. Two of these studies were Sound-wide (Reid, et al. (1979); Pellegrino and Hubbard (1983)); others have focused on specific areas of the Sound, including the Central Basin (McCall (1977), (1978); Rhoads, et al. (1977); Rhoads & Germano (1982)) and Fishers Island Sound (Franz (1976); Swanson (1977); Biernbaum (1979)). Monitoring studies designed to evaluate impacts of dredging and the placement of dredged material at sites in the Sound have been conducted under the USACE DAMOS program since 1977, and sampling in Long Island Sound has been part of EPA's Environmental Monitoring and Assessment Program (EMAP) and NCA since 1990. In addition to offshore deepwater surveys, inshore benthic studies have been conducted in support of discrete energy projects affiliated with the Northeast Utilities (NUSCO, 1999) Nuclear Power plant and the Long Island Power Authority/Connecticut Light and Power Company Long Island Replacement Cable Project (Ocean Surveys, Inc., 2010). While most of these studies were conducted in the Central Basin and do not provide optimum spatial resolution, together they provide a general overview of benthic conditions in the Sound.

The basic findings of most of the studies reviewed have shown that community structure and abundance are related to the composition of the sediments. The Sanders study in the early 1950s (Sanders, 1956) revealed the importance of bottom type variability in determining trends in benthic community structure. That study found that while predominant grain size regimes could be recognized at each station, the sediments were generally heterogeneous across the basin and that stations with intermediate levels of sand-silt (13% to 35%) correlated with the highest biomass values.

Reid, et al. (1979) conducted the first area-wide survey of the Long Island Sound benthos, sampling 142 stations three times over a period of two years in 1972 and 1973. Low species diversity values (between 1.0 and 2.0 H′) were prevalent throughout much of the western portion of the Sound, with patches of higher diversity occurring in nearshore areas and patches of lower diversity occurring in offshore areas. Species diversity was lowest at the deep-water stations with high silt-clay content, although some shallow-water stations also had low diversities. Highest diversities (greater than 3.0 H′) were found in the eastern end of the Sound near Fishers Island and south of Niantic Bay. Moderate diversity was observed throughout much of the eastern portion of the Sound as well as along several transects in the central portion of the Sound and at nearshore sites in the western Sound.

A later study by Pellegrino and Hubbard (1983) confirmed several of the trends seen in the study by Reid, et al., including the increase from west to east in species richness and mean density (individuals per sample). A reanalysis of Pellegrino and Hubbard's data (Zajac, 1998a) suggested that community structure was actually quite variable throughout the Sound and that while general trends did exist; such trends should not be interpreted as smooth transitions in community structure from west to east or shallow to deep water. Similar analysis of Reid, et al. (1979) data revealed three faunal groups in the central and western portions of the Sound: a muddy, deep-water group; a sandy, shallow-water group; and a transitional shallow-water assemblage.

The benthic communities of Long Island Sound go through strong seasonal changes (Zajac, 1998b) usually consisting of elevated abundances in the spring/early summer followed by sharp declines during the mid- to late summer. These declines were observed to be most pronounced (Zajac, 1998b) in deep-water sections of the study areas and are likely associated with late-season hypoxia (or loss of oxygen from the water column, discussed further in Section 4.6). However, there are no long-term, consistent datasets to inform an understanding of the long-term impact of seasonal hypoxia in the Sound. Those that did include a temporal component (McCall (1977); Reid, et al. (1979); Zajac & Whitlatch (1988) (1989)) showed that the benthos in Long Island Sound exhibit seasonal changes in composition and abundance generally expected for this geographic area. Such changes are correlated with reproductive cycles, with higher abundances generally seen during the warmer summer months.

In nearshore and harbor areas, sand and mud faunal assemblages are affected by many of the same physical and biotic processes and are similar to those found in the deeper subtidal areas of Long Island Sound. It is notable, however, that studies examining the structure of the benthic communities in harbors tend to clearly identify characteristics that suggest natural or anthropogenic disturbances. Two surveys (Ocean Surveys, Inc. (2010); Cerrato & Holt (2008)) found benthic community characteristics indicative of stress in harbor populations, including lower-than-expected species richness, low abundance, and dominance by low-successional, opportunistic species.

A benthic index of estuarine condition (Paul, et al., 1999) was constructed for the Virginian Biogeographic Province (from Cape Cod, Massachusetts, to the mouth of Chesapeake Bay, Virginia) with data collected during summers of 1990 through 1993 by the EMAP. Forty-eight metrics, based on attributes of the benthic environment, were considered for the index, including measures of biodiversity, community condition, individual health, functional organization, and taxonomic composition. This index is based on a measure of diversity and the abundance of pollution tolerant taxa. Positive values signify healthy community conditions, and negative values indicate degraded communities. The index represents an attempt to reduce a complex set of biological measurements to a simple, interpretable value.

The EMAP calculated the benthic index for the waters of Long Island Sound based on data collected in the early 2000s. The benthic index for Long Island Sound was reported on a Sound-wide basis in the National Estuary Program Coastal Condition Report (EPA, 2007b). In 2007, the Sound-wide benthic index indicated Good Quality at 56% of the stations sampled in the Sound and Poor Quality at 37% of the stations, with 7% of the data reported as “missing.” These numbers were based on results from 86 NCA sites sampled in Long Island Sound in 2000 and 2001. The study reported that the east-to-west gradient noticeable in other parameters (i.e., sediment quality, which is most impaired in the western region of the Sound) was absent in the results for the benthic index. Rather, the best results were clustered in the western and central portions of the Sound, and the poorest results were grouped in the nearshore waters and tributaries in New York and Connecticut. Consequently, there was a poor correlation between benthic condition and measures of sediment contaminant impairment (EPA, 2007b).

The Long Island Sound Study used the same index to evaluate benthic community data collected from 2002 to 2006 by basin in the 2012 Sound Health report (EPA, 2013a). General conditions by basin were reported as: Western Basin=51% poor quality, 49% good; Central Basin=5% poor, 95% good; Eastern Basin=25% poor; 75% good.

Spatial trends in the Sound generally show that species richness increases from west to east over the full extent of the Sound; however, significant heterogeneity in both sediment type and community structure is found within basins. Areas that appear to have higher species richness tend to coincide with coarser sediments. The large-scale, east-to-west gradient likely reflects a larger potential species pool at the eastern end of Long Island Sound and the connection to the open coastal waters of Block Island Sound and the Atlantic Ocean. In the Central and Western Basins, lower species richness may reflect a smaller pool of potential species that have entered the Sound proper, but also a smaller set that can successfully maintain populations (Latimer, et al., 2014). Patch and smaller-scale spatial differences in species richness may be related to the sediment characteristics of specific patches, with lower richness in muddy sediments and higher richness in sandy and coarser sediments. Furthermore, species richness may be affected by small-scale, physical, and biogenic habitat characteristics (e.g., Hewitt, et al. (2005)), but interactions between small-scale habitat structure and species richness are not well-known for Long Island Sound (Latimer, et al., 2014).

4.8.2 Benthic Resources in the Open-Water Environment

General, historic information on benthic resources provided by the Sound-wide studies described above can be augmented by more-recent monitoring studies at discrete placement sites. The USACE DAMOS Program has monitored placement sites in Long Island Sound since 1977, including the four open-water alternative sites. These surveys typically utilize SPI sampling to compare placement site stations (i.e., directly affected by a placement of dredged material) and reference sites (outside the area of disturbance) to provide an indication of benthic recovery in response to dredged material placement operations. Data from these surveys and especially from the reference (undisturbed) stations provide updated information on benthic resources at the open-water sites. EPA and USACE also sampled benthic resources, including both SPI and grab samples, at the Western and Central Long Island Sound disposal sites in 2000 to support site designations (EPA (2004) [Appendix H-1 and H-2]).). Descriptions of the benthic community at WLDS and CLDS (below) are based on the 2000 surveys.

Unconfined Open-Water Placement

Western Long Island Sound Disposal Site

Five stations at the WLDS were sampled for sediment composition and benthic community structure in 2000 and 2001 (EPA, 2004). The selected stations represent a range of geographical areas relative to the placement site (active, historical, reference, farfield and no-impact). Historic data indicated that the WLDS is surrounded by many areas of sediment sorting and reworking. SPI images taken in 1996 showed the sediments to be predominantly fine-grained (greater than 4 phi). In the 2000 survey, three of the five stations showed primarily fine sediments, ranging from 70% to 89% fines in February and from 84% to 94% fines in July, while two stations were sandier. The active station (a location receiving dredged material) was 46% sand in February and 31% sand in July, while the reference station had a sand fraction of 70% in February and 55% in July.

The infaunal communities found within the WLDS alternative and its nearby reference site during the 2001 sediment characterization surveys were very similar. The number of infaunal animals within each area in July 2000 was relatively high, with about 23,000 individuals per square meter found within the alternative and about 25,000 individuals per square meter occurring within the reference area (Table 4-16). The average number of species found in the placement site samples was 36, and the average number of species found in the reference site samples was 45. These values were reflected in the moderately high Shannon-Wiener diversity (H′) values calculated for the WLDS samples (Table 4-16). Evenness values were moderately high in the alternative and at the reference station (0.7) (Table 4-16).

Table 4-16. Benthic Resources Present at the WLDS Alternative Site.

Environment	Alternative Type	Alternative ID	Infaunal Benthic Community Feature	Value	
				Alternative	Reference
Open-Water Environment	**Unconfined Open-Water Placement**	**WLDS[1]**	Average Abundance (per sample)	910 (~23,000/m^2)	1,002 (~25,000/m^2)
			Average Species (per sample)	36	45
			Average Diversity (H′)	3.6	3.9
			Average Evenness (J’)	0.7	0.7
			Five Most Abundant Taxa	*Nucula annulata* *Mediomastus ambiseta* *Ampharete finmarchica* *Macoma tenta* *Tharyx sp.* 1B	*Nucula annulata* *Ampharete finmarchica* *Mediomastus ambiseta* *Macoma tenta* *Tharyx sp.* 1B

Source: EPA (2004); sampled February and July 2000.

Three deposit feeders—the small clams *Nucula annulata* and *Macoma tenta* and the polychaete worm *Mediomastus ambiseta*—were the most abundant infaunal organisms among the WLDS samples (Table 4-16). Together they accounted for about 49% of the fauna identified from the alternative in July 2000 (EPA (2004) [Appendix H-1]). The average density of *N. annulata* across all WLDS samples collected in July 2000 was about 10,800 individuals per square meter. Other numerically important species were the tube-dwelling polychaete worm *Ampharete finmarchica* and the surface deposit feeding worm *Tharyx* sp. 1B. Dominant species at each site correlated with sediment grain size, with *N. annulata* being dominant at the stations that were predominantly fine-grained. At the sandier stations, *Mediomastus ambiseta* and *Macoma tenta* were dominant, while *N. annulata* was present in much smaller numbers.

Site monitoring for dredged material placement impacts and recovery as part of the DAMOS program (see Chapter 5 for further discussion of this program and its findings) shows that the benthic communities typically recover from material placement within a few years (ENSR, 2005c). Results of monitoring from 1990 to 2004 showed that, despite ongoing placement activity in the area, there was little to no apparent impact on the benthic community from these activities (ENSR, 2005c).

Central Long Island Sound Disposal Site

The CLDS alternative site is located in the eastern portion of the large depositional basin comprising much of the central area of Long Island Sound (Knebel & Poppe, 2000). Sediments at five of the six stations studied at this alternative in 2000 and 2001 were composed primarily of fine-grained sediments ranging from 82% to 91% fines in February and from 83% to 92% fines in July (EPA, 2004). The considerable variability in grain size seen at one of six stations over the same timeframe (32% to 72% fines) may illustrate the potential for heterogeneity in this area (EPA, 2004).

The infaunal communities found within CLDS and its nearby reference area during the sediment 2000 and 2001 characterization surveys shared several features (EPA, 2004). The number of infaunal animals within each area in July 2000 or 2001 was moderate, with about 10,000 to 17,000 individuals per square meter found within the alternative and about 16,000 individuals per square meter occurring within the reference area (Table 4-17). The average number of species found in the alternative site samples was 29 to 36; the average number of species found in the reference site samples was 27. The number of species at the reference site in July 2001 was slightly less than that found in July 2000. The resulting Shannon-Wiener diversity (H′) values calculated for the CLDS and reference samples were moderate, ranging from 3.0 to 3.6 (Table 4-17). Rarefaction analysis showed that species diversity among most of the alternative stations was very similar. However, diversity at the historic station N74 sampled in July 2001 was much higher than that at any other station. Diversity at the reference station in July 2000 and July 2001 was slightly lower than that at the other stations. Evenness values were moderate to moderately high in the alternative and at the reference station (0.6 to 0.7) (Table 4-17).

Table 4-17. Benthic Resources Present at the CLDS Alternative Site.

Environment	**Alternative Type**	**Alternative ID**	**Infaunal Benthic Community Feature**	**Value**	
				Alternative	**Reference**
Open-Water Environment	**Unconfined Open-Water Placement**	**CLDS[1]**	Average Abundance (per sample)	413–682 (~10,000–17,000/m^2)	640 (~16,000/m^2)
			Average Species (per sample)	29–36	27
			Average Diversity (H′)	3.0–3.6	3.1
			Average Evenness (J’)	0.6–0.7	0.7
			Five Most Abundant Taxa	*Levinsenia gracilis* *Nucula annulata* *Ampharete finmarchica* *Tharyx sp.* 1B *Mediomastus ambiseta*	*Levinsenia gracilis* *Nephtys incisa* *Nucula annulata* *Tharyx sp.* 1B *Sigambra tentaculata*

Source: EPA (2004); sampled February and July 2000.

The predominant species comprising the infaunal community within the boundaries of the alternative and at the reference locations were the small surface deposit-feeding worms *Levinsenia gracilis* and *Tharyx sp.* 1B and the small clam *Nucula annulata* (Table 4-17). Other polychaete worms were numerically common within the alternative (*Mediomastus ambiseta*, *Ampharete finmarchica*) or in the reference site (*Nephtys incisa*, *Sigambra tentaculata*). The clam *Nucula annulata* was abundant in July 2000, attaining a density of about 4,800 individuals per square meter and accounting for about 34% of the identified infaunal animals (EPA, 2004). However, the species was considerably less abundant at the stations sampled in July 2001, occurring at a density of about 250 individuals per square meter and accounting for about 3% of the identified animals (EPA, 2004). Similar marked changes in abundance between the two years has been noticed previously for other infaunal animals in Long Island Sound (McCall, 1978).

In addition to the 1999 SPI survey which supported the Long Island Sound EIS (SAIC, 2002), the DAMOS program has collected SPI data at CLDS several times since the 2000/2001 benthic community surveys described above. DAMOS conducted SPI surveys at the CLDS site in 2003 (ENSR, 2004), in 2004 (ENSR, 2005d), and in 2009 (Valente, Carey, Read, & Esten, 2012). Each analysis concluded that the benthic habitats within and near the alternative were generally recovering as expected, given the timing of recent sediment placement events.

Cornfield Shoals Disposal Site

The CSDS, located in eastern Long Island Sound, is managed by USACE as dispersive (non-depositional) placement site. Material is expected to leave the site; no attempt is made to create stable mounds at CSDS. While CSDS is monitored to track sediment transport and remobilization following placement of dredged material, benthic community and SPI surveys are not typically conducted. Characteristics of the benthic community in the eastern basin, as described above, pertain to the community expected at Cornfield Shoals.

New London Disposal Site

Dredged material placement in the vicinity of New London, Connecticut, has taken place since 1955. Currently, the NLDS is used for the unconfined placement of sediments suitable for open-water placement, as well as the subaqueous capping of sediments deemed unsuitable for open-water placement without management action. The U.S. Navy conducted an initial comprehensive study of New London in 1973. Under the DAMOS Program, NLDS has been monitored periodically to assess the stability and thickness of dredged material and benthic recolonization status relative to previous survey results and in comparison to nearby references areas.

A 2007 NLDS survey (AECOM, 2009) was conducted eight months after the last recorded dredged material placement activity; this provided ample time for recolonization of the new mound. As expected, the Apparent Color Redox Potential Discontinuity (RPD) layer depths at the new mound were significantly shallower than reference area values. The average depth of the apparent RPD at the reference stations ranged from 0.5 inch to 1.5 inches during the 2007 DAMOS survey (AECOM, 2009), with an overall average of 0.9 inch. However, all stations had advanced stages of recolonization with extensive burrowing and feeding voids present. In contrast, the reference area stations showed benthic assemblages in the late stages of colonization (stage 2 or 3) with evidence of deposit feeding activity.

Infaunal density and bioturbational activity at New London was moderate at the recently formed mounds, and quite typical for the response one year after placement ceased. Recolonization at the older mounds had continued as expected, with mature stage three communities found at almost every station on the older mounds. The infaunal community at each of the older mounds was considered to be fully recovered, with habitat conditions similar to those found at the reference stations.

As seen at WLDS and CLDS, benthic communities at New London appear to recover from material placement within a few years.

Confined Open-Water Placement

Benthic infaunal communities at the Site E alternative (Sherwood Island Borrow Pit) could be expected to be similar to other open-water sites. Site-specific assessments of benthic communities may be required during project-specific NEPA assessments. Recovery at Site E may depend partly on the type of material used for capping as well as the time frame for use of site.

4.8.3 Nearshore/Shoreline Environment

Benthic infauna are likely present in all subtidal and intertidal areas associated with potential nearshore and shoreline placement sites. Site-specific assessments of benthic communities may be required during project-specific NEPA assessments.

Confined Placement

There are 17 confined placement alternative sites. Benthic infauna that occurs on sandy beaches or coastal marshes may be found in these areas or adjacent to the areas proposed as shoreline CDFs.

Beneficial Use

Nearshore Bar/Berm Placement

There are 39 total nearshore bar/berm placement alternative sites. Benthic infauna that occurs in these subtidal areas may be found at or adjacent to these locations.

Beach Nourishment

There are 67 total beach renourishment alternative sites. If a beach location were to be identified within the study area, the presence of benthic infauna would need to be investigated at that time.

4.8.4 Upland Environment

Benthic resources are not applicable to the upland alternative sites.

4.9 COMMERCIAL AND RECREATIONAL SHELLFISH RESOURCES

4.9.1 General Long Island Sound Setting

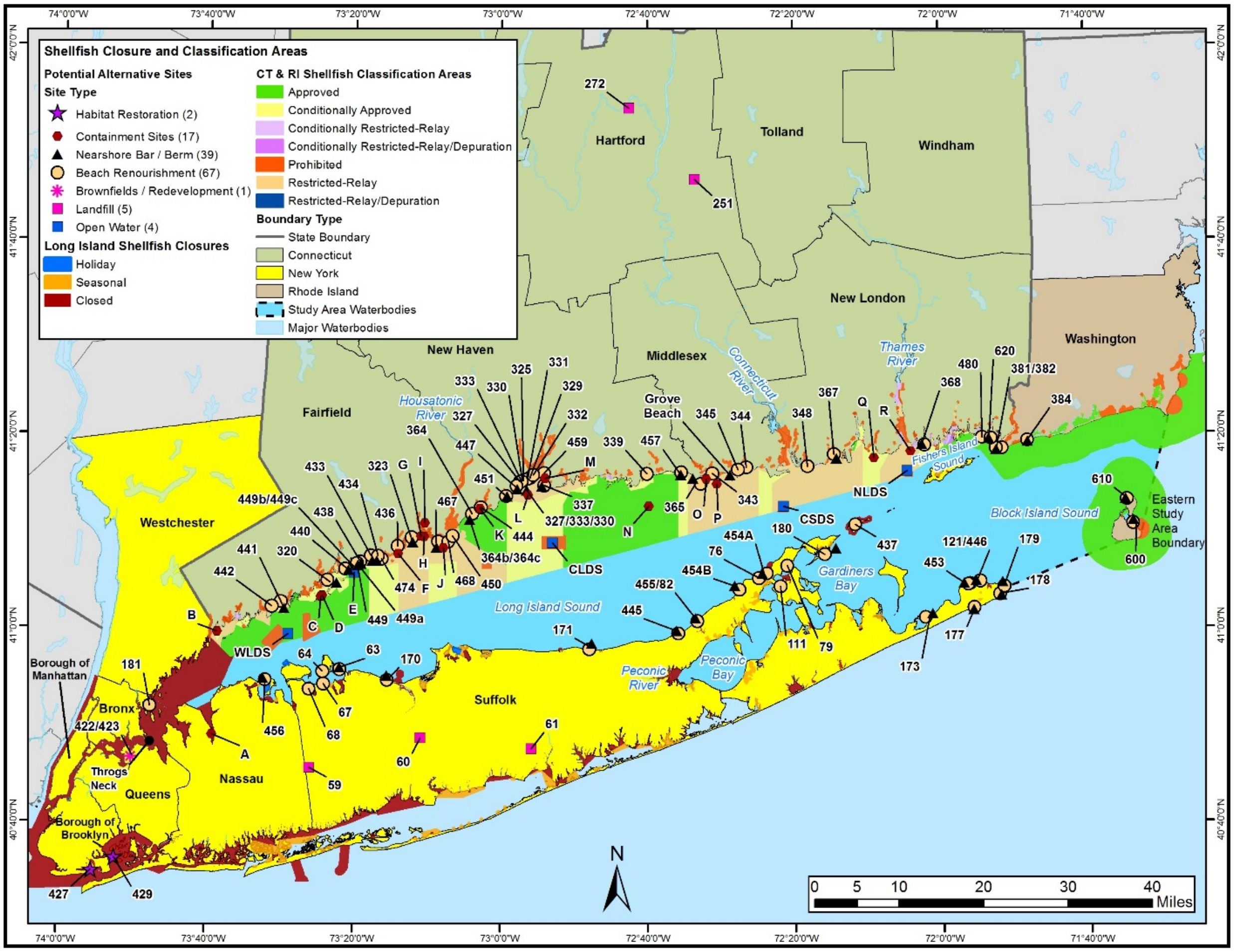
Several commercially harvestable shellfish species occur throughout the study area, including American lobster, eastern oyster, bay scallop, blue crab, northern quahog/hard clam, softshell clam, surfclam, blue mussel, horseshoe crab, channeled whelk, and knobbed whelk. State and local authorities regulate harvesting of these marine shellfish based on stock assessments, management goals, and health regulations using lease agreements, harvesting seasons, and licenses (Figure 4-31). There is no essential fish habitat (EFH) for invertebrate species currently identified within the project area. Smaller, marine infaunal invertebrates that occur in the study area, but are not commercially fished, are discussed in Section 4.8 (Benthic Resources), and squid, which are free-swimming invertebrates, are discussed in Section 4.10 (Fish).

This section summarizes the status of the principal commercial and recreational shellfish resources within the study area. Key factors likely influencing the long-term population trends of these resources are also discussed. Table 4-18 provides general information on the life stages and distribution of the highlighted species present in the study area, the habitat where the species are generally found, and the preferred food sources.

American lobster

The American lobster occurs from Cape Hatteras to Labrador and is found in habitats ranging from shallow coastal waters to depths of up to 2,300 ft (Idoine, 2000). Over their geographical range, lobsters are found primarily in rocky areas of coastal waters; however, in the project area they may be locally abundant in muddy areas where they can create burrows (Idoine, 2000). On average, lobsters attain the legal harvesting size of 3.3 inches (carapace length) in 5 to 8 years in Long Island Sound. Lobsters feed on a variety of foods, including fish and benthic invertebrates such as crabs, sea stars, worms, and sea urchins.

In coastal waters such as those occurring in Long Island Sound, inshore lobsters are thought to move only in localized areas during their lifetime (MacKenzie & Moring, 1985). Lobsters in the Western and Central Basin typically remain in Long Island Sound waters, whereas Eastern Basin populations typically migrate through “the Race” and can be found in offshore locations for part of the year (Balcom & Howell, 2006). There has been a shift in lobster distribution in the Central and Western Basins of Long Island Sound based on information collected during recent CTDEEP trawl surveys (CTDEEP, 2012d). At sites with muddy bottom sediment, which is a preferred habitat for lobster in this area, catches have shifted from shallow inshore waters to deeper mid-Sound waters. It is speculated that the loss of optimal nearshore habitat due to oceanic warming trends has forced lobsters to move to deeper waters (Latimer, et al., 2014).



Source: EPA (2004).

Figure 4-31. Shellfish Closure and Classification Areas.

Table 4-18. Life Stages Present in Study Area, Habitat, Food, and Distribution of the Predominant Shellfish Species Present in the Study Area.

Species	Life Stages Present in the Study Area	Habitat	Water Depth	Preferred Food	Potential Environmental Stressors	Distribution in Study Area
American lobster (*Homarus americanus*)	Larvae	Water column	Intertidal zone to 2,300 ft	Plankton	Temperature, salinity, DO, pathogens	Potentially throughout salt water study area; temperature, salinity and DO all potentially limiting
	Juvenile/Adult	Rocky coastal areas; muddy habitats for burrowing; offshore canyons		Fish, crustaceans, echinoderms, polychaetes		Potentially throughout the salt water study area
Eastern oyster (*Crassostrea virginica*)	All life stages. Spawning in June/July.	Attached to natural or artificial hard substrates at or below tide level	8 to 35 ft.	Filter feed for phytoplankton, zooplankton, bacteria, detritus	Salinity, pH, dCO_2, pathogens	CT waters: Occur in nearshore waters. Low to high abundance in parts of Western and Central Basins. NY waters: low abundance in coastal embayments in Western Basin; medium abundance nearshore in Central Basin.
Bay scallop *(Argopecten irradians)*	All life stages. Spawning in June/July and settlement within 14 days.	Eggs: eelgrass beds preferred; Adults: sandy and muddy bottoms; offshore in shallow to moderately deep water, such as bays and harbors	Most abundant 1-2 ft (at low tide) but found to depths of 33 ft.	Filter feed for phytoplankton and zooplankton	Temperature/ salinity interactions, pH, turbidity, lack of settling substrate for juveniles; nutrients/ pathogen interactions, dCO_2	Nearshore waters for nursery habitat; small bays and harbors of Peconic Bay on the eastern end of Long Island and also found in Great South Bay, Moriches Bay, and Shinnecock Bay

Table 4-18. Life Stages Present in Study Area, Habitat, Food, and Distribution of the Predominant Shellfish Species Present in the Study Area (continued).

Species	Life Stages Present in the Study Area	Habitat	Water Depth	Preferred Food	Potential Environmental Stressors	Distribution in Study Area
Blue crab (*Callinectes sapidus*)	All life stages.	Prefer areas with natural cover, such as submerged aquatic vegetation, marshes, and soft-sediments, but can be found on any substrate and are highly tolerant of temperature and salinity variations.	Up to 120 ft, but may migrate deeper in winter.	Omnivore, eating both plants and animals, such as thin-shelled bivalves, annelids, small fish, plants, carrion, and animal waste		Bottom-dweller of both fresh and salt water habitats, especially common in estuaries. Habitat ranges from the low tide line to waters 120 ft deep. Females remain in higher salinity portions of an estuary system, especially for egg laying.
Northern quahog/ hard clam (*Mercenaria mercenaria)*	All life stages.	Sandy or muddy sediments	Intertidal zone to 50 ft.	Filter feed for phytoplankton, zooplankton, bacteria, detritus	DO, dCO_2, salinity, turbidity, substrate	CT waters: Occur up to 2 nmi offshore and in water <50 ft deep. NY waters: Abundant close to shore in part of the Western Basin and most of the Central Basin. Rarely found at the alternative sites.
Softshell clam (*Mya arenaria)*	All life stages.	Prefer multi-habitats, including clay, mud, sand, and gravel	Intertidal zone to a depth of 20 ft.	Filter feed for phytoplankton, zooplankton, bacteria, detritus	DO, dCO_2, salinity, turbidity, substrate	CT waters: medium abundance at a few sites in the Western and Central Basins, otherwise low in relative abundance. NY waters: abundant only in nearshore waters in Western Basin. Medium abundance in Central Basin.

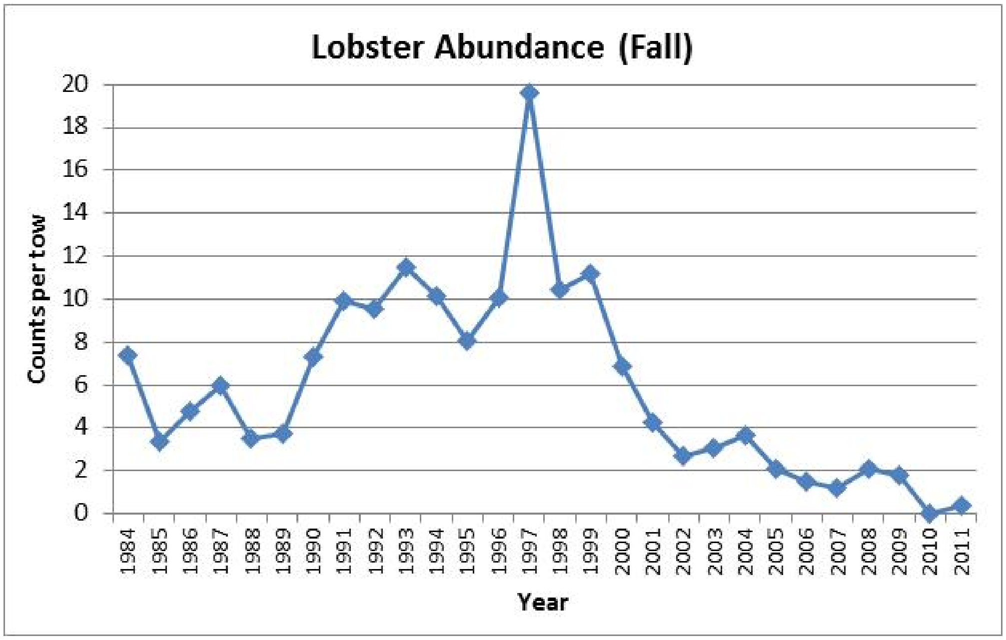
Table 4-18. Life Stages Present in Study Area, Habitat, Food, and Distribution of the Predominant Shellfish Species Present in the Study Area (continued).

Species	Life Stages Present in the Study Area	Habitat	Water Depth	Preferred Food	Potential Environmental Stressors	Distribution in Study Area
Atlantic surf clam (*Spisula solidissima)*	All life stages.	Shallow, subtidal areas with coarse sediments.	Most common in surf zone to <240 ft	Filter feed for phytoplankton, zooplankton, bacteria, detritus	DO, dCO_2, salinity, turbidity, nutrients	CT waters: no abundance data. NY waters: occur in medium abundance along north shore of Long Island.
Blue mussel (*Mytilus edulis*)	All life stages.	Attached to rocks, pilings and other solid objects; intertidal and shallow subtidal	Attached to rocks, pilings and other solid objects	Filter feeder	Salinity change, dCO_2, H_2S/ DO interaction	Throughout Long Island Sound attaching to hard surfaces with its byssal threads
Horseshoe crab (*Limulus polyphemus*)	All life stages. Spawn in May/June. Hatchlings emerge two weeks later. Sexual maturity is reached a decade later.	Live primarily in and around shallow ocean waters on soft sandy or muddy bottoms. Occasionally come onto shore in May and June to mate.	Prefer depths <100 ft, but may be found up to 650 ft	Worms, mollusks, crustaceans, small fish	DO, spawning/ nursery habitat	Live year round in Long Island Sound with higher abundances in the western part of the Sound compared to the eastern Sound and Peconic Bay.
Channeled whelk (*Busycon canaliculatum*)	All life stages.	Shallow, intertidal to continental slope; sandy or muddy sediments	Intertidal zone to 150 ft	Carnivore feeding on dead fish, gastropods, annelids, and bivalves	Salinity	Throughout Long Island Sound
Knobbed whelk (*Busycon carica*)	All life stages.	Shallow, intertidal to continental slope; sandy or muddy sediments	Intertidal zone to 150 ft	Carnivore feeding on dead fish, gastropods, annelids, and bivalves	Salinity	Throughout Long Island Sound

Sources: EPA (2004), EPA and USACE (2004).

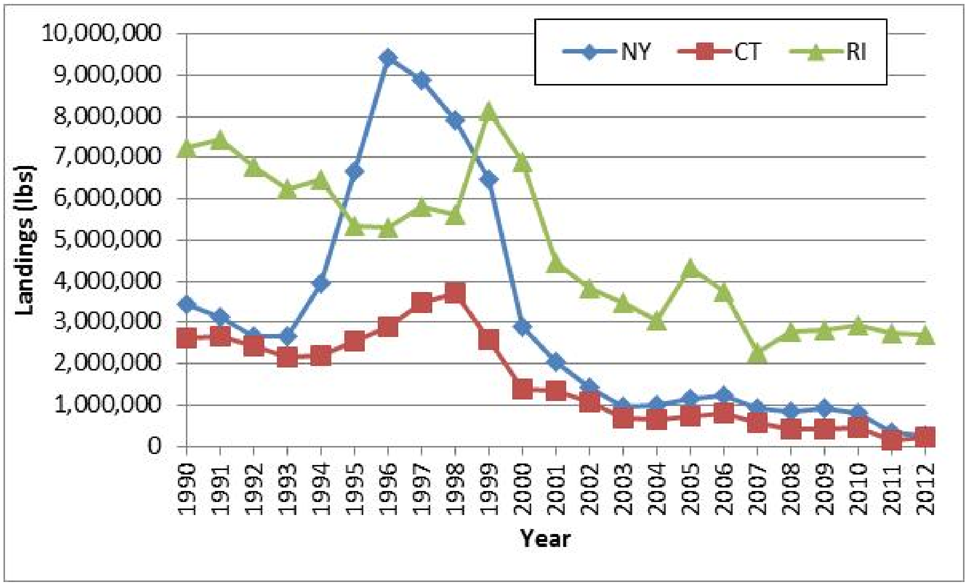
DO = dissolved oxygen
dCO_2 = dissolved carbon dioxide
H_2S = hydrogen sulfide

The fishing pressure on lobster in Long Island Sound is tremendous. The fishery is believed to capture 90% of the lobsters larger than the legal limit each year (Landers, et al., 2001). The CTDEEP Long Island Sound Trawl Survey uses a standardized catch (i.e., number or weight collected per survey tow) of lobsters to assess the relative abundance of the local stock (EPA, 2014d). The NMFS also provides a summary of annual landings data for the commercial fishery in Long Island Sound (NOAA, 2014d), which is particularly useful in understanding the economic benefit of the Long Island Sound fishery (see Section 4.19). The annual trawl survey data provide a more accurate representation of year-to-year variability and population trends of lobsters in Long Island Sound compared to the NMFS data because landings are influenced by gear type, annual fishing effort, and socioeconomic factors such as market price that can vary from year to year. Standardized lobster catch data (i.e., the average number of lobsters captured in a survey tow) for the Long Island Sound Trawl Survey (CTDEEP, 2013c) from 1984 to 2011 show an abundance peak in 1997 (Figure 4-32). This peak was followed by a steady decline in the standardized catch since 1999, when American lobsters in western and central Long Island Sound (in both Connecticut and New York waters) experienced a significant mortality event. Commercial landings data for New York, Connecticut, and Rhode Island (Figure 4-33) are generally consistent with the survey data (timing differences are likely attributable to among-year variation in fishing effort and areas targeted).



Source: CTDEEP (2013c).

Figure 4-32. Fall Lobster Abundance, 1984 – 2011.



Source: NOAA (2014e).

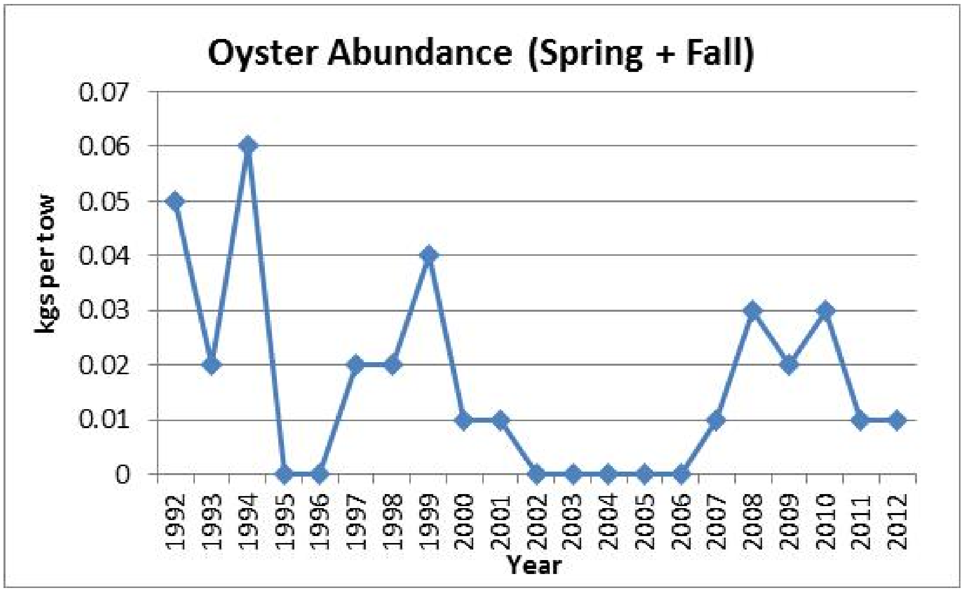
Figure 4-33. NMFS Commercial Landings Data for the American Lobster.

Although warming water temperatures (Dove, et al., 2005), (Howell, et al., 2005) and seasonal anoxia (Cuomo, et al., 2005), (Draxler, et al., 2005) in western Long Island Sound have been proposed as the primary causes of lobster population decline, other environmental factors such as disease and contaminants have also been proposed as contributing. Following the 1999 mass mortality event, a collaborative research initiative including nearly 60 researchers was funded to investigate the effects of environmental factors, mosquito control pesticides and diseases on the physiology and health of the American lobster. In addition to the habitat-related stressors (Valente & Cuomo, 2005), the involvement of a parasitic amoeba (Mullen, et al., 2004) was also potentially implicated in the 1999 mass mortality event. General climate change (e.g., (Rowley, et al., 2014), habitat structure and predation refugia for early life stages (e.g., (Johns & Mann, 1987); (Wahle & Steneck, 1992)), and other pathogens, especially epizootic shell disease or ESD (Cobb & Castro, 2006); (Castro, et al., 2012); (Shields, 2011); (Shields, 2012)) have also been considered potential factors limiting the Long Island Sound lobster population recovery. Although the potential impacts of alkyphenols (Jacobs, et al., 2012), metals (Leblanc & Prince, 2012) and increased pesticide runoff associated with the West Nile virus response (Miller, et al., 2005), (Zulkosky , et al., 2005) have also been evaluated, existing literature does not support a strong role for environmental contaminants in explaining either the 1999 event or the subsequent lack of recovery (Castro, et al., 2012).

The collaborative research study concluded that "the physiology of the lobsters was severely stressed by sustained, hostile environmental conditions, driven by above average water temperatures" in Long Island Sound (Balcom & Howell, 2006). Weakened by exposure to elevated temperatures, lobsters became susceptible to other stressors, including shell disease and contaminants such as pesticides. The complex interaction of multiple stressors (Glenn & Pugh, 2006); (Pearce & Balcom, 2005); (Robohm, et al., 2005); (Shields, 2013) interacted to cause the ongoing Long Island Sound lobster population recruitment failure. The warmer water temperatures documented in Long Island Sound that are believed to have been a primary initiator of the 1999 lobster mortality event are consistent with the significant increase in global sea temperatures measured over the past 30 years (IPCC, 2014) as well as trend data collected at the Millstone Power Station located in Watertown, Connecticut (Latimer, et al., 2014). Global warming trends are anticipated to interact with additional natural and anthropogenic influences, particularly in coastal estuarine areas (e.g., hypoxia is exacerbated by climate-driven ocean warming effects, which decreases oxygen solubility in seawater) (IPCC, 2014). It should be noted that while fishing pressure had been building for at least two decades (e.g., the 300% increase in New York landings between 1993 and 1996 in Figure 4-33) before the start of the precipitous decline in 1999 (Balcom & Howell, 2006), there is no direct evidence implicating the commercial lobster harvest itself on the collapse of this fishery (Wahle, et al., 2009).

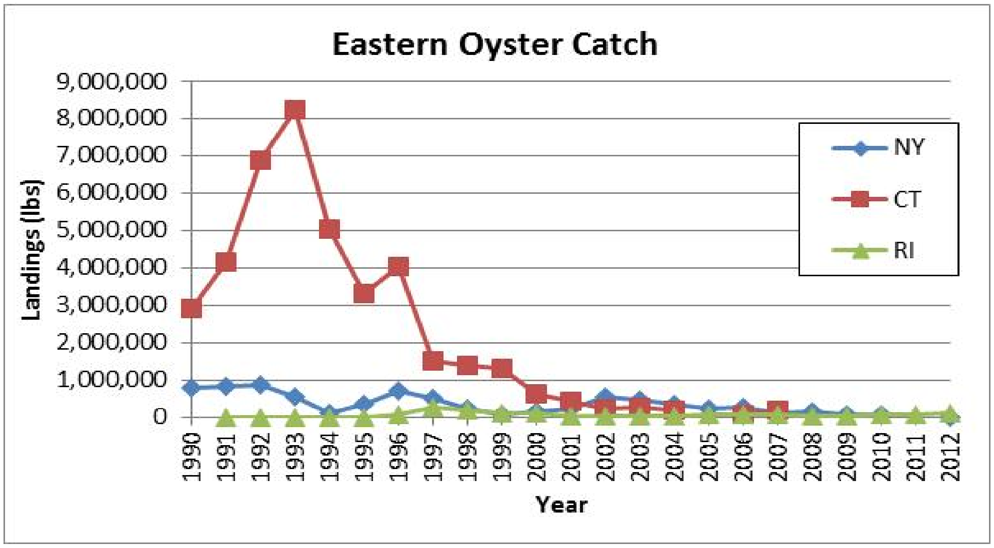
Eastern oyster

The eastern oyster ranges from the Gulf of St. Lawrence to the Gulf of Mexico. Adults can grow on either hard or any muddy substrate capable of supporting colony weight. Although oysters can occur at depths of up to 100 ft, they prefer shallow depths (less than 10 ft) where they filter planktonic organisms from the water column. The Long Island Sound oyster harvest peaked in the early 1990s; by 1997, the population began to experience high mortality attributable to a parasitic disease caused by *Haplosporidium nelsoni* and referred to as Multinucleated Sphere X. Supported by state-regulated oyster farming operations, some recovery has been observed since 2000; however, the Long Island Sound oyster populations are no longer self-sustaining (NOAA, 2007). Standardized catch data for the eastern oyster obtained from the CTDEEP annual surveys (1992 to 2012) are presented in Figure 4-34; the NMFS commercial landings data for the period between 1990 and 2012 are presented in Figure 4-35. Both datasets demonstrate the long-term trends in this fishery, although the recent population recovery suggested in the survey data is not apparent in the landings data. As discussed above, this discrepancy is likely due to factors such as price and harvest effort; moreover, a lag period between population rebound and commercial activity is expected. In addition, harvest statistics for Connecticut were under-reported between 2008 and 2010 and have not been available since then.



Source: CTDEEP (2013c).

Figure 4-34. Eastern Oyster Abundance, 1992 – 2012.



Source: NOAA (2014e).

Figure 4-35. NMFS Commercial Landings Data for the Eastern Oyster.

Additional stressors are related to global climate change, including warmer ocean temperatures and elevated acidity that “can alter the distributions of oysters, their predators, competitors and associated diseases especially at extreme distribution or tolerance limits” (NOAA, 2007). Cooperative efforts to improve habitats and stock disease-resistant oysters are under way to help the oyster fishery recover (EPA, 2013a), and increased harvests have been reported since production was impacted by the sediment smothering of oyster beds caused by Tropical Storm Irene in 2011 (Munroe, et al., 2013).

Bay scallop

The bay scallop ranges from Cape Cod to the Gulf of Mexico; East Coast populations support a large U.S. fishery. Preferred habitat includes shallow protected coastal bays and estuaries with sandy and muddy bottoms and eelgrass beds. Although found at depths ranging from 1 to 30 ft, bay scallops are typically most abundant in tidal flats with 1 to 2 ft of water at low tide. In New York, they are mostly found in small bays and harbors of Peconic Bay on the eastern end of Long Island and in Great South Bay, Moriches Bay, and Shinnecock Bay.

The bay scallop fishery has decreased since the 1950s as a result of loss of sea grass habitat, which provides structural habitat for bay scallop spat. Although adult scallops are free-living, juvenile bay scallops require a stable substrate (e.g., stones, seaweed for attachment). In addition to habitat-related stressors, scallops are known to be susceptible to increased nutrient loadings, particularly nitrogen.

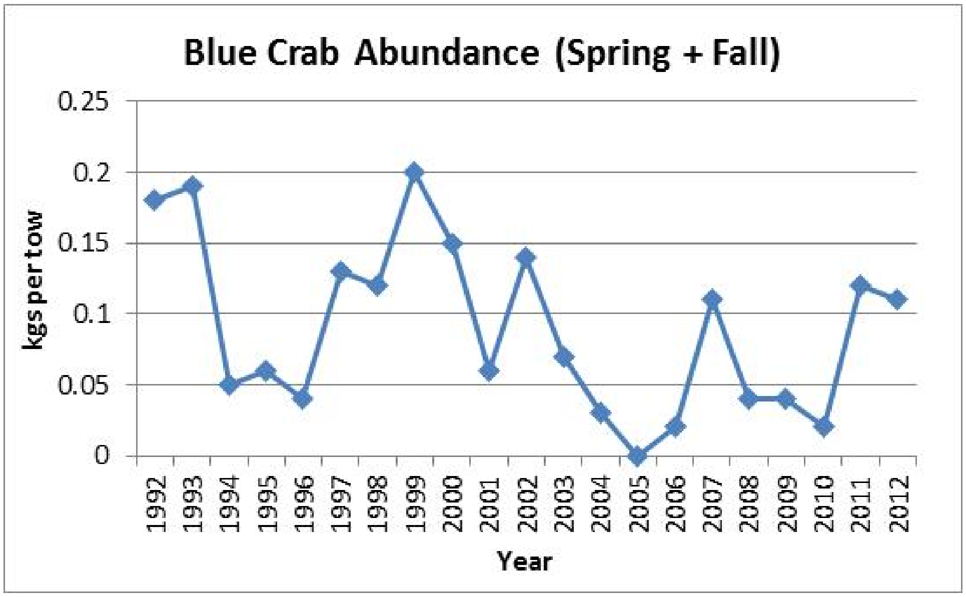
Bay scallops grow to approximately 3 to 3.5 inches in length and live to two years of age (NYSDEC, 2014a). Standardized survey abundance data are not available for the bay scallop. The available NMFS commercial landings data (primarily New York) show a relatively limited bay scallop catch between 1990 and 2012, with the notable exception of two peak harvest years in 1994 and 2010.

Blue crab

The blue crab is found along the western edge of the Atlantic Ocean from Nova Scotia to Argentina, including the entire coast of the Gulf of Mexico. The blue crab can be found on any substrate and is highly tolerant of temperature and salinity variations. Peak abundances occur in estuaries, but adult females disperse to higher salinity areas to spawn each year. Blue crabs are omnivorous, feeding on thin-shelled bivalves, crabs (including juvenile blue crabs), annelids, small fish, plants, carrion, and animal waste. Because of its commercial and environmental value, the blue crab fishery is managed over much of the species range, including the study area.

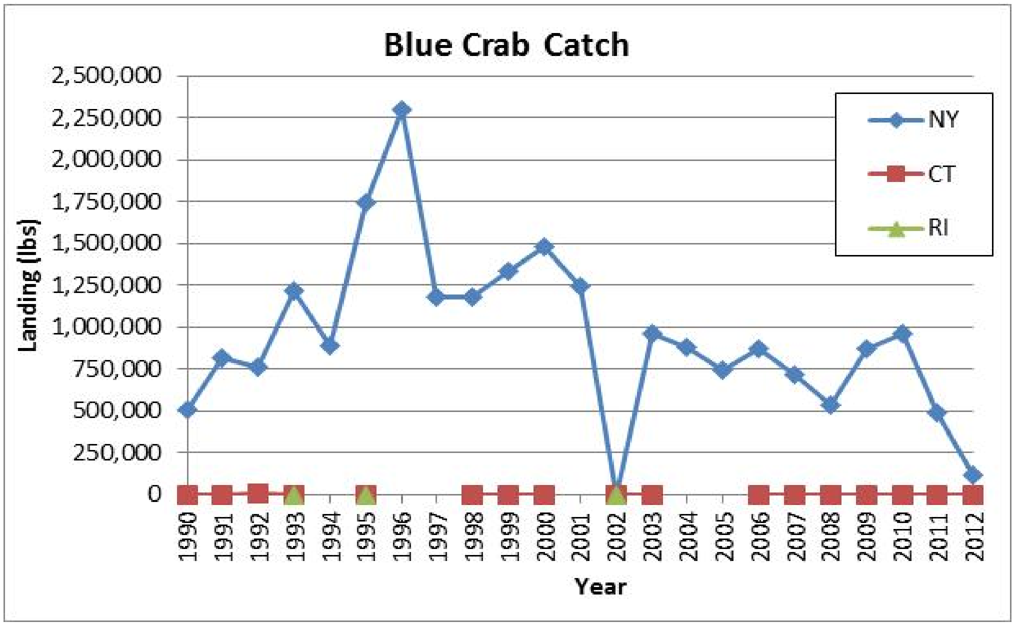
Standardized blue crab catch data (combined spring and fall surveys) for the Long Island Sound Trawl Surveys (CTDEEP, 2013c) conducted between 1992 and 2012 are shown in Figure 4-36. The data are standardized to the number of tows conducted during the survey year, which varied from 78 to 200. For this period, the standardized catch data peaked in 1999 and then generally declined with considerable variability through 2010. Standardized catches for 2011 and 2012 suggest a recent upward trend in population abundance.

The NMFS commercial landings data for blue crab from 1990 to 2012 are presented in Figure 4-37. Although available landings data for Connecticut and Rhode Island are incomplete, the annual harvest in these two states appears to be much lower than in New York. However, it is difficult to identify specific locations for individual shellfish species capture because the catch landed in Long Island Sound ports does not necessarily mean the shellfish were caught within its waters (and vice-versa) (Latimer, et al., 2014). Generally consistent with the CTDEEP trawl data, the NMFS catch data demonstrate a long-term decline in the Long Island Sound blue crab fishery since peaking in 1996.



Source: CTDEEP (2013c).

Figure 4-36. Blue Crab Abundance, 1992 – 2012.



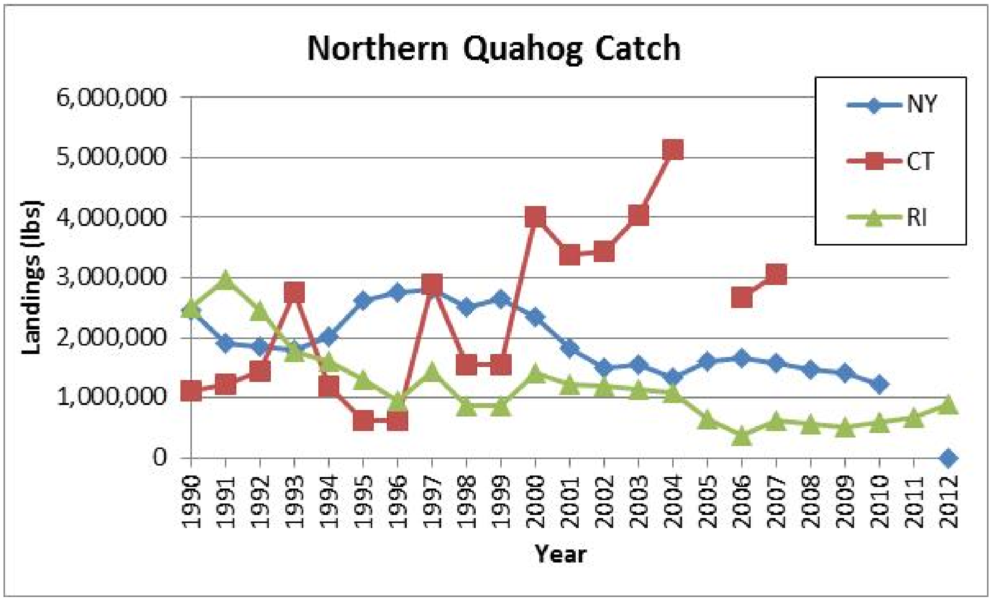
Source: NOAA (2014e)

Figure 4-37. NMFS Commercial Landings Data for the Blue Crab.

Northern quahog/hard clam

The northern quahog/hard clam ranges from the Gulf of St. Lawrence to the Gulf of Mexico. It generally occurs only along shallow coastlines and in estuaries and rivers ranging from the intertidal zone to depths exceeding 50 ft (FAO, 2014). Northern quahog populations are found on a variety of bottom substrate types, including sand, mud, and cobble. The quahog filters plankton and microorganisms being carried in bottom currents for nourishment. Hard clams live in a variety of subsurface environments but prefer sediments that are a mixture of sand and mud with some coarse material.

The overall northern quahog harvest has more than tripled in the past decade, in part because some lobster fishermen have turned to clamming as lobster harvests have declined (EPA, 2014e). Connecticut harvest information for the period 1990 through 2007 shows that the annual hard clam harvest increased three- to four-fold through 2004 (Figure 4-38). NMFS landings data for New York and Rhode Island indicate a long-term decline in annual harvest of hard clams. However, this apparent decline may be due in part to New York clammers landing their catch outside of New York (EPA, 2014e).

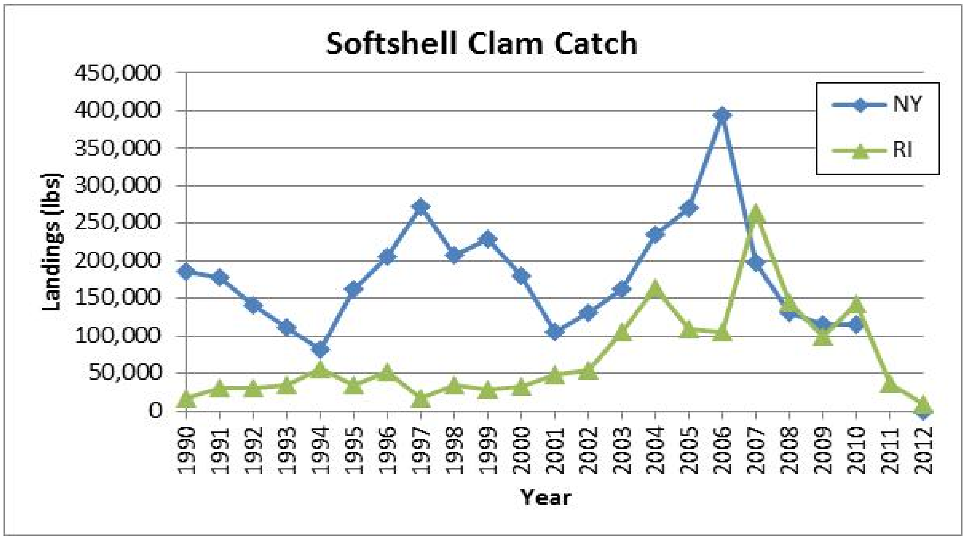


Source: NOAA (2014e)

Figure 4-38. NMFS Commercial Landings Data for the Northern Quahog.

Softshell clam

Softshell clams are distributed along the Atlantic coast from Canada to Florida. Although known to occur in subtidal habitat to depths of 600 ft, this species is most abundant in intertidal mudflats in shallow embayments up to a water depth of approximately 20 ft. New York and Rhode Island have similar trends in commercial landings data, with increases in softshell clam landings from 2001 to 2006 (New York) and 2007 (Rhode Island) followed by a steady decline to 2012 (Figure 4-39). Commercial landings data are not available for Connecticut.



Source: NOAA (2014e).

Figure 4-39. NMFS Commercial Landings Data for the Softshell Clam.

Atlantic surf clam

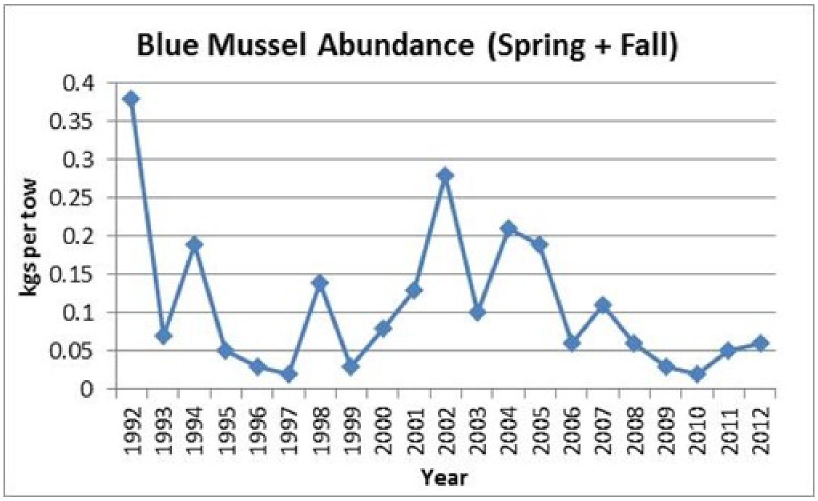
The Atlantic surf clam inhabits sandy continental shelf habitats from the southern Gulf of St. Lawrence to Cape Hatteras, North Carolina (Cargnelli, et al., 1999). Atlantic surf clams are planktivorous filter feeders that pump water through their siphons over the gills to trap food. The largest concentrations of Atlantic surf clams usually occur in well-sorted, medium sand, but the species may also occur in fine sand and silty-fine sand. Areas of coarse grain size (i.e., pebbles or cobbles) are virtually devoid of surf clams (Murawski, 1979). Atlantic surf clams inhabit waters from the surf zone to a depth of 420 ft but are more common at depths less than 240 ft.

Commercial landings data are not available for Connecticut, and only two years of data (2004 and 2010) are available for Rhode Island. In New York, the Atlantic surf clam landings data are variable, with peak landings in 1993 and 2003. Since 2005, the annual New York harvest has steadily declined.

Blue mussel

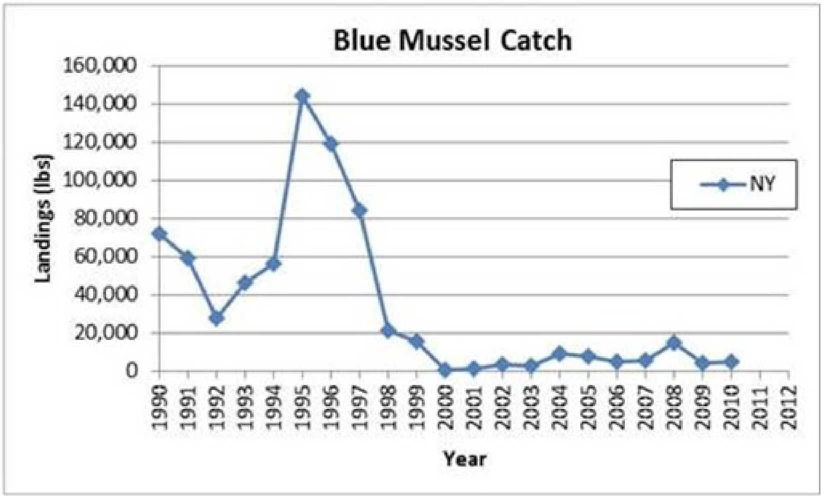
The blue mussel occurs throughout coastal environments in the northern hemisphere and ranges from Labrador to Cape Hatteras along the eastern coastline of North America. Although reported occurring to depths of 1,500 ft, blue mussels are most abundant in intertidal and shallow, subtidal areas and on wave-exposed shores; they often dominate within the mid-intertidal zone (Latimer, et al., 2014).

The species is harvested (both wild harvesting and aquaculture) commercially from Maine to Long Island, New York (MEDMR, 2014). Standardized catch data obtained from the CTDEEP annual surveys (spring and fall combined) are presented in Figure 4-40. Average biomass per tow in the surveys was highest in 1992, variable throughout the 1990s, and, after some relatively strong years between 2002 and 2005, has been trending downward. Commercial landings data for New York are available for the period 1990 to 2010; landings peaked in 1995 and decreased by 99% by 2000 (Figure 4-41). Landings have been variable and low (relative to the peak) since 2010. There are no commercial landings data for Connecticut. Four years of data for Rhode Island show that blue mussel landings increased from 2009 to 2010 and then steeply declined in 2012 (Figure 4-42).



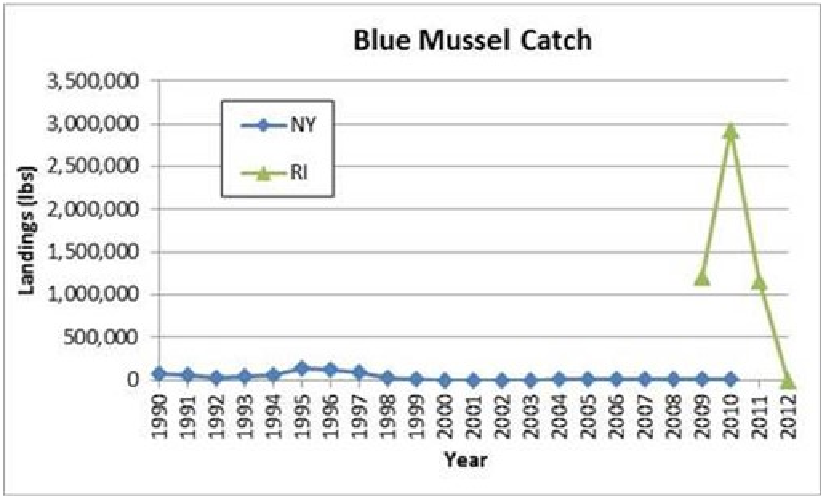
Source: CTDEEP (2013c)

Figure 4-40. Blue Mussel Abundance, 1992 – 2012.



Source: NOAA (2014e).

Figure 4-41. Blue Mussel Landings, New York, 1990 – 2010.



Source: NOAA (2014e).

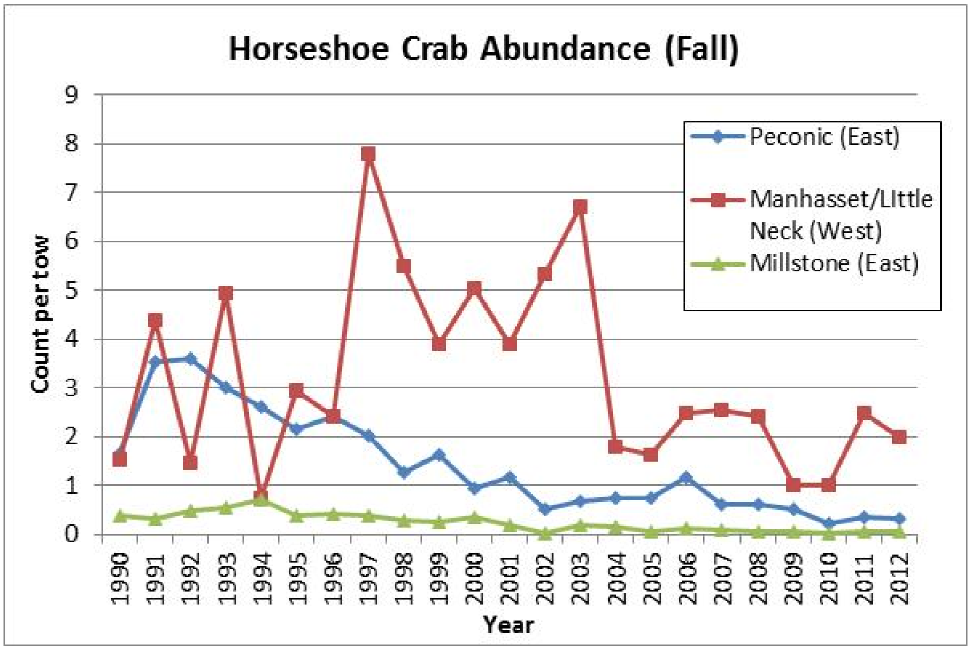
Figure 4-42. Blue Mussel Landings, Rhode Island, 2008 – 2012.

Horseshoe crab

Horseshoe crabs are found from Nova Scotia to Mexico. They are year-round residents in Long Island Sound. Although the animals have been found at depths greater than 650 ft, adults appear to prefer depths of less than 100 ft. They are usually found on the ocean floor searching for worms and mollusks, which are their main food, but they may also feed on crustaceans and even small fish. During the breeding season, horseshoe crabs migrate to shallow coastal water areas adjacent to spawning beaches and feed on bivalves. Spawning adults prefer sandy beach areas within protected bays (which provide optimal spawning habitat) and coves (which provide nursery habitat).

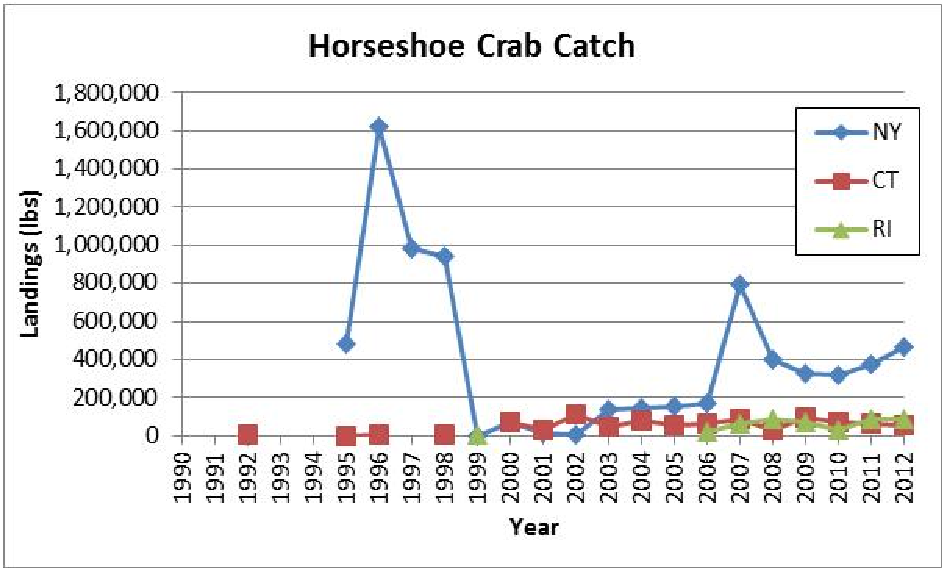
The blood of the horseshoe crab is harvested from living specimens to make *Limulus* amebocyte lysate, which is used to detect bacterial endotoxins in medical applications. Horseshoe crabs are also used as bait to fish for eels and whelk. The protein-rich horseshoe crab eggs are fed upon by migratory shorebirds. Reduced horseshoe crab abundance in New Jersey and Delaware Bay has been implicated in the steep decline in species such as the Red knot, which rely on this protein-rich resource on their annual circumpolar migrations. As a result, adaptive-management plans are being developed to regulate horseshoe crab harvests and protect migrating shorebirds.

CTDEEP trawl surveys collected data on horseshoe crabs in Long Island Sound from 1984 through 2012. Figure 4-43 shows standardized abundance data (counts/tow) for Peconic, Manhasset/Little Neck and Millstone sites from 1990 to 2012. The CTDEEP data are variable, with standardized data generally increasing to a peak in 2003 and subsequent data leveling off to about 50% of the peak abundance. Standardized data for the Millstone site exhibits a peak in 1995, followed by a gradual decline; recent data suggest that horseshoe crabs are less common in the vicinity of Millstone compared to historical conditions. For the New York dataset, standardized counts for the Peconic area (also located in the eastern portion of Long Island Sound) are similar to those for Millstone (early peak followed by gradual decline to relatively low numbers); however, relative abundances are higher by a factor of 10 or so. Results for Manhasset and Little Neck are quite variable, with peak counts/tow occurring in 1997 and 2003; since 2005, standardized results appear to have leveled off with counts (per tow) that are 25% to 35% of the peak values. NMFS commercial horseshoe crab landings data (lbs) from New York show variable abundance from 1992 to 2012, with an overall peak in 1996 followed by a precipitous decline to a low in 1999. Since 2000, the landings data have exhibited an upward trend with a secondary peak in 2007 (Figure 4-44). In Connecticut, commercial horseshoe crab landings increased from a low in 1995 to a peak in 2002; since then, landings have been variable, averaging 50% to 60% of the peak value (Figure 4-44). Commercial landings data in Rhode Island are available only for 1999 and from 2006 to 2012. With the exception of the low value in 1999, the Rhode Island horseshoe crab landings are comparable in terms of variability and magnitude to the Connecticut results. As noted previously, landings data are important tools for fishery management of the species, but they are difficult to determine exactly where the catch was collected within Long Island Sound and the study area (Latimer, et al., 2014).



Source: CTDEEP (2013c).

Figure 4-43. Horseshoe Crab Biomass in Long Island Sound, 1990 to 2012.



Source: NOAA (2014e).

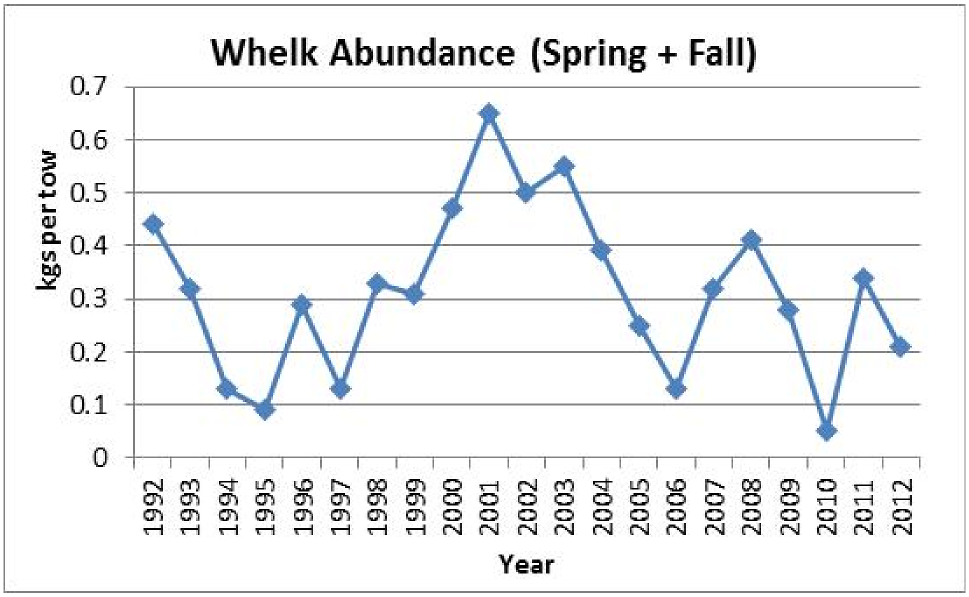
Figure 4-44. NMFS Commercial Landings Data for the Horseshoe Crab.

Channeled and knobbed whelk

Conchs, including the channeled whelk and knobbed whelk, are generally found in the colder waters of southern New England, including Long Island Sound. These species may be found in various bottom habitat types, but are most common on sandy bottoms in shallow waters (less than 60 ft) (Pratt, 1973). They are commonly distributed from intertidal regions to the continental slope (Davis & Sisson, 1988). Whelks are voracious carnivores, feeding on gastropods, annelids, and bivalves, as well as dead fish, and are relatively mobile, with the potential to travel over 500 ft in 12 hours (Davis & Sisson, 1988). The channeled whelk, which grows up to 7 inches long, occurs from intertidal habitats to those just below low-tide level. Channeled whelks are abundant in the shallow bays of southern New England and in Long Island Sound (Page, 2002). This species is primarily nocturnal during warmer months, diurnal and nocturnal in the spring and fall, and primarily diurnal in winter. Channeled whelks lay eggs only in spring.

The knobbed whelk, which grows up to 8 to 9 inches long, occurs along the coast from Massachusetts to northern Florida. This species migrates to the deeper offshore waters during the extreme weather conditions prevalent during the summer and winter months, returning to shallow waters of nearshore mud flats during the spring and fall months (Page, 2002). This migratory behavior possibly results in lower counts of knobbed whelk in Long Island Sound (CTDEEP, 2013c). While on mud flats, whelks prey on oysters, clams, and other marine bivalves. Mating and egg-laying occur during the spring and fall migrations.

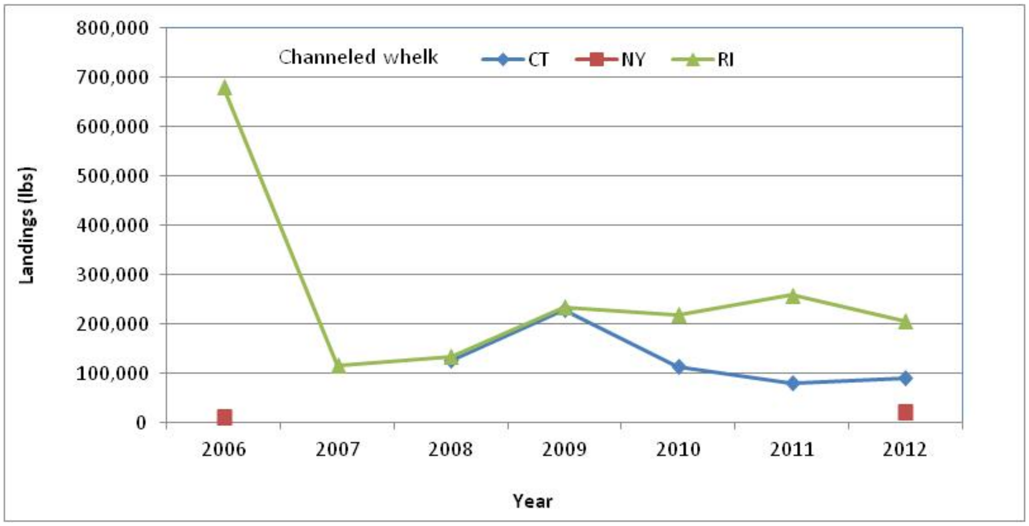
Figure 4-45 shows the relative abundance of these two species collected in Long Island Sound between 1992 and 2012 as part of the CTDEEP Long Island Sound Trawl Survey (CTDEEP, 2013c). Survey results are comparable to those for blue mussel (Figure 4-40), with relatively low biomass in the 1990s, peaking in 2001, and more variable results since 2003.



Source: CTDEEP (2013c).

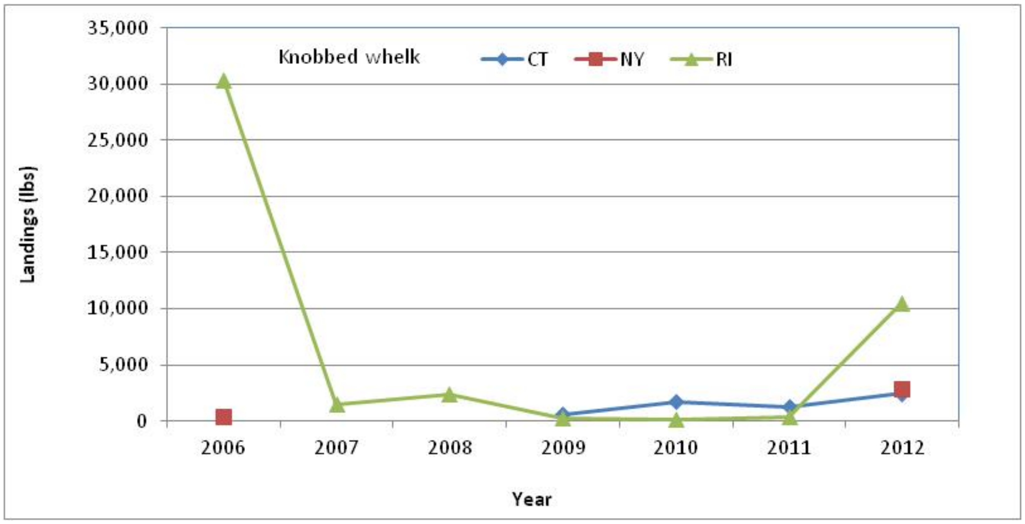
Figure 4-45. Combined Channeled Whelk and Knobbed Whelk Abundance.

Figure 4-46 and Figure 4-47 present the available commercial landings data for New York, Connecticut, and Rhode Island for the channeled and knobbed whelks, respectively. The landings data indicate that the channeled whelk is much more important commercially and represents up to 95% of the combined whelk catch on an annual basis. Peak landings for both species were reported in 2006 by Rhode Island, with much reduced but fairly stable landings reported in subsequent years. For the channeled whelk, Connecticut landings were initially comparable to Rhode Island but declined after 2009; Connecticut landings for the knobbed whelk have typically exceeded the reported Rhode Island catch with the exception of 2012, when Rhode Island reported a substantial increase in landings. For both species, New York landings data are limited to 2006 and 2012. In 2012, reported New York landings data for channeled whelk were less than either Rhode Island or Connecticut (Figure 4-46); New York landings of knobbed whelk were comparable to Connecticut but less than Rhode Island (Figure 4-47).



Source: NOAA (2014e).

Figure 4-46. NMFS Commercial Landings Data for Channeled Whelk.



Source: NOAA (2014e).

Figure 4-47. NMFS Commercial Landings Data for Knobbed Whelk.

4.9.2 Open-Water Environment

Shellfish species found at each of the open-water placement locations (including both unconfined and confined alternatives) are shown in Table 4-19. Where available, additional information on available habitat and the potential occurrence of shellfish resources for individual sites is provided below.

Table 4-19. Commercial and Recreational Shellfish Species in Open-Water Environments.

Environment	Alternative Type	Alternative ID	Resources Present	Shellfish Closure/ Classification
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS	American lobster[1]	Approved
		CLDS	American lobster, hard clam[1]	Prohibited
		CSDS	American lobster, blue crab, blue mussel, horseshoe crab, and softshell clam[2]	Prohibited
		NLDS	American lobster, blue crab, Atlantic surfclam, horseshoe crab, and softshell clam[2]	Prohibited
	Confined Open-Water Placement	E	3 species documented within 1 mi[3]	Approved

Sources: [1] EPA (2004); [2] NOAA (2014f); [3]USACE (2012a).

Unconfined Open-Water Placement

All four open-water alternative sites may have a variety of shellfish species either transiting through (lobsters, blue crab, horseshoe crab) or residing at (clams, oysters, mussels) these locations. Water depths for these four alternatives range from 40 ft in NLDS to 190 ft in CSDS. Species such as the softshell clam and Atlantic surfclam prefer nearshore or coastal habitat but may also be found in deeper waters. The sediment at these four open-water alternatives ranges across the full spectrum, from gravel to very fine silt/clay and even muds in some locations. Species preferences will depend on various environmental factors such as water depth, substrate type, proximity to shore, and food availability. In addition, specific environmental stressors (e.g., hypoxic conditions) may limit the suitability of some of these areas to different shellfish species.

Western Long Island Sound Disposal Site

Water depths within the WLDS generally range from 75 ft MLW along a ridge on the southern boundary to 112 ft near the center of the site (ENSR, 2007). Grain size is primarily fine-grained with a layer of silty, very fine sand overlying silt/clay muds (ENSR, 2005c). According to the NOAA Environmental Sensitivity Index Data Viewer (NOAA, 2014f), WLDS is situated within 0.75 mi of American lobster and blue crab habitat. Non-sedentary shellfish resources at WLDS were evaluated using trawl data collected from 1984 to 2000 (EPA (2004) [Appendix H-6]) and benthic characterization samples collected in support of the site designation EIS (EPA, 2004). This study demonstrated that lobsters occur at WLDS; however, no clam species or eastern oyster was found. A recent study (ENSR, 2005c) concluded that the WLDS benthic infaunal community was consistent with reference areas and would thus support mobile shellfish such as lobster and blue crab that rely on these resources. However, seasonal hypoxia has been reported in the WLDS, and sensitive species such as the lobster could be affected.

Central Long Island Sound Disposal Site

Water depths above the disposal mounds at the CLDS have typically ranged from 49 to 56 ft (mean lower low water [MLLW]) (ENSR, 2007). Grain size ranges from silt/clay to very coarse sand (Valente, et al., 2012). The SPI survey conducted as part of the 2009 monitoring survey demonstrated that historical dredged placement mounds have been recolonized and that the benthic community associated with the older mounds is consistent with nearby reference areas. Recovery of the newer mounds was ongoing at the time of the survey, with the benthos considered to have an "intermediate successional status" requiring some additional time to reach the characteristics typical of reference areas (Valente, et al., 2012). According to NOAA (2014f), the CLDS is within 2.2 mi of American lobster and blue crab habitat. Motile shellfish resources at the site were evaluated using trawl data collected from 1984 to 2000 (EPA (2004) [Appendix H-6]) and benthic characterization samples collected in support of the 2004 site designation EIS. The results showed lobsters and the potential for hard clams at the CLDS; however, no evidence of the presence of hard clams was found.

Cornfield Shoals Disposal Site

Water depths range from a minimum of 150 ft MLW in the northeast corner of the site to a maximum depth of 190 ft MLW in the southwestern quadrant (ENSR, 2005a). The maximum depth was located within a depression approximately 5 ft deep in the southern portion of the site. Grain size ranges from sand to fine-grained dredged material. The CSDS is characterized by relatively strong currents paralleling the coastline that can transport and disperse sediments. However, various surveys have concluded that shellfish beds located in the vicinity to the north are not impacted by sediment migration from the CSDS due to the current alignment (east-west).

New London Disposal Site

Water depths range from 40 to 80 ft at the deepest location (AECOM, 2009), with seafloor topography dominated by the presence of various mounds associated with historical dredged material placement at the NLDS. Historical placement activities have been managed to create broad, flat mounds and maintain a minimum water depth to reduce the potential effects of bottom currents and storm-generated waves and allow for safe passage of deeper draft vessels transiting through the NLDS area. Sediment particle grain size ranges from gravel to silt/clay, with muddy fine sand, often with shell fragments, dominating much of the seafloor. With the exception of the most recent placement event (NL-06), the seafloor mounds have been recolonized by benthos, and the macroinvertebrate community throughout is consistent with reference conditions. Benthic recolonization and substrate development is ongoing at NL-06 (AECOM, 2009). Several benthic species (including starfish, crabs, limpets, and snails), along with large aggregations of living blue mussels, were observed during the bottom surveys.

Confined Open-Water Placement

The borrow pit for Alternative Site E has an average depth of -20 ft MLW. Three species were documented within 1 mi (USACE, 2012a).

4.9.3 Nearshore/Shoreline Environment

All species discussed in Section 4.9.1 can occur in Long Island Sound's nearshore and shoreline environments. The distribution and relative abundance of specific shellfish species will depend on their individual life history attributes (Table 4-18), environmental requirements, and the biological, physical, and chemical characteristics of a given area. Shellfish species found at each of the nearshore/shoreline placement locations are provided in Table 4-20. Where available, additional information for individual sites is provided below.

Table 4-20. Commercial and Recreational Shellfish Species in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1]	Shellfish Closure/ Classification
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	5 species documented within 1 mi	Prohibited
		H	5 species documented within 1 mi	Prohibited
		M	6 species documented within 1 mi	Restricted
	Island CDF	B	3 species documented within 1 mi	Conditionally Approved
		L	5 species documented within 1 mi	Restricted
		N	ND	Approved
		P	1 species documented within 1 mi	Restricted
		Q	3 species documented within 1 mi	Conditionally Approved
		R	1 species documented within 1 mi	Restricted
	Shoreline CDF	A	4 species documented within 1 mi	Prohibited
		C	4 species documented within 1 mi	Conditionally Approved
		D	3 species documented within 1 mi	Conditionally Approved
		F	6 species documented within 1 mi	Restricted
		I	2 species documented within 1 mi	Prohibited
		J	6 species documented within 1 mi	Restricted
		K	3 species documented within 1 mi	Restricted
		O	2 species documented within 1 mi	Restricted
	Nearshore Bar Placement/ Nearshore Berm Sites	177	3 species documented within 1 mi	No classification within 1 mi
		178	3 species documented within 1 mi	No classification within 1 mi
		179	3 species documented within 1 mi	No classification within 1 mi
		121/446	4 species documented within 1 mi	Seasonally Closed (5/15 – 10/15)
		453	4 species documented within 1 mi	Prohibited
		173	4 species documented within 1 mi	No classification within 1 mi
		180	7 species documented within 1 mi	Seasonally Closed (5/1 – 10/31)
		454A	7 species documented within 1 mi	Seasonally Closed (5/1 – 11/30)
		454B	4 species documented within 1 mi	No classification within 1 mi
		455/82	5 species documented within 1 mi	Prohibited
		445	4 species documented within 1 mi	No classification within 1 mi
		171	4 species documented within 1 mi	No classification within 1 mi
		170	4 species documented within 1 mi	Prohibited
		63	5 species documented within 1 mi	No classification within 1 mi

Table 4-20. Commercial and Recreational Shellfish Species in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[1]	Shellfish Closure/ Classification
		456	5 species documented within 1 mi	Seasonally Closed (on holidays – variable)
		441	3 species documented within 1 mi	Conditionally Approved
		320	3 species documented within 1 mi	Conditionally Approved
		440	3 species documented within 1 mi	Conditionally Approved
		449	3 species documented within 1 mi	Conditionally Approved
		438	3 species documented within 1 mi	Conditionally Approved
		433	3 species documented within 1 mi	Restricted
		434	3 species documented within 1 mi	Conditionally Approved
		323	3 species documented within 1 mi	Restricted
		467	2 species documented within 1 mi	Restricted
		364	3 species documented within 1 mi	Approved
		451	3 species documented within 1 mi	Restricted
		447	3 species documented within 1 mi	Restricted
		327/333/330	3 species documented within 1 mi	Restricted
		337	3 species documented within 1 mi	Restricted
		457	2 species documented within 1 mi	Conditionally Approved
		365	2 species documented within 1 mi	Restricted
		GP	2 species documented within 1 mi	Restricted
		367	3 species documented within 1 mi	Restricted
		368	4 species documented within 1 mi	Conditionally Approved
		381/382	3 species documented within 1 mi	Approved
		384	3 species documented within 1 mi	Approved
		600	1 species documented; no commercially exploited shellfish populations; potential lobster fishery within 1 mi[2]	Approved
		610	Potential lobster fishery within 1 mi[3]	Approved
		620	4 species documented within 1 mi	Approved
	Beach Nourishment	323	ND	Restricted
		433	ND	Restricted
		434	ND	Conditionally Approved
		436	ND	Restricted
		365	ND	Restricted
		457	ND	Conditionally Approved
		364	ND	Restricted
		444	ND	Restricted
		451	ND	Restricted
		337	ND	Restricted

Table 4-20. Commercial and Recreational Shellfish Species in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[1]	Shellfish Closure/ Classification
		320	ND	Conditionally Approved
		441	ND	Conditionally Approved
		442	ND	Restricted
		450	ND	Prohibited
		447	ND	Prohibited
		438	ND	Restricted
		440	ND	Conditionally Approved
		449	ND	Restricted
		181	ND	Prohibited
		453	ND	Prohibited
		63	ND	No classification within 1 mi
		456	ND	Seasonally Closed (on holidays - variable)
		454E	ND	No classification within 1 mi
		454W	ND	Prohibited
		455/82	ND	Prohibited
		384	ND	Approved
		367	ND	Restricted
		368	ND	Conditionally Approved
		171	ND	No classification within 1 mi
		173	Possible fish/shellfish grants offshore of the beach.	No classification within 1 mi
		177	ND	No classification within 1 mi
		178	ND	No classification within 1 mi
		179	ND	No classification within 1 mi
		170	ND	Prohibited
		180	ND	Seasonally Closed (5/1 – 10/31)
		445	ND	No classification within 1 mi
		446	ND	Prohibited
		343	ND	Restricted
		474	ND	Prohibited
		339	ND	Conditionally Restricted
		459	ND	Restricted
		348	ND	Restricted
		480	ND	Restricted

Table 4-20. Commercial and Recreational Shellfish Species in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[1]	Shellfish Closure/ Classification
		467	ND	Restricted
		468	ND	Restricted
		325	ND	Prohibited
		327	ND	Prohibited
		329	ND	Prohibited
		330	ND	Prohibited
		331	ND	Prohibited
		332	ND	Prohibited
		333	ND	Prohibited
		344	ND	Restricted
		345	ND	Restricted
		121	ND	Prohibited
		64	ND	Seasonally Closed (5/1 – 10/31)
		67	ND	Seasonally Closed (5/1 – 10/31)
		68	ND	Prohibited
		111	ND	Prohibited
		76	ND	Seasonally Closed (5/1 – 11/30)
		79	ND	Seasonally Closed (4/1 – 12/14)
		381	ND	Approved
		382	ND	Approved
		437	ND	Prohibited
		600	1 species documented; no commercially exploited shellfish populations[2]	Prohibited
		610	1 species documented within ½ mi; no commercially exploited shellfish populations[3]	Approved
		620	ND	Approved

Sources: [1] USACE (2010a) and (2012a), unless otherwise noted.
[2]USACE (1994)
[3]USACE (1992).
Note: ND = No data.

Confined Placement

A total of 17 nearshore/shoreline locations were identified as potential containment sites (USACE, 2012a); these sites were characterized as Harbor CAD cells, Island CDFs, and Shoreline CDFs. For each identified Harbor CAD cell, up to six species were identified as being found within 1 mi of the site. Island CDFs had up to five shellfish species within 1 mi of each site with the exception of Alternative N, which did not have any shellfish species identified in the area. Between two and eight shellfish species were documented within 1 mi of each shoreline CDF.

Beneficial Use

All in-water, beneficial use sites are likely to contain shellfish. Each of the berm sites was found to have shellfish present in the vicinity (up to seven species within 1 mi of the site) (USACE, 2012a). Shellfish species were not identified for specific beach renourishment sites; however, it is likely that similar shellfish may be present in the intertidal and subtidal areas as are found at the corresponding berm locations (USACE, 2010a). In addition, Site 173, Hither Hills State Park in East Hampton, New York, was noted to have possible fish/shellfish grants offshore of the beach (USACE, 2010a). The eastern oyster and blue mussel are typically found in the shallow depths attached to hard structures. Bay scallops are more likely in coastal bays and harbors. It is likely that Northern quahog, softshell clam, Atlantic surf clam, two species of whelks, and horseshoe crabs could occur in mudflat areas or shallow intertidal areas associated with the beneficial use sites.

No specific Island or Shoreline Restoration sites have been identified to date. If a location were to be identified within the Long Island Sound study area, some shellfish species would be expected to be present and could be identified at that time.

4.9.4 Upland Environment

Shellfish are relevant only for the two habitat restoration areas (Table 4-21). Both Site 427 and Site 429 were found to be horseshoe crab habitats.

Table 4-21. Commercial and Recreational Shellfish Species in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	N/A
	Landfill Cover/Capping	60	N/A
		61	N/A
		251	N/A
		272	N/A
	Brownfields & Other Redevelopment	422/423	N/A
	Habitat Restoration / Enhancement or Creation	427	Horseshoe crab mating area[1] Shellfish Prohibited Area
		429	Horseshoe crab mating area[1]; Shellfish Prohibited Area

Sources: [1] USACE (2010a).
Note: N/A = not applicable

4.10 FISH

4.10.1 General Long Island Sound Setting

Marine Fish in the Study Area

Finfish species found within the study area can be divided into two categories: demersal (bottom-dwelling) and pelagic (living and feeding in the water column). Finfish can be characterized by their habitat preferences (such as warm water, cold water, or year-round inhabitants) and their sensitivity to levels of oxygen in the water (hypoxia). Finfish in Long Island Sound can also be grouped by agency designations, such as those for which EFH has been identified and those protected under the Endangered Species Act (ESA) (i.e., listed as threatened or endangered). While there are many species of fish found within the study area, this section focuses on those fish that are determined to have EFH designations or are commercially or recreationally important. Squid share similar habitats and behavior with many finfish species and are also important to the commercial fishing industry in the study area; therefore, they are also discussed in this section. Shellfish species and lobster are discussed in Section 4.9.

EFH fish and those found to be commercially or recreationally important within the study area are listed in Table 4-22. The table also provides important information about each species: selected life-stage characteristics, habitat preferences, preferred food sources, distribution, and, where applicable, NMFS EFH and ESA designations. Project-specific NEPA assessments may require additional consultation with NMFS and the USFWS to determine if additional fish species should be investigated for the specific alternative sites being considered.

The following provides information on the types of fish described above.

Demersal vs. Pelagic

Fish can be divided into two broad categories, demersal and pelagic, based on where they are typically found within the water column. Demersal fish live and feed primarily on or near the seafloor. Typically bottom feeders, they rest on and feed from a variety of habitats consisting of mud, sand, gravel, and rocks. Flounder, plaice, halibut, and stingrays are all examples of demersal fish species.

Pelagic fish live and feed in the water column. They can be further divided into coastal pelagic fish and oceanic pelagic fish. Coastal pelagic fish inhabit the relatively shallow and productive waters of the continental shelf, including near coastal areas. Oceanic fish inhabit the ocean waters beyond the continental shelf. Pelagic fish range from small coastal forage fish, such as herrings and sardines, to large predatory oceanic species such as bluefin tuna and oceanic sharks.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Species with Essential Fish Habitat within the Study Area				
Atlantic salmon (*Salmo salar*) [a, d]	Juvenile and adult	All salinity regimes. Benthopelagic fish, preferring to inhabit the bottom half of an open-water environment.	Juveniles: tiny invertebrates and occasionally small fish. Adults: Arctic squid, sand eels, amphipods, Arctic shrimp, and sometimes herring.	Extirpated from Long Island Sound in 1800s but have become reestablished. Greatest abundance observed in eastern half of the Sound (mouth of Connecticut River) in shallow sandy areas and transitional areas in Eastern Basin and Mattituck Sill.
Atlantic cod (*Gadus morhua*) [a, b, c, d]	Adult	Cold water, Rocky slopes or ledges, rock, gravel, mud, sand, clay; water column.	Fish, benthic invertebrates (e.g., clams, crabs, mussels, polychaetes, echinoderms).	Rare in Long Island Sound. Extensive migrations with seasons, and in response to food.
Pollock (*Pollachius virens*) [a, b, c, d, e]	Juvenile and adult	Salinity >25 psu. Found in water up to 590 ft deep over rocks and anywhere in the water column.	Euphausiids, fish, and mollusks.	Not commonly caught in the surveys of Long Island Sound, and none recorded since 1989. Just 24 juveniles were caught in surveys conducted throughout Long Island Sound from 1984-1990. All were caught during July-August, at all depths and bottom types except sand.
Whiting (also known as Silver hake) (*Merluccius bilinearis*) [a, b, c, d, e]	All life stages	Year-round. All substrate types.	Herring, other small schooling fish, benthic invertebrates, squid.	Adults: most abundant in April and May. Juveniles: most abundant in the summer and fall. Move inshore in spring and offshore in fall; shift vertically in water column in response to prey. Largest catches are within the Long Island Sound placement areas and on Stratford Shoal.
Red hake (*Urophycis chuss*) [a, b, c, d, e]	All life stages	Year-round. Soft mud and silt (juveniles near shellfish beds). Abundance increases with depth. Salinity >0.5 PSU.	Benthic invertebrates (e.g., shrimp, worms, crabs), zooplankton (copepods), fish.	Most common in spring and fall. Extensive seasonal migrations – inshore in spring and summer and offshore in winter. Typically found along the coastlines. Prefer muddy sediments but can be found in sandy areas as well.
Winter flounder (*Pseudopleuronectes americanus*) [a, b, c, d, e]	All life stages	Cold water. Muddy sand with patches of eelgrass, sand, clay, gravel, or cobble. Highest spring catches were in Central Basin over mud and transitional sediments.	Benthic invertebrates (shrimps, amphipods, sandworms, small fish, small crabs, worms, bivalves, sea cucumbers).	More abundant in open water in spring than in fall. Generally localized small-scale movement inshore in winter. Highest fall catches were in shallow areas of the Western and Central Basins. Moves inshore to spawn during the winter then migrates offshore into

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
		Sensitive to low DO. Salinity greater than 0.5 PSU.		deeper, cooler waters for the summer as water temperatures rise in the spring.
Windowpane flounder (*Scopthalmus aquosus*) [b, c, d, e]	All life stages	Sand, mixtures of sandy silt, or mud. Low DO. Tolerate salinity greater than 0.5 PSU.	Plankton (planktonic shrimp), benthic invertebrates (e.g., crabs, small mollusks, worms, epibenthic shrimp), squid.	One of the most common species seen in the trawls and most abundant from April to June. Juveniles dominate the summer and fall catches. Adults dominate April and May. Highest catch numbers are in the Western and Central Basins, especially over muddy and transitional sediments.
American plaice (*Hippoglossoides platessoides*) [a, b]	Juvenile and adult	Salinity >25 PSU.	Small benthic crustaceans, sand dollars, sea urchins, and worms.	Found primarily in the Gulf of Maine to Canada and on Stellwagen and Georges Bank. Were not caught in surveys conducted throughout Long Island Sound from 1984-1990.
Ocean pout (*Macrozoarces americanus*) [a, b, c, d, e]	All life stages	Salinity >25 PSU. Prefer depths greater than 60 ft and either mud or transitional bottoms	Benthic invertebrates (e.g., amphipods, polychaetes, mollusks, crustaceans, sand dollars).	Most pout caught in late spring. Juveniles and adults not migratory except for seasonal, local movements. Hypoxia sensitive. Higher numbers in western Long Island Sound, but also found in central and eastern Long Island Sound.
Atlantic sea herring (*Clupea harengus*) [a, b, c, d, e]	Juvenile and adult	Cold water. Water column, mud and sandy bottoms. Salinity greater than 0.5 PSU.	Plankton (copepods), euphausiids, pteropods.	Most abundant in spring. Particularly abundant in shallow areas.
Bluefish (*Pomatomus saltatrix*) [a, b, c, d, e]	Juveniles (primarily) and adults	Warm water. Juveniles may occur along beaches, estuaries, tidal creeks over sand and gravel. Water column, sandy bottoms, rocky and transitional sediments. Sensitive to low DO. Salinity greater than 0.5 PSU.	Fish, shrimp, squid, benthic invertebrates (crabs, annelid worms), shrimp.	Most frequently caught between July and October. Migrate north in spring and south in fall. Abundance peak on Connecticut side of Long Island Sound in midsummer and throughout entire Sound in September.
Atlantic mackerel (*Scomber scombrus*) [a, b, c, d, e]	All life stages	Cold water. Water column. Salinity >25 PSU.	Plankton (copepods, amphipods), shrimp, pelagic mollusks (squid).	Greatest numbers caught in April and June. Not abundant in Long Island Sound. Anglers catch migrating mackerel off Long Island in March or November.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Summer flounder (*Paralichthys dentatus*) [a, b, c, d, e]	Juvenile and adult	Year-round. Mud or sand; near-bottom water column. Sensitive to low DO. Salinity zones >0.5 PSU. Move offshore in fall.	Benthic invertebrates (rock crabs, shrimp, bivalves, polychaete worms, sand dollars), fish (esp. scup), squid.	Juveniles: most abundant in spring and fall, with numbers dropping off in summer; abundant along Connecticut shoreline between Guilford and New Haven, as well as near the mouth of the Connecticut River, in Niantic Bay, and near Mattituck, New York. Found in coastal waters when the water is warm.
Scup (*Stenotomus chrysops*) [a, b, c, d, e]	All life stages	Year-round. Rocky bottoms. Generally found over transitional or sandy bottoms in depths >60 ft. Sensitive to low DO. Salinity >25 PSU.	Benthic invertebrates (crustaceans, worms, mollusks), vegetable debris.	Most abundant during spring and fall, with adults dominating catches in April-June and juveniles dominating in fall. Move inshore in spring-summer and offshore in winter. Largest numbers occur south of Milford, Connecticut, around the mouth of the Thames River, and in Niantic Bay.
Black sea bass (*Centropristus striata*) [a, b, c, d, e]	Juvenile and adult	Sand, water column, rocky and transitional sediments. Salinity >25 PSU.	Benthic invertebrates (crabs, mussels), squid.	Not very abundance in LISTS but greatest numbers reported between April and June. Generally found in shallow, nearshore areas.
King mackerel (*Scomberomorus cavalla*) [a, c, d]	All life stages	All salinities. Typically inhabit waters of between 32-36 PSU. Occurs inshore, in the mouths of inlets and harbors, commonly at depths of 40 to 150 ft.	Primarily pelagic carnivores; squid, menhaden, jacks, cutlassfish, weakfish, grunts, striped anchovies.	Subtropical species that ranges from Brazil to Gulf of Maine. Considered an "uncommon" late summer/early fall migrant to Long Island Sound waters.
Spanish mackerel (*Scomberomorus maculatus*) [a, c, d, e]	All life stages	Warm water. All salinities; typically inhabit waters of between 32-36 PSU and believed to avoid low-salinity areas near river mouths.. Shallow water, preferring sand bottom in depths of 10 to 40 ft, occasionally as deep as 80 ft.	Primarily pelagic carnivores; small fish, shrimp, squid.	Common in some years in Long Island. Migrates from Mexico to Cape Cod, reaching New York waters in July and usually return south in the fall in September. Spawns in late August to late September in northernmost part of its range (i.e., Sandy Hook, NJ and Long Island).In Long Island Sound, most are captured in localized nearshore areas including Smithtown Bay (near Shoreham) and between Norwalk and New Haven.
Cobia (*Rachycentron canadum*) [c, d]	All life stages	Found in a variety of habitats including over mud, rock, sand and gravel bottoms. Salinities 5 to 44 PSU.	Primarily pelagic carnivores; crabs, squid, fish.	Typically found in Gulf of Mexico to as far north as Maryland; considered an "uncommon" late summer/early fall migrant to Long Island Sound waters. Warming ocean may shift distribution to the north.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
		Tropical to warm temperate waters.		
Sand tiger shark (*Carcharias taurus*) [a, d]	Larvae	Subtropical and temperate waters inhabiting the continental shelf, from sandy shorelines and submerged reefs to a depth of around 600 ft.	Bony fish, crustaceans, squid, skates, and other sharks.	In coastal waters from Gulf of Maine to Florida. Juveniles in the Cape Cod region move away from coastal areas when water temperatures decrease below 60 ºF.
Common thresher shark (*Alopias vulpinus*) [a, d]	Larvae, juvenile, and adult	Found both close to shore and in the open ocean, from the surface to a depth of 1,800 ft.	Small schooling forage fishes such as herrings and anchovies.	Tropical and temperate waters, though it prefers cooler temperatures (rare south of New England).
Blue shark (*Prionace glauca)* [a, d]	Larvae, juvenile, and adult	Inhabits deep waters in temperate and tropical oceans. Prefers cooler waters.	Small fish and squid, but can take larger prey.	Found worldwide and prefers waters with a temperature range of 45-61 ºF.
Dusky shark (*Carcharhinus obscurus*) [a, d]	Juvenile	Inhabits tropical and warm-temperate continental seas worldwide. From the coast to the outer continental shelf; up to depths of 1,300 ft.	Bony fishes, sharks, rays, octopus, and squid.	Populations migrate toward the poles in the summer and toward the equator in the winter. Distribution ranges from Massachusetts and Georges Bank to Brazil.
Shortfin mako shark (*Isurus oxyrinchus*) [a, d]	Juvenile	Open ocean.	Fish, squid, other sharks.	Distribution ranges from Gulf of Maine to Brazil. Usually found offshore in the ocean, but can occasionally be found inshore.
Sandbar shark (*Carcharhinus plumbeus*) [a, d]	Juvenile and adult	Muddy or sandy bottoms in shallow coastal waters such as bays, estuaries, harbors, or mouths of rivers. Also found in deeper waters (650 ft).	Fish, rays, crabs.	Distribution ranges from Massachusetts to Brazil.
Atlantic bluefin tuna (*Thunnus thynnus*) [a, c, d]	Juvenile and adult	Open ocean.	Small fish and invertebrates (e.g., squid and crustaceans).	Western and eastern Atlantic Ocean.
Little skate (*Leucoraja erinacea*) [a, b, d, e]	Juvenile and adult	Year-round. Usually found on sandy or gravelly bottoms in water depths ranging from shallow shoals to nearly	Mostly mollusks, but also small fish, crabs, squid, shrimp, amphipods, and clams.	Moves inshore and offshore seasonally. In the shallow water during spring and into deeper water in winter. Long Island Sound Study surveys (1984-1994) show little skate most abundant in spring and

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
		1,000 ft.; sandy or gravelly bottoms. Also occur on mud.		fall on transitional and sand bottoms. Abundances were lowest in July, August, and September.
Winter skate (*Leucoraja ocellata*) [a, b, d, e]	Juvenile and adult	Residing in waters from the surface to 300 ft in depth. Prefers sand and gravel bottoms in shoal water.	Fish and crustaceans.	Found in the surf zone of Long Island during May, June, October, and November, based on surveys from 1984-1994. Occur in lowest abundances in Long Island Sound in the months of July, August, and September.
Threatened, Endangered, Special Concern, or Historical Species				
Blueback herring (*Alosa aestivalis*) [a, c, d, e, g, i]	All life stages	Coastal marine waters as adults. Spawning occurs in deep freshwater systems with hard substrate.	Zooplankton.	Adults in Long Island Sound, spawning and juveniles in coastal rivers of Connecticut and New York.
Shortnose sturgeon (*Acipenser brevirostrum*) [a, c, d]	Adults	Inhabit rivers and estuaries or nearshore marine waters.	Benthic feeders, eating crustaceans, mollusks, and insects.	Endangered. Migrating in and out of the Connecticut River.
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) [c, d, e]	Juveniles and adults	Mud, transitional sediments. Adults spawn in freshwater in the spring and early summer and migrate into estuarine and marine waters where they spend most of their lives. Sub-adults and adults live in coastal waters and estuaries, generally shallow (30-160 ft depth) nearshore areas dominated by gravel and sand substrates.	Benthic invertebrates, gastropods, shrimp, sand lance.	Endangered. Most abundant during September and October. Greatest numbers found in >88 ft of water. Large numbers found in the Eastern Basin and around the mouth of the Connecticut River in <30 ft of water.
Longnose sucker (*Catostomus catostomus*) [g]	All life stages	Deep waters of lakes and coldwater tributaries.	Benthic invertebrates.	Streams and lakes in western Connecticut.
Banded sunfish (*Enneacanthus obesus*) [i]	All life stages	Heavily vegetated lakes, bogs, and streams.	Insects and benthic invertebrates.	The Peconic drainage of eastern Long Island.
American brook lamprey (*Lampreta appendix*) [g, i]	All life stages	Sandy and silty pools. [b]	Zooplankton and detritus. [b]	Long Island and portions of Connecticut.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Burbot (*Lota lota*) [g, j]	All life stages	Deep lakes and streams with cool waters.	Insects and aquatic invertebrates.	Portions of Connecticut.
Bridle shiner (*Notropis bifrenatus*) [h,k]	All life stages	Shallow ponds and slow moving streams and swamps.	Plankton and small insects.	Streams of eastern Long Island and portions of Connecticut.
Swamp darter (*Etheostoma fusiforme*) [i]	All life stages	Slow moving water with decaying organic material and abundant aquatic vegetation.	Amphipods, small crustaceans, and insects.	The Peconic drainage of eastern Long Island.
Other Commercially/Recreationally Important Species				
Goosefish (also known as Monkfish) (*Lophius americanus*) [a, b, c, d, e]		Year-round. Hard sand, sand-shell mix, mud gravel, algae covered rocks. Juveniles occur most frequently in the deeper, silty basins of Long Island Sound. Eggs have been reported in open coastal bays and sounds in low numbers.	Fish, sea birds, lobsters, crabs of several species, hermit crabs, squids, annelid worms, shellfish, starfish, sand dollars, and even eelgrass.	Collected throughout the year in the CTDEEP Trawl Survey but relatively rare. Moves inshore in fall. Seasonal onshore-offshore migrations occur and appear to be related to spawning and possibly food availability.
Atlantic butterfish (*Peprilus triacanthus*) [a, b, c, d, e]		Year-round. Highest abundances in water column over mud and transitional bottoms at depths between 30-90 ft.	Plankton (copepods), small fish, benthic invertebrates (polychaete worms, amphipods, crabs, bivalves).	Most abundant in early fall. Found in large numbers around Stratford Shoal and within Central Long Island Sound. Move offshore and south during winter.
Spiny dogfish (*Squalus acanthias*) [a, b, d, e]		Warm water. Sand, mud, and transitional sand-mud bottoms. Caught in deep waters of the central basin and eastern Sound, occurred as far west as the Western Basin.	Fish, clams, mussels.	In Long Island Sound in late spring (May and June) and depart when waters become too warm. Return again in the fall. Move into coastal waters during spring and fall and to edge of shelf during summer. Relative uncommon in Long Island Sound.
Atlantic menhaden (*Brevoortia tyrannus*) [a, c, d, e]		Warm water. Water column. Sensitive to low DO.	Zooplankton, phytoplankton, diatoms.	Largest abundances caught between April and September. During summer months, largest numbers caught near New Haven Harbor in <90 ft of water. In fall, largest numbers caught along the shoreline between Norwalk and Guilford, Connecticut.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Weakfish (*Cynoscion regalis*) [a, c, d, e]	Juveniles and adults	Warm water. Water column. Rocky and transitional sediments. Schooling fish that prefer shallow, sandy-bottom areas along beaches, in the mouths of inlets, and in larger estuaries during spawning. Migrating offshore and in southern waters in the fall and winter.	Fish, shrimp, squid, benthic invertebrates (crabs, clams).	Most abundant in fall. In spring, adults are commonly found along Mattituck Sill and both Connecticut and New York coastlines. In fall, the central basin coastline of Long Island has the greatest abundance. Adults move inshore and north during warm months, inhabiting the surf, inlets, bays, channels, and estuaries. Juveniles inhabit estuaries, which serve as nurseries. They head south in the fall.
Haddock (*Melanogrammus aeglefinus*) [a, b, c, d]	Adults	Prefers deep, cool water and gravelly sand or smooth rock substrates.	Juveniles: small crustaceans such as copepods in the water column, marine worms, and small fish. Adults: crustaceans, worms, mollusks, and fish.	In coastal New England, most abundant during summer months in the shallower waters of the Gulf of Maine. Haddock were not caught in surveys conducted from 1984-1990 throughout Long Island Sound.
Mummichog (*Fundulus heteroclitus*) [a, c, d]	All life stages	Warm water. Shallow, nearshore, eelgrass beds.	Insects, larvae, small fish, crustaceans, and plant material at the water's surface.	Abundant throughout Long Island Sound. Spawn from June to early August in shallow, shady spots.
Tautog (*Tautoga onitis*) [a, c, d, e]		Warm water. Rocks, sand, pilings, jetties, artificial wrecks in relatively shallow (<55 ft) depths.	Benthic invertebrates (mussels, clams, crabs, sand dollars, shrimps, lobsters).	Most are caught in spring. Overall abundance peaks in May-July (when they move from deep into shallow local waters), drops off, then peaks again in early fall. Annual Long Island Sound Survey data suggest that abundance is greatest along Connecticut shoreline between New Haven and Norwalk; north of Hempstead, New York; and off of Eaton's Neck, Connecticut.
Yellowfin tuna (*Thunnus albacares*) [c, d]		Warm water. Generally in the top 330 ft of the water column. Usually in deep offshore waters, but may approach shore when prey is concentrated inshore.	Fish, squid.	Tropical and subtropical oceans worldwide; "irregular" occurrence in Long Island Sound but typically found off continental shelf south of New England.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Silverside (*Menidia menidia*) [a, c, d]	All life stages	Coastal waters and tributaries. Inhabit marshes and creeks that can become warm and low in DO in summer.	Benthic invertebrates, fish eggs, squid, worms, insects, algae.	High abundance in spring, summer, and fall in nearshore environments.
Bay anchovy (*Anchoa mitchilli*) [a, c, d]	All life stages	Inhabit marshes and creeks that can become warm and low in DO in summer.	Small crustaceans, mollusks, fish.	In Long Island Sound, spawning typically occurs in estuarine water less than 65 ft deep, but can also occur out to the edge of the continental shelf.
American eel (*Anguilla rostrata*) [a, c, d]	Adults	Inhabit marshes and creeks that can become warm and low in DO in summer. Lives in freshwater, but spawns in salt water. Prefer deep water and mud-bottom.	Small fish, insects, crustaceans, shrimp.	Young eels migrate back to freshwater, even 400 mi upstream in the Connecticut River. Males remain in coastal, brackish and saltwater areas.
Striped bass (*Morone saxatilis*) [a, c, d, e]	"Young-of-the-year" and adults	Water column. Rocky areas near jetties and transitional sediments. Sensitive to low DO. Inhabit marshes and creeks that can become warm and low in DO in summer.	Fish, shrimp, squid, benthic invertebrates (crabs, clams).	Most common in May and November, with abundances decreasing in summer. Commonly found along Connecticut shorelines (esp. near mouths of Connecticut and Housatonic Rivers) and Long Island shorelines (usually in <60 ft of water). In late summer and fall, "young-of-the-year" fish move into western Long Island bays, where they live until large enough to join adults off the coast. Adults move offshore in the winter and migrate back to Long Island Sound in the spring to head upriver to spawn.
Northern pipefish (*Syngnathus fuscus*) [a, c, d, e]	All life stages	All salinities. Sensitive to low DO. Inhabits seagrass beds in bays and estuaries, but also enters freshwater. Depth range from 16 ft to 200 ft.	Amphipods, zooplankton.	Distributed from Canada to Florida. Resides in estuaries during spring through fall. Migrates into nearshore continental shelf waters during winter. Abundant to the south of Long Island but uncommon in Long Island Sound trawl surveys. Reported spawning early to late summer in various localities between New Jersey and New England.
Fourspine stickleback (*Apeltes quadracus*) [a, c, d]	All life stages	Low DO tolerant. Wide salinity tolerance. Often found among bottom debris	Zooplankton, benthic invertebrates.	Mostly a nearshore marine species, but can be found inland in some rivers. Abundant in vicinity of Long Island with specific reports of larvae and juveniles

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
		and vegetation; never in open water.		being locally abundant in summer in the Mystic River.
Northern sea robin (*Prionotus carolinus*) [a, c, d, e]		Mud, sand, water column. Low DO tolerant.	Benthic invertebrates (crabs, worms, epibenthic shrimp), fish.	Abundance increases dramatically in early summer. Most abundant along the Mattituck Sill in sandy and transitional habitats as well as in deep waters of the Western Basin.
Hogchoker (*Trinectes maculatus*) [a, c, d, e]		Most abundant at depths greater than 55 ft on mud and transitional bottoms. Low DO tolerant.	Benthic invertebrates (crustaceans, polychaetes, shrimp).	Most abundant in spring and exhibit seasonal inshore/offshore distribution pattern. Uniformly dispersed but never deeper than 88 ft. High early summer abundance along Long Island shoreline between Shoreham and Eaton's Neck. In July, high catches moved to Connecticut shoreline.
Spot (*Leistomus xanthurus*) [a, c, d, e]	All life stages but primarily juveniles	Low DO tolerant. Most commonly caught over mud and sand bottoms in shallows and offshore to 400 ft.	Benthic invertebrates (e.g., worms, crustaceans, mollusks).	In estuaries and shallow coastal waters until about 2 years, and then migration to deep ocean waters to spawn. "Erratic" distribution in Long Island area although widespread further south in Chesapeake and Delaware Bays.
Fourspot flounder (*Paralichthys oblongus*) [a, c, d, e]		Near-bottom water column to depths of 100 ft in New York and Rhode Island. Most abundant on mud bottoms in Central and Western Basins.	Benthic invertebrates (e.g., arthropods, mollusks, shrimp, crabs) and fish.	Most abundant in early summer. Found in all habitats, but prefers muddy sediments. Reported to be a common component of fish fauna in vicinity of Long Island.
Long-finned squid (*Loligo pealeii*) [b, e]	All life stages	Year-round. Appear to prefer transitional and sand bottoms at depths >55 ft. Sensitive to low DO. Female squid attach fertilized eggs to a structure on the bottom such as a rock or seaweed.	Crabs, small fish, crustaceans.	Ranges from Newfoundland to Gulf of Venezuela. Open ocean but inshore during summer. Long Island Sound provides important nursery habitat. Typically, most abundant invertebrate (by biomass) in annual Long Island Sound trawl surveys.
Rainbow smelt (*Osmerus mordax*) [a, d, e]	Juveniles and adults	Lives in estuaries, harbors, and offshore waters during summer, fall, and winter. Appear to prefer shallow (<55 ft) depths over sand and transitional bottoms in river mouths.	Shrimp, marine worms, amphipods, mysids, euphausiids, small fish.	Endangered (Connecticut only) and rarely observed in the Long Island Sound trawl surveys. Migrates into rivers and streams to spawn beginning in late winter; eastern Connecticut basin and Rhode Island.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
Fourbeard rockling (*Enchelyopus cimbrius*) [a, c, d, e]	All life stages	Prefer mud bottoms at depths greater than 55 ft.	Shrimp, isopods and other small crustaceans; less often fish fry.	"Common" in Long Island Sound; peak abundance in June and observed in both the Central and Western Basins, with non in the Eastern Basin. Spawns in Long Island Sound between February and early June.
American sand lance (*Ammodytes americanus*) [a, c, d]	All life stages	Demersal; chiefly found schooling along sandy shorelines and shoals	Feed primarily on small crustaceans (particularly copepods) and fish fry.	Abundant. In Long Island Sound, spawns mid-winter in polyhaline waters.
Longhorn sculpin (*Myoxocephalus octodecemspinosus*) [a, d, e]	All life stages	Demersal; prefer transitional and sand bottoms and deeper water (> 90 ft).	Omnivorous diet including shrimps, crabs, amphipods, hydroids, annelid worms, mussels and fish fry. Also a voracious scavenger.	Most abundant in spring and in the Eastern Basin and on the Mattituck Sill where abundance increases with depth. Retreat to deeper waters in fall.
Sea raven (*Hemitripterus americanus*) [a, c, d, e]	All life stages	Prefer hard substrate but found on transitional and sand bottoms and deeper water (> 60 ft).	Voracious omnivore: mollusks, crustaceans, sea urchins, worms and fish fry.	Common in ocean during summer and move towards shore in winter (associated with spawning). Spawning occurs within a mile of shore in water depths of 55 – 85 ft in late fall/early winter off Rhode Island. Within Long Island Sound, most abundant in spring and in the Eastern Basin and on the Mattituck Sill where abundance increases with depth.
Largemouth bass (*Micropterus salmoides*) [i]	All life stages	Warm, shallow waters of lakes and ponds with abundant aquatic vegetation.	Fish, invertebrates, and frogs.	Lakes and ponds throughout the study area.
Smallmouth bass (*Micropterus dolomieu*) [i]	All life stages	Cool, clear waters of lakes and flowing streams with gravel substrate.	Insects and fish.	Lakes, ponds, and streams throughout the study area.
Walleye (*Sander vitreus*) [i]	All life stages	Deep water sections of lakes, streams, and rivers.	Minnows and juvenile fishes.	Lakes and streams of New York and Connecticut.
Brook trout (*Salvelinus fontinalis*) [i]	All life stages	Small to moderate sized streams and ponds with clean, cool waters.	Plankton, insects, amphibians, and fish.	Small streams on Long Island and Connecticut.

Table 4-22. Life History Characteristics of Specific Finfish Species in the Study Area.

Species	Life Stages Present	Preferred Habitat	Preferred Food	Distribution in the Study Area
American shad (*Alosa sapidissima*) [a, c, d, e, f, i]	All life stages	Shallow coastal waters. Spawn in freshwater over gravel or mud substrate.	Zooplankton.	Primarily along the Connecticut coast with spawning in Connecticut rivers and streams. Seasonal inshore/offshore pattern observed with greatest abundance of shad changing from Connecticut shore (spring) to Central Basin and Mattituck Sill (summer)
Chain pickerel (*Esox niger*) [c, d, i]	All life stages	Quiet waters with abundant aquatic vegetation.	Primarily fishes and amphibians.	Lakes, ponds, and streams throughout the study area.
Hickory shad (*Alosa mediocris*) [a, c, d, e, i]	All life stages	Coastal waters with spawning in freshwater streams.	Zooplankton.	Relatively uncommon and appear to exhibit seasonal inshore/offshore pattern. Adults in Long Island Sound, spawning and juveniles in coastal rivers of Connecticut.
Kokanee (*Oncorhynchus nerka)* [i]	All life stages	Deep lakes and ponds where water temperatures remain below 60 F.	Primarily plankton and insects.	Deep lakes of Connecticut.
Northern pike (*Esox lucius*) [d, i]	All life stages	A wide range of freshwater habitats.	Primarily small fishes.	Lakes, ponds, and streams throughout the study area.
Brown trout (*Salmo trutta*) [d, i]	All life stages	Small to moderate sized streams and ponds with clean, cool waters.	Plankton, insects, amphibians, and fish.	Small streams throughout the study area.
Lake trout (*Salvelinus namaycush*) [h, i]	All life stages	Deep waters of lakes and reservoirs.	Fish and insects.	Deep lakes of Connecticut.
Rainbow trout (*Oncorhynchus mykiss*) [d, i]	All life stages	Streams, ponds, and lakes; more tolerant of warmer waters than other trout.	Plankton, insects, amphibians, and fish.	Lakes, ponds, and streams throughout the study area.
White perch (*Morone Americana*) [a, c, d, i]	All life stages	Brackish waters, rivers, lakes, and reservoirs.	Plankton and small fish.	Lakes, ponds, and streams throughout the study area.

Sources: [a]Bigelow & Schroeder (1953); [b]NOAA (2014g); [c]USFWS (1978); [d]Briggs & Waldman (2009).
[e]NOAA (2000); [f]EPA (2004); [g]USGS (2014a); [h]Kraft, et al. (2006); [i]NYSDEC (2014b); [j]NHESP (2008).

Warm-water, Cold-water, or Year-round Inhabitants

Seasonal changes in the abundance and distribution of many fish species found within the study area are influenced by water temperature. Some species migrate into and out of the study area, whereas others remain as year-round residents, shifting habitats from shallow to deeper areas depending on the seasons. As water temperatures increase during the spring, there is an influx of warm-water species such as bluefish, menhaden, weakfish, black sea bass, haddock, mummichog, dogfish, tautog, and yellow-fin tuna from the south (NOAA, 2014d). At the same time, cold-water species such as Atlantic herring, mackerel, cod, and winter flounder begin leaving the area, heading farther north. Many species, such as scup, butterfish, goosefish, summer flounder, silver hake, red hake, skates, and longfin squid, are found year-round; however, they also exhibit seasonal inshore-offshore migrations correlated with the temperature cycle. These migrations within the study area are generally inshore in April–May and offshore during winter months to avoid colder temperatures. However, as reflected in observed stock sizes, the local fish populations (particularly commercially fished species) are highly variable year-to-year.

Hypoxia Sensitive

Another factor that can influence the distribution of fish species throughout the study area is changes in DO levels. A condition of low DO level is termed hypoxia (discussed in more detail in Section 4.6, Water Quality).

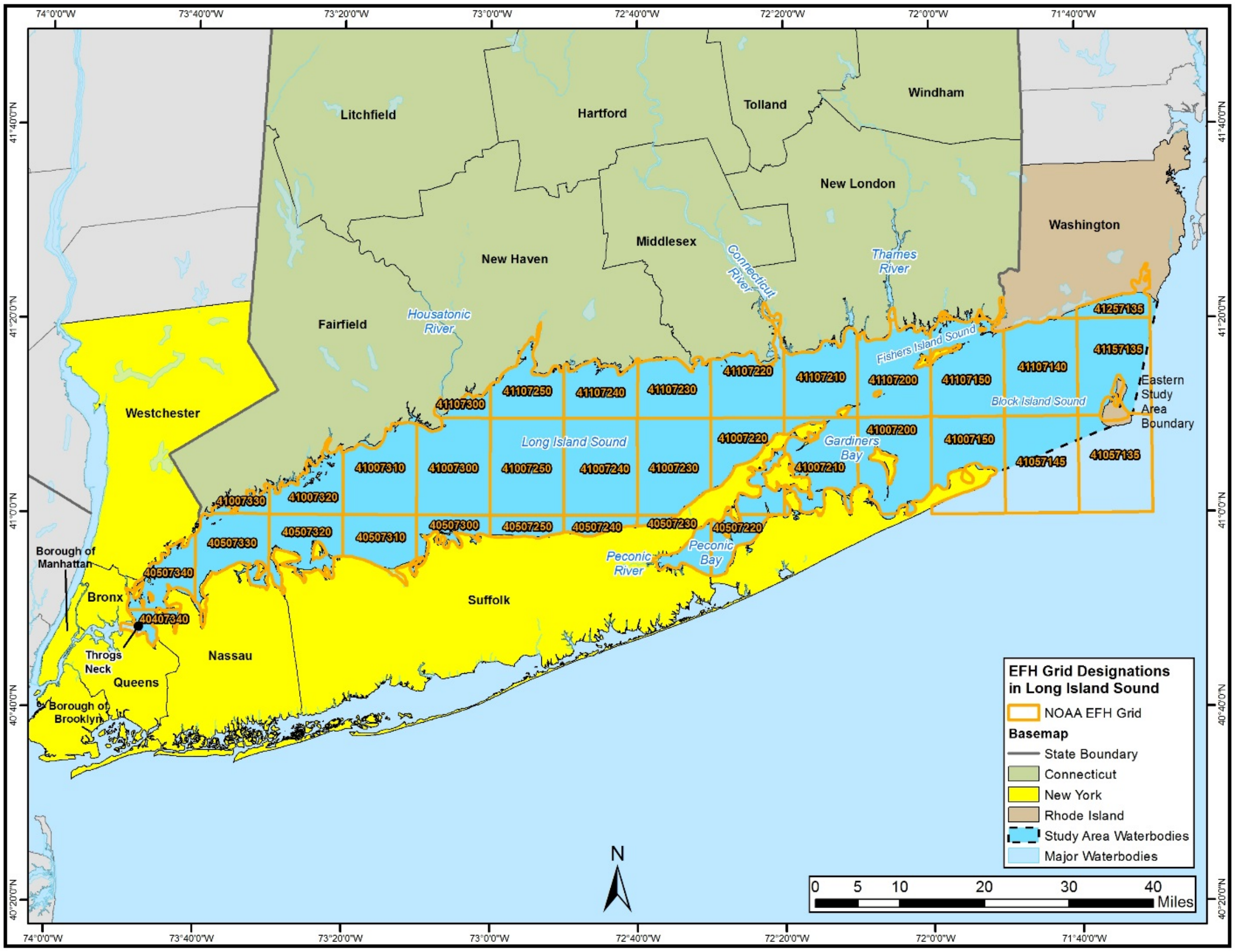
Low DO levels have been linked to lower abundance counts in some species (Latimer, et al., 2014). Many commercially and recreationally important species are sensitive to low oxygen levels, including long-finned squid and bluefish striped bass, northern pipefish, winter flounder, scup, Atlantic menhaden, and summer flounder. Fourspine stickleback, windowpane flounder, Northern sea robin, hogchoker, and spot are more tolerant (Latimer, et al., 2014).

Hypoxia also impacts some marine fish that use the nearshore waters and wetlands of the study area as nursery habitats for feeding and rapid growth critical to the success of juveniles. Early life stages of mummichog, silverside, bay anchovy, American eel, tautog, winter flounder, weakfish, bluefish, and striped bass all inhabit marshes and creeks that become warm and hypoxic in summer (Latimer, et al., 2014). Hypoxia produces a variety of reactions in fish eggs and larvae, including delayed or stimulated hatching, reduced hatching success, or induced deformities (Latimer, et al., 2014).

Designated Essential Fish Habitat

Many marine habitats are critical to the productivity and sustainability of marine fisheries. The 1996 amendments to the Magnuson-Stevens Act required that an EFH consultation be conducted for any activity that may adversely affect important habitats of Federally managed marine and anadromous fish species. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). In this definition, “waters” refers to the physical, chemical, and biological properties of aquatic areas that are currently being used or have historically been used by fish. “Substrate” refers to sediment, hard bottom, or other underwater structures and their biological communities. The term “necessary” indicates that the habitat is required to sustain the fishery and support the fish species' contribution to a healthy ecosystem.

NOAA has designated EFH for 28 finfish species and for long-finned squid within the study area. Table 4-23 provides information on those species with designated EFH near each alternative based on the EFH designations for individual 10-minute grid squares (Figure 4-48). A subset of these species (Atlantic salmon, pollock, red hake, winter flounder, windowpane flounder, Atlantic sea herring, bluefish, Atlantic mackerel, summer flounder, scup, black sea bass, king mackerel, Spanish mackerel and cobia) have specific EFH designations within Long Island Sound; Gardiner's Bay, New York; and the Connecticut River estuary. Actual locations included in each of these estuary-based designations are based on the salinity regime in which the life stage can be found (i.e., freshwater with salinities less than 0.5 psu; saltwater with salinities greater than 25 PSU; and mixed salinity zones with salinities from 0.5 to 25 PSU). In addition to EFH designations for specific life stages, the three estuaries also provide specific adult spawning EFH designations for winter flounder and windowpane flounder.



Source: NOAA (2014h).

Figure 4-48. NOAA EFH square designations in Long Island Sound.

Table 4-23. Finfish EFH Designations for 10-Minute Squares Within the Study Area.

EFH 10-Minute Grid Square Number(a)	41007210	40507230	40507240	40507310	40507320	40507330	41007150	41007200
Atlantic salmon (*Salmo salar)*	J, A	J, A	J, A	J, A	J, A	J, A		J, A
Atlantic cod *(Gadus morhua)*								
Pollock *(Pollachius virens)*		J, A	J, A	J, A	J, A	J, A		
Whiting *(Merluccius bilinearis)*			A	A			E, L, J	
Red hake *(Urophycis chuss)*		E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
Winter flounder *(Pseudopleuronectes americanus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Windowpane flounder *(Scophthalmus aquosus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	J, A	E, L, J, A
American plaice *(Hippoglossoides platessoides)*								J, A
Ocean pout *(Macrozoarces americanus)*				E, L, A			E, L, A	
Atlantic sea herring *(Clupea harengus)*	J, A	J, A	J, A	J, A	J, A	J, A		J, A
Bluefish *(Pomatomus saltatrix)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	J, A
Long-finned squid (*Loligo pealeii*)					E, L		J	
Atlantic mackerel *(Scomber scombrus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		E, L, J, A
Summer flounder *(Paralichthys dentatus)*	J	J, A	J	J	J	J	J, A	J
Scup *(Stenotomus chrysops)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	J, A	E, L, J, A
Black sea bass *(Centropristis striata)*	J, A	J	J	J	J	J	J	J, A
Spiny dogfish (*Squalus acanthias*)							J, A	
King mackerel *(Scomberomorus cavalla)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Spanish mackerel *(Scomberomorus maculatus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Cobia *(Rachycentron canadum)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Sand tiger shark *(Carcharias taurus)*	L	L	L	L	L	L	L	L
Common thresher shark (*Alopias vulpinus*)								
Blue shark (*Prionace glauca)*	A	A	A				L, J, A	A
Dusky shark *(Carcharhinus obscurus)*		L	L				L, J	L
Shortfin mako shark (*Isurus oxyrinchus)*							J	
Sandbar shark (*Carcharhinus plumbeus*)		L, J, A	L, J, A				L, J, A	L, J, A
Bluefin tuna *(Thunnus thynnus)*	A						J, A	
Little skate (*Leucoraja erinacea)*	J, A	J, A	J, A	J, A	J, A	J, A		J, A
Winter skate *(Leucoraja ocellata)*	J, A	J, A	J, A	J, A	J, A	J, A		J, A

Table 4-23. Finfish EFH Designations for 10-Minute Squares Within the Study Area (continued).

EFH 10 Minute Square Number[(a)]	41007220	41007230	41007250	41007300	41007310	41007320	41007330	41107140	41107150
Atlantic salmon (*Salmo salar)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A		
Atlantic cod *(Gadus morhua)*								A	A
Pollock *(Pollachius virens)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A		
Whiting *(Merluccius bilinearis)*		A	A	A	A				
Red hake *(Urophycis chuss)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
Winter flounder *(Pseudopleuronectes americanus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
Windowpane flounder *(Scophthalmus aquosus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
American plaice *(Hippoglossoides platessoides)*			J, A	J, A	J, A	J, A	J, A		
Ocean pout *(Macrozoarces americanus)*					E, L, J, A	E, L, J, A			
Atlantic sea herring *(Clupea harengus)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	A	A
Bluefish *(Pomatomus saltatrix)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	A	J, A
Long-finned squid (*Loligo pealeii*)						E, L			
Atlantic mackerel *(Scomber scombrus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
Summer flounder *(Paralichthys dentatus)*	J, A	J	J	J	J	J	J		
Scup *(Stenotomus chrysops)*	E, L, J	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A		
Black sea bass *(Centropristis striata)*	J	J	J	J	J	J	J		
Spiny dogfish (*Squalus acanthias*)									
King mackerel *(Scomberomorus cavalla)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Spanish mackerel *(Scomberomorus maculatus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Cobia *(Rachycentron canadum)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Sand tiger shark *(Carcharias taurus)*	L	L	L	L	L	L	L	L	L
Common thresher shark (*Alopias vulpinus*)								L, J, A	
Blue shark *(Prionace glauca)*								L, J, A	L, A
Dusky shark *(Carcharhinus obscurus)*								J	J
Shortfin mako shark (*Isurus oxyrinchus)*								J	
Sandbar shark (*Carcharhinus plumbeus*)								J, A	
Bluefin tuna *(Thunnus thynnus)*									
Little skate (*Leucoraja erinacea)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	A	A
Winter skate *(Leucoraja ocellata)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A		

Table 4-23. Finfish EFH Designations for 10-Minute Squares Within the Study Area (continued).

EFH 10-Minute Square Number$^{(a)}$	**41107200**	**41107210**	**41107220**	**41107230**	**41107240**	**41107250**	**41107300**	**41107130**
Atlantic salmon (*Salmo salar)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	
Atlantic cod *(Gadus morhua)*								A
Pollock *(Pollachius virens)*		J, A	J, A	J, A	J, A	J, A	J, A	
Whiting *(Merluccius bilinearis)*				A	A	A	A	E, L, J
Red hake *(Urophycis chuss)*	A	E, L, J, A	E, L, J, A	E, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J
Winter flounder (*Pseudopleuronectes americanus)*		E, L, J, A			E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Windowpane flounder *(Scophthalmus aquosus)*		E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	J, A
American plaice *(Hippoglossoides platessoides)*								
Ocean pout *(Macrozoarces americanus)*								E, L, J, A
Atlantic sea herring *(Clupea harengus)*	A	J, A	J, A	J, A	J, A	J, A	J, A	J, A
Bluefish (*Pomatomus saltatrix)*	J, A	J, A	J, A	J, A	J, A	J, A	J, A	J, A
Long-finned squid (*Loligo pealeii*)								A
Atlantic mackerel *(Scomber scombrus)*					E, L, J, A	E, L, J, A	E, L, J, A	
Summer flounder *(Paralichthys dentatus)*					J	J	J	A
Scup *(Stenotomus chrysops)*					E, L, J, A	E, L, J, A	E, L, J, A	J, A
Black sea bass *(Centropristis striata)*					J	J	J	J, A
Spiny dogfish (*Squalus acanthias*)								
King mackerel *(Scomberomorus cavalla)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Spanish mackerel *(Scomberomorus maculatus)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Cobia (*Rachycentron canadum)*	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A	E, L, J, A
Sand tiger shark *(Carcharias taurus)*	L	L	L	L	L	L	L	
Common thresher shark (*Alopias vulpinus*)								L, J, A
Blue shark (*Prionace glauca)*								L, J, A
Dusky shark *(Carcharhinus obscurus)*	J							J
Shortfin mako shark (*Isurus oxyrinchus)*								J
Sandbar shark (*Carcharhinus plumbeus*)								J, A
Sand tiger shark *(Carcharias taurus)*								L
Bluefin tuna *(Thunnus thynnus)*	A							A
Little skate (*Leucoraja erinacea)*		J, A	J, A	J, A	J, A	J, A	J, A	
Winter skate *(Leucoraja ocellata)*		J, A	J, A	J, A	J, A	J, A	J, A	

Sources: NOAA (2014h), (2014i), (2014j).

[a] EFH can be designated for any of the four life stages (E – egg, L – larval, J – juvenile, and A – adult).

Threatened or Endangered Fish Species

Currently, three marine fish species are listed as threatened or endangered in the study area: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), and rainbow smelt (*Osmerus mordax*). Shortnose sturgeon and Atlantic sturgeon are protected under the ESA and managed by the NMFS. Rainbow smelt are state-listed in Connecticut and are protected under Connecticut's state laws.

The shortnose sturgeon is listed as endangered throughout the study area (CTDEEP (2014e); NYSDEC (2014c)) and listed as a state historical[2] species for Rhode Island (RIDEM, 2006) due to its unknown current population status. Shortnose sturgeon occurs in the lower Connecticut River from the Holyoke Pool to Long Island Sound. Shortnose sturgeon spawns in freshwater within a one- to two-week period from the end of April to the first week of May (CTDEEP, 2014e). Populations of shortnose sturgeon in North America have declined due to overfishing, loss of habitat, limited access to spawning areas, and water pollution. Unlike other anadromous species such as salmon and shad, shortnose sturgeon does not appear to make long-distance offshore migrations (NMFS, 2014a). It is possible that shortnose sturgeon utilize portions of Long Island Sound since the species is known to spawn in the Connecticut River; however, they have not been captured in the CTDEEP trawl survey, which has been sampling Long Island Sound from 1984 to 2012, or in any other sampling programs conducted in Long Island Sound (EPA (2004) [Appendix H-6]).

The Atlantic sturgeon is listed as "threatened in inland waters" for the state of Connecticut (CTDEEP, 2014e) and as a state historical species for Rhode Island (RIDEM, 2006). The Connecticut designation means that the Atlantic sturgeon is not protected within the waters of Long Island Sound under Connecticut's endangered species legislation, but a moratorium on harvesting the species in Long Island Sound has been enacted. In February 2003, a proposal was made to change the status of the Atlantic sturgeon to "endangered in all state waters" (NMFS, 2007). As a result, the New York Bight distinct population segment was listed as endangered, but the Atlantic sturgeon was still listed as threatened in Connecticut (USFWS, 2010). The Atlantic sturgeon appears to be less abundant in the Connecticut River than shortnose sturgeon, which is also Federally endangered. Though it is strictly regulated, Atlantic sturgeon is still commercially harvested in other areas (USFWS, 2010).

Atlantic sturgeon is an anadromous species that lives up to 60 years, reaching lengths up to 14 ft and weighing over 800 lbs (NMFS, 2014b). Long Island Sound may be an important feeding or resting area while these sturgeon migrate to and from spawning areas in the Hudson River because all sizes of Atlantic sturgeon have been observed or captured in the Sound. Atlantic sturgeon has been caught in all three basins of Long Island Sound, but they were mainly located in the vicinity of Falkner Island (Savoy & Pacileo, 2003). More details about the life history and distribution of this species are found in EPA (2004).

Rainbow smelt are listed by Connecticut as endangered due to a century of decline caused by habitat loss, pollution, and obstruction of spawning routes (Buckley, 1989). These minnow-like

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[2] A designation (SH) assigned to native species which have been documented for the state during the last 100 years, but which are currently unknown to occur within the state boundaries (RIDEM, 2006).

fishes are primarily marine but enter freshwater to spawn. Larval and juvenile smelt typically feed on zooplankton; adults include amphipods, polychaetes, and even small fish (e.g., mummichog) in their diet (Buckley, 1989). Adults swim into streams at night, rarely progressing more than a few hundred yards upstream to spawn and then return to the estuary.

Commercially Important Fisheries

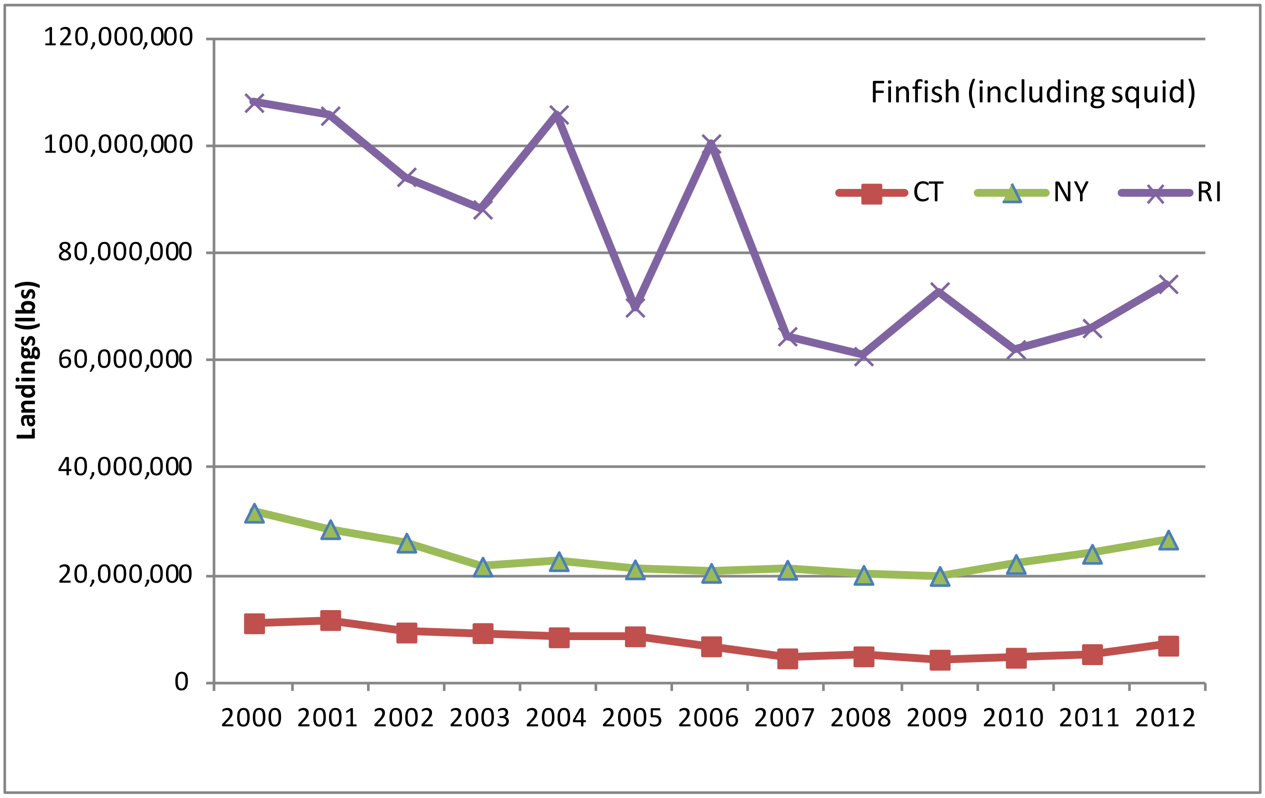
As part of its overall marine resource management responsibilities, NMFS has long collected data on commercial fisheries throughout the country. Fishermen are responsible for routinely filing Vessel Trip Reports (VTRs) that report not only the catch but also gear type and area fished. This information is used to evaluate the commercial fish and shellfish catch (weight in pounds and metric tons) that are harvested from and landed (reported) in a given region. To determine which fisheries are most commercially important, the NMFS commercial landing data were accessed to determine which species in Connecticut, New York, and Rhode Island were most often landed (NOAA, 2014d).

Commercial landings data are available for finfish species and squid for Connecticut, New York, and Rhode Island. However, it is difficult to specifically identify the catch location of individual finfish species solely from state-based catch landing data because “landed” fish may not have been caught within a particular state’s waters or the study area (Latimer, et al., 2014). Even with this ambiguity, landings data are an essential tool used by fisheries scientists and managers to track trends in harvest and provide evidence of ecosystem dynamics.

Combined finfish (including squid) landings from the three states decreased over the past decade. The largest overall decrease in million pounds of fish occurred in Rhode Island, where the catch has decreased from 108 million lbs in 2000 to 74 million lbs in 2012. This represents a decrease of 31% of the catch in 13 years. Although Connecticut and New York have substantially lower overall landings for these same years, they also experienced substantial decreases in landings. New York landings decreased 30%, while Connecticut landings decreased 38% between 2000 and 2012 (Figure 4-49). In general, the most commonly caught species include bluefish, butterfish, Atlantic cod, goosefish, summer flounder, winter flounder, red hake, silver hake, scup, skates, spiny dogfish and longfin squid.

For the last 29 years, CTDEEP has conducted trawl surveys throughout Long Island Sound. In 20 of those 29 years, butterfish was the most numerous finfish caught by the trawl surveys in Connecticut waters. For example, in 2012, butterfish represented 38% of the catch by count and 11% by weight. Scup, the second most abundant fish, led by weight, accounting for 35% of the overall weight caught in 2012. Five species accounted for 82% of the total annual catch and 52% of the total weight caught. Along with butterfish and scup, silver hake, weakfish, and bluefish rounded out these top five species (CTDEEP, 2013c).

NOAA landings data for these same species illustrate that the catch varies widely depending on the year and the state (Figure 4-50). For example, while butterfish landings in Connecticut were fairly consistent from 2000 to 2012, landings in New York decreased by 48% and those in Rhode Island decreased (ignoring the anomalous 500% increase in landings between 2000 and 2001 as shown in Figure 4-50) by 57% (NOAA, 2014h).

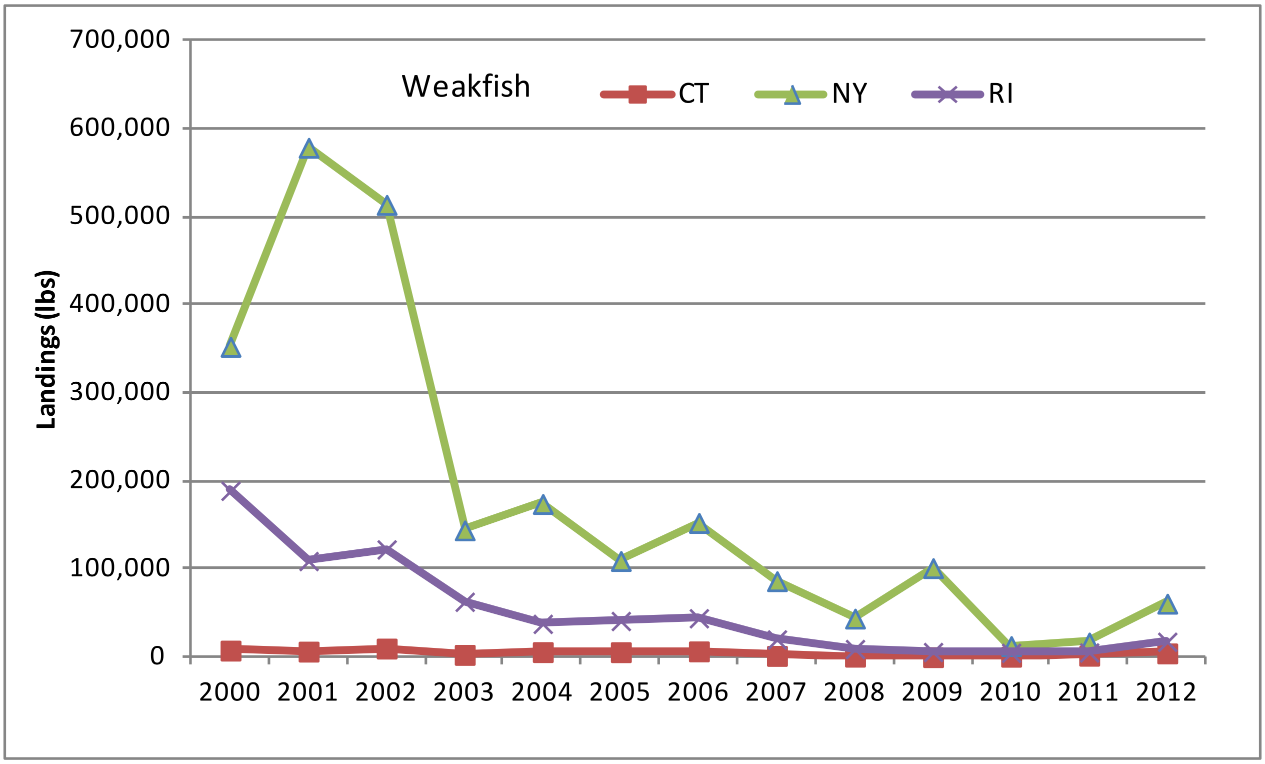


Source: NOAA (2014d).

Figure 4-49. Total Landings of Finfish Annually for Connecticut, Rhode Island, and New York.

Source: NOAA (2014d).

Figure 4-50. Total Landings Annually for Each Species in Connecticut, Rhode Island, and New York.



Source: NOAA (2014d).

Figure 4-50. Total Landings Annually for Each Species in Connecticut, Rhode Island, and New York (continued).

In summary, the finfish resources within the study area are spatially and temporally variable, primarily because fish are mobile, moving within and outside of Long Island Sound in search of prey or habitat. Several species that migrate in conjunction with temperature changes also contribute to this variability. The NMFS Connecticut and New York landings data indicate that fish populations in Long Island Sound in the summer (May through August) are larger than during other seasons of the year. However, Rhode Island landings data indicate that fish populations are highest in January through March. These data suggest that different fish species use the diverse habitats at varying times of the year.

Long-term changes in the distribution, abundance, and productivity of marine fish populations can be caused by a variety of factors, including habitat degradation, contamination, overfishing, and climate change (induced naturally and/or anthropogenically). It is likely that these different categories can operate interactively to effect population changes, with the relative importance of each dependent on species-specific attributes (Robinson & Pederson, 2005). For example, overexploitation is generally considered to be the primary cause of the precipitous contraction of the New England ground fishery (e.g., flounders) in the 1970s and 1980s. However, the increased use of more efficient fishing techniques such as otter trawls, which led to destruction of bottom substrate critical to the survival of juvenile fish, most likely also contributed to this general decline. Aquatic exposure to contaminants (including endocrine disruptors) may induce stress in exposed fish and increase their susceptibility to disease, parasitism, and predation (Kime, 1998).

Various effects associated with climate change (including altered temperature, modified salinity regimes, precipitation, wind fields, and sea level rise) will affect the distribution, abundance, and productivity of marine organisms (Scavia, et al., 2002). In particular, estuarine-dependent fish may be particularly affected by altered freshwater flows, rising sea level, and increased runoff (which introduces elevated loadings of suspended sediments, pollutants, and nutrients to the estuary). Warming ocean temperatures may also lead to latitudinal shifts in distributions (Scavia, et al., 2002) and the local extirpation of sensitive species at their geographical range limits.

Within Long Island Sound (particularly in the Western Basin), seasonally low DO levels including anoxic conditions have been documented since the 1990s. Conditions have slowly been improving since implementation of a nutrient-focused TMDL approved by Connecticut and New York in 2001 (Bricker, et al., 2007). The overall condition of Long Island Sound is categorized as “poor” based on the most recent National Estuary Program Coastal Condition Report (EPA, 2007b). Of the four indices evaluated, Long Island Sound water quality was rated fair, while sediment quality, benthic index, and fish tissue contaminant indices were all rated “poor”.

Freshwater Fish in the Study Area

The upland portions of the study area include habitat for freshwater fish that are considered threatened or endangered by either Federal or state classifications. Several recreationally important fish species are also found in waterbodies of the upland areas.

Threatened and Endangered Freshwater Fish

The shortnose sturgeon (*Acipenser brevirostrum*) and the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) occur in both marine waters and freshwaters of the study and are discussed above in Section 4.10.1.

Along with these Federally listed species, each state may develop and maintain separate lists for threatened, endangered, and special concern species pursuant to state regulations. The NYSDEC maintains a list of endangered, threatened, and special concern species according to 6NYCRR part 182.2(g). In addition to the two Federally listed species, two other freshwater species within the study area—the banded sunfish (*Enneacanthus obesus*) and the swamp darter (*Etheostoma fusiforme*)—are considered threatened by the state (Table 4-24).

The Connecticut ESA of 1989 developed a state program to identify and protect native plant and animal populations from extinction. Under CGS Section 26-303, three additional freshwater species are considered endangered (the American brook lamprey [*Lampetra appendix*], the burbot [*Lota lota*], and the rainbow smelt [*Osmerus mordax*]); one species is considered threatened (the swamp darter [*Etheostoma fusiforme*]); and four species are considered of special concern (the blueback herring [*Alosa aestivalis*], the longnose sucker [*Catostomus catostomus*], the banded sunfish [*Enneacanthus obesus*], and the bridle shiner [*Notropis bifrenatus*]) by the state (Table 4-24).

The Rhode Island Natural Heritage Program was established in 1978 to identify vulnerable natural resources within the state. In addition to listing threatened and endangered species in Rhode Island, the program also identifies historical species which were documented in the last 100 years but are currently unknown to occur. The current list includes one state historical species (the Atlantic sturgeon [*Acipenser oxyrinchus oxyrinchus*]) and one state threatened species (the American brook lamprey [*Lampetra appendix*]) (Table 4-24).

Table 4-24. Threatened and Endangered Freshwater Fish in the Study Area.

Species	Status
Shortnose Sturgeon (*Acipenser brevirostrum*)	NY: Federally Endangered CT: Federally Endangered RI: Federally Endangered
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	NY: Federally Endangered CT: Threatened RI: State Historical
Blueback Herring (*Alosa aestivalis*)	CT: Special Concern
Longnose Sucker (*Catostomus catostomus*)	CT: Special Concern
Banded Sunfish (*Enneacanthus obesus*)	NY: Threatened CT: Special Concern
American Brook Lamprey (*Lampetra appendix*)	CT: Endangered RI: Threatened
Burbot (*Lota lota*)	CT: Endangered
Bridle Shiner (*Notropis bifrenatus*)	CT: Special Concern
Rainbow Smelt (*Osmerus mordax*)	CT: Endangered
Swamp Darter (*Etheostoma fusiforme*)	NY: Threatened

Recreational Freshwater Fish in the Study Area

The freshwater habitats of the study area are home to several coldwater and warmwater fisheries important to recreational anglers. No commercially important freshwater fisheries were identified in the study area.

The New York portion of the study area consists of over 500 lakes and ponds and more than 30 mi of streams (NYSDEC, 2015). Several New York counties are limited to catch-and-release fishing only; these counties are primarily fished for largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), native brook trout (*Salvelinus fontinalis*), and a variety of panfish.

The state of Connecticut has over 180 public lakes and ponds and thousands of miles of fishable rivers and streams (CTDEEP, 2014e). Recreationally important species include landlocked blueback herring (*Alosa aestivalis*), American eel (*Anguilla rostrata*), American shad (*Alosa sapidissima*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), chain pickerel (*Esox niger*), hickory shad (*Alosa mediocris*), kokanee (*Oncorhynchus nerka*), northern pike (*Esox Lucius*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), lake trout (*Salvelinus namaycush*), rainbow trout (*Oncorhynchus mykiss*), white perch (*Morone americana*), and walleye (*Sander vitreus*), along with various carp and panfish.

Key recreational species in Rhode Island include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), chain pickerel (*Esox niger*), northern pike (*Esox Lucius*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), lake trout (*Salvelinus namaycush*), rainbow trout (*Oncorhynchus mykiss*) and panfish.

4.10.2 Fish in the Open-Water Environment

A summary of fish found within the influence of the proposed alternative open-water sites is presented in Table 4-25. Both EFH and non-EFH fish species described above may be found at any of the unconfined open-water alternative sites (WLDS, CLDS, CSDS, and NLDS) and at the confined open-water site Alternative E.

Table 4-25. Fish in Open-Water Environments.

Environment	Alternative Type	Alternative ID	EFH Designations
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS	EFH Square 40507320 (15 species documented)[1]
		CLDS	EFH Square 41007250 (17 species documented)[1]
		CSDS	EFH Square 41107220 (10 species documented)[1]
		NLDS	EFH Square 41107200 (10 species documented)[1]
	Confined Open-Water Placement	E	EFH Square 41007310 (18 species documented)[2]

Source: [1]NOAA (2014i); [2]USACE (2012a).
Note: Of the 35 species that have been identified in historical trawl surveys; only 18 finfish have designated EFH.

Unconfined Open-Water Placement

According to the NOAA EFH square designations, the WLDS alternative has 15 Federally managed species, the CLDS alternative has 17 Federally managed species, the CSDS alternative has 10 Federally managed species, and the NLDS alternative has 10 Federally managed species.

Confined Open-Water Placement

At confined open-water Site Alternative E (Sherwood Island Borrow Pit), NOAA EFH designations identify 18 Federally managed species present in the vicinity (USACE, 2012a).

4.10.3 Fish in the Nearshore/Shoreline Environment

A summary of fish found within the influence of alternative nearshore and shoreline placement sites is presented in Table 4-26. Nearshore species that may be found along the shoreline adjacent to berms or beaches or in nursery habitats include Atlantic menhaden, American eel, winter flounder, Atlantic herring, perch, Northern pipefish, fourbeard rockling, American sand lance, longhorn sculpin, sea raven, searobin, Atlantic and inland silverside, and rainbow smelt (CTDEEP, 2012d).

Confined Placement

The *Final Long Island Sound Dredged Material Management Plan (DMMP) Investigation of Potential Containment Sites for Placement of Dredged Materials* (USACE, 2012a) documents 33 to 35 Federally managed species (Magnuson-Stevens Act) within the vicinity of the 17 potential confined placement sites.

Beneficial Use

Nearshore Bar/Berm Placement

The *Final Long Island Sound Dredged Material Management Plan (DMMP) Investigation of Potential Nearshore Berm Sites for Placement of Dredged Materials* (USACE, 2012b) documents between 34 and 40 Federally managed species within the vicinity of 39 potential berm sites.

Beach Nourishment

Specific fish present at the beach locations were not identified. In general, EFH species similar to those found at the nearshore berm sites would be expected to be present depending on tidal stage.

4.10.4 Fish in the Upland Environment

Based on the USFWS Critical Habitat for Threatened and Endangered Species dataset, no Federally listed freshwater fish species are expected to occur within the Landfill Placement, Landfill Capping/Cover, Brownfields/Redevelopment, or Habitat Restoration sites. Based on the three state lists of threatened, endangered, and special concern species, there is potential for some of these species to occur within 1 mi of certain upland sites (Table 4-27).

Table 4-26. Fish in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	EFH Designations [1]
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	EFH Square 41007310 (18 species documented)
		H	EFH Square 41007310 (18 species documented)
		M	EFH Square 41107250 (16 species documented)
	Island CDF	B	EFH Square 41007330 (16 species documented)
		L	EFH Square 41107250 (16 species documented)
		N	EFH Square 41107240 (16 species documented)
		P	EFH Square 41107230 (11 species documented)
		Q	EFH Square 41107210 (11 species documented)
		R	EFH Square 41107200 (10 species documented)
	Shoreline CDF	A	EFH Square 40507330 (15 species documented)
		C	EFH Square 41007320 (18 species documented)
		D	EFH Square 41007330 (16 species documented)
		F	EFH Square 41007310 (18 species documented)
		I	EFH Square 41007310 (18 species documented)
		J	EFH Square 41007300 (17 species documented)
		K	EFH Square 41107300 (16 species documented)
		O	EFH Square 41107230 (11 species documented)
	Nearshore Bar Placement/ Nearshore Berm Sites	177	EFH Square 41007150 (19 species documented)
		178	EFH Square 41007150 (19 species documented)
		179	EFH Square 41007150 (19 species documented)
		121/446	EFH Square 41007150 (19 species documented)
		453	EFH Square 41007150 (19 species documented)
		173	EFH Square 41007200 (17 species documented)
		180	EFH Square 41007210 (14 species documented)
		454A	EFH Square 41007220 (15 species documented)
		454B	EFH Square 41007220 (15 species documented)
		455/82	EFH Square 41007230 (16 species documented)
		445	EFH Square 40507230 (18 species documented)
		171	EFH Square 40507240 (19 species documented)
		170	EFH Square 40507310 (17 species documented)
		63	EFH Square 40507320 (15 species documented)
		456	EFH Square 40507330 (15 species documented)
		441	EFH Square 41007320 (18 species documented)
		320	EFH Square 41007320 (18 species documented)
		440	EFH Square 41007320 (18 species documented)
		449	EFH Square 41007310 (18 species documented)
		438	EFH Square 41007310 18 species documented)

Table 4-26. Fish in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	EFH Designations [1]
		433	EFH Square 41007310 (18 species documented)
		434	EFH Square 41007310 (18 species documented)
		323	EFH Square 41007310 (18 species documented)
		467	EFH Square 41007300 (17 species documented)
		364	EFH Square 41007310 (18 species documented)
		451	EFH Square 41007250 (17 species documented)
		447	EFH Square 41007250 (17 species documented)
		327/333/ 330	EFH Square 41007250 (17 species documented)
		337	EFH Square 41007250 (17 species documented)
		457	EFH Square 41107230 (11 species documented)
		365	EFH Square 41107230 (11 species documented)
		GP	EFH Square 41107220 (10 species documented)
		367	EFH Square 41107210 (11 species documented)
		368	EFH Square 41107200 (10 species documented)
		381/382	EFH Square 41107150 (10 species documented)
		384	EFH Square 41107140 (13 species documented)
		600	EFH Square 41107130 (22 species documented)[2]
		610	EFH Square 41107130 (22 species documented)[2]
		620	EFH Square 41107150 (10 species documented)
	Beach Nourishment	323, 323, 433, 434, 436, 365, 457, 364, 444, 451, 337, 320, 441, 442, 450, 447, 438, 440, 449, 181, 453, 63, 456, 454E, 454W, 455/82, 384, 367, 368, 171, 173, 177, 178, 179, 170, 180, 445, 446, 343, 474, 339, 459, 348, 480, 467, 468, 325, 327, 329, 330, 331, 332, 333, 344, 345, 121, 64, 67, 68, 111, 76, 79, 381, 382, 437, 600, 610, 620	No EFH Designations for Beach Nourishment sites

Sources: [1]NOAA (2014i); [2]NOAA (2014j).

Table 4-27. Freshwater Fish in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1]
Upland Environment	**Landfill Placement**	59	None Documented
	Landfill Cover/Capping	60	None Documented
		61	None Documented
		251	Possible CT Listed Species Possible Recreational Species
		272	Possible CT Listed Species Possible Recreational Species
	Brownfields & Other Redevelopment	422/423	Possible NY Listed Species Possible Recreational Species
	Habitat Restoration / Enhancement or Creation	427	Possible NY Listed Species Possible Recreational Species
		429	Possible NY Listed Species Possible Recreational Species

Source: [1]NOAA (2014i).

4.11 SUBMERGED AQUATIC VEGETATION AND SENSITIVE UPLAND VEGETATION

4.11.1 General Long Island Sound Setting

The waters of Long Island Sound include habitat areas for SAV, while upland portions of the study area include a number of rare and sensitive plants. These plant species have specific habitat requirements and are protected by various state and Federal regulations. Wetland plants are discussed separately in Section 4.15.

Long Island Sound Submerged Aquatic Vegetation

SAV in Long Island Sound includes eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). Eelgrass, the primary seagrass in the study area, historically had a wide distribution in the shallow coastal waters of the Sound, while widgeon grass distribution is typically limited to the more estuarine and freshwater environs (Latimer, et al., 2014). Seagrass beds are extremely productive ecosystems; they provide critical habitat for marine fishes, sea turtles, and invertebrates, including many commercially important species such as the bay scallop *(Argopecten irradians*), hard clams (*Mercenaria mercenaria*), and American lobsters (*Homarus americanus*) (NYNHP, 2013).

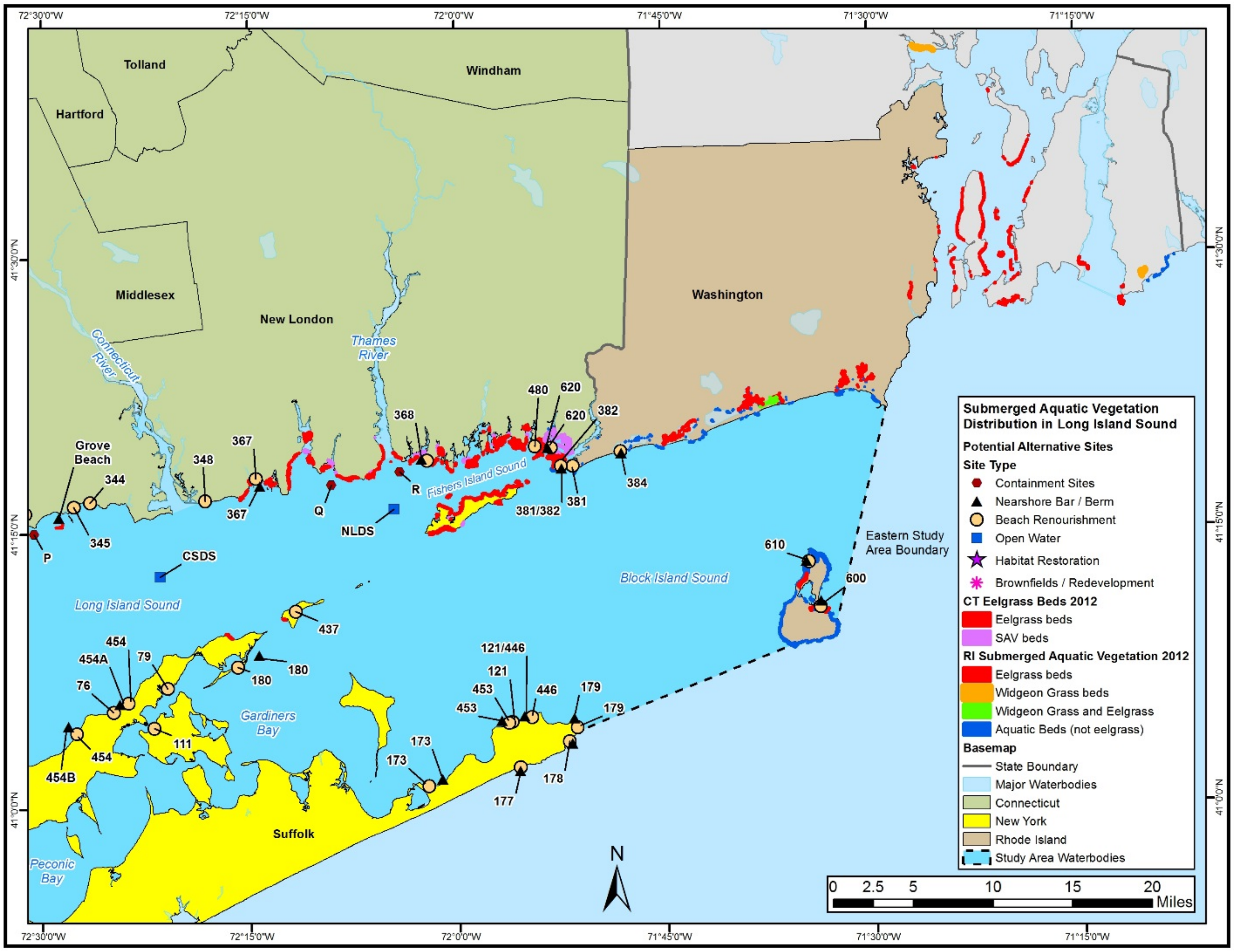
SAV habitat is dependent on nutrients, temperature, and light penetration through the water column. Most seagrasses, including eelgrass, require a significant amount of sunlight in comparison to macroalgae and phytoplankton; therefore, light penetration and water clarity are often the limiting factors determining seagrass distribution and survival (Latimer, et al., 2014). The light requirements for eelgrass and light attenuation in Long Island Sound waters were used to calculate a maximum depth contour for potential eelgrass occurrence of 5 ft in western Long Island Sound and 10 ft in eastern Long Island Sound (Latimer, et al., 2014). This shallow depth requirement limits eelgrass to the extreme coastal environment, where the plants are susceptible to impacts from upland runoff and physical disturbance.

Prior to 1930, eelgrass beds were common in coastal waters from North Carolina to New England, including Long Island Sound. For example, eelgrass beds may have covered 200,000 acres of New York State waters before 1930 when a wasting disease caused by a slime mold (*Labyrinthula zosterae*) destroyed all but 1% of the entire North Atlantic population (Latimer, et al., 2014). A partial and patchy recovery of wasting disease-resistant eelgrass was reported in portions of the Sound through the 1950s (Long Island Sound Study, 2004). Since then, increasingly poor coastal water quality and clarity from nitrogen loading, harmful algal blooms, and sedimentation led to a steady loss of eelgrass beds throughout the study area (Latimer, et al., 2014). For example, less than 22,000 acres of eelgrass are currently found in New York State waters (NYNHP, 2013) and much of the eelgrass along the Connecticut shoreline west of the Connecticut River that was abundant in the early 1990s (Koch & Beer (1996), Randall, et al. (1999)) is no longer present. Today, the distribution of SAV beds in the study area is limited to the eastern portion of Long Island Sound and portions of Washington County and Block Island in Rhode Island (Figure 4-51).

While eelgrass is not protected through Federal or state programs, various conservation efforts are under way to protect and restore these sensitive beds. These efforts focus on improving coastal water quality through the development of TMDLs for nutrients, considering eelgrass habitat during coastal development projects, restricting certain types of fishing gear in eelgrass areas, and implementing replanting programs.

Sensitive Upland Plants in the Study Area

Federal and state governments maintain lists of threatened and endangered plants and animals that are subject to special consideration for conservation and preservation due to their current population status. The Federal ESA of 1973 established a framework to classify native species that are considered in peril and granted authority to the USFWS and the NMFS to protect those species and their habitats from further degradation. Under the ESA, a species can be listed as either "endangered", with the threat of extinction throughout most or all of its range, or "threatened", which is likely to become endangered in the near future. State agencies may maintain separate lists that further expand on these classifications based on local population status.



Source: CTDEEP (2012e); RIGIS (2014a).

Figure 4-51. Distribution of SAV and Alternative Sites in the Long Island Sound Study Area (Eastern Basin).

The study area includes several threatened or endangered upland plants; other threatened or endangered species within the study area are discussed in Section 4.10 (Fish), Section 4.13 (Birds), Section 4.14 (Marine Mammals and Marine Reptiles), and Section 4.16 (Terrestrial Wildlife and Threatened and Endangered Species).

Federally Listed Plants

Two Federally listed upland plants occur within all three states of the study area: the sandplain gerardia (*Agalinis acuta*) and the small-whorled pogonia (*Isotria medeolooides*). In addition, the seabeach amaranth (*Amaranthus pumilus*), a Federally listed plant, occurs within the New York portion of the study area. These three plants are briefly described as follows:

Sandplain gerardia (*Agalinis acuta*) is found in the coastal grasslands around Long Island Sound which occur on glacial outwash plains with nutrient-poor and well-drained soils (Long Island Sound Study, 2003). Sandplain gerardia grows in sandy, exposed soils that depend on disturbances like mowing or periodic fires to maintain an open habitat (USFWS, 2012). The plant has been listed as a Federally endangered species since 1988.

Small-whorled pogonia (*Isotria medeolooides*) is an orchid that grows in hardwood forests and has been considered endangered since 1982. The plant prefers a thick leaf litter and an open understory canopy. Development leading to habitat destruction is the primary threat to the small-whorled pogonia. It is a Federally threatened species believed to be extirpated from its New York range (USFWS, 2014a).

Seabeach amaranth (*Amaranthus pumilus*), a Federally threatened species, is found only in the New York portion of the study area, including confirmed communities in Nassau, Queens, and Suffolk Counties (NYNHP, 2010). This plant's range includes beach dunes in the states of New York, North Carolina, and South Carolina. The plant grows in the barrier beach landscape above the high tide line in areas where sand is deposited (USFWS, 2014b).

State Listed Plants

Along with the Federally listed species described above, each state may develop and maintain separate lists for threatened, endangered, and special concern species pursuant to state regulations.

The Connecticut ESA of 1989 developed a state program to identify and protect native plant and animal populations from extinction. To date, 334 plant species have been listed under CGS Section 26-303 as threatened, endangered, or of special concern (CTDEEP, 2010b).

In New York, rare plants are catalogued through the New York Natural Heritage Program Rare Plant Status List according to 6NYCRR part 193.3. Currently, 574 plants are under the legal classification of the New York Natural Heritage Program, including approximately 240 species within the counties included in the study area (NYNHP, 2010).

The Rhode Island Natural Heritage Program was established in 1978 to identify rare plants and provide guidance on land preservation and development within the state. The current list includes 1,700 plants, including species from 55 different plant families within Washington County (Enser, 2007).

4.11.2 Open-Water Environment

Unconfined Open-Water Placement

No mapped SAV resources exist within 1 mi of the open-water placement sites.

Confined Open-Water Placement

No mapped SAV resources exist within 1 mi of the confined open-water placement site.

4.11.3 Nearshore/Shoreline Environment

SAV habitat occurs in the nearshore environment; however, no mapped eelgrass beds occur within a 1-mi radius of the proposed In-Harbor CAD Cells or Shoreline CDF alternative sites because of their location in the Western and Central Basins of the Sound where eelgrass is currently non-existent. Two of the proposed Island CDFs, Alternative Site Q (Twotree Island CDF) and Alternative Site R (Groton Black Ledge CDF), are within 1 mi of mapped eelgrass beds (Table 4-28 and Figure 4-51).

Beneficial Use

Based on the current mapped eelgrass beds in the study area, 15 of the selected berm and beach renourishment sites are expected to have eelgrass within 1 mi; these sites are listed in Table 4-28 and shown on Figure 4-51. No specific Island or Shoreline Restoration sites have been identified to date. If a location were to be identified within the Long Island Sound study area, the presence of threatened, endangered, and special concern plant species would need to be investigated at that time.

Table 4-28. SAV and Plants in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G, H, M	None documented
	Island CDF	B, L, N, P	None documented
		Q, R	SAV within 1 mi[2]
	Shoreline CDF	A, C, D, F, I, J, K, O	None documented
	Nearshore Bar Placement/ Nearshore Berm Sites	177, 178, 179, 121/446, 453, 173, 180, 454A, 454B, 455/82, 445, 171, 170, 63, 456, 441, 320, 440, 449, 438, 433, 434, 323, 467, 364, 451, 447, 327/333/330, 337, 457, 365, 381/382, 384	None documented
		GP, 367, 368, 620	SAV within ½ mi[2]
		600, 610	SAV within ½ mi[1]
	Beach Nourishment	323, 433, 434, 436, 365, 457, 364, 444, 451, 337, 320, 441, 442, 450, 447, 438, 440, 449, 181, 453, 63, 456, 454E, 454W, 455/82, 384, 171, 173, 177, 178, 179, 170, 180,	None documented

Table 4-28. SAV and Plants in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present
		445, 446, 343, 474, 339, 459, 348, 467, 468, 325, 327, 329, 330, 331, 332, 333, 344, 345, 121, 64, 67, 68, 111, 76, 79	
		367, 368, 480, 381, 382, 437, 620	SAV within ½ mi[2]
		600, 610	SAV within ½ mi[1]

Sources: [1]USACE (1994); [2]CTDEEP (2012e).

4.11.4 Upland Environment

Based on the USFWS Critical Habitat for Threatened and Endangered Species dataset, no Federally listed plant species are expected to occur within the Landfill Placement, Landfill Capping/Cover, Brownfields/Redevelopment, or Habitat Restoration sites. Based on the three state lists of threatened, endangered, and special concern species, there is potential for some of these species to occur within 1 mi of these upland sites (Table 4-29).

No specific Upland CDF or Innovative Technology sites have been identified to date. If a location were to be identified within the Long Island Sound study area, the presence of threatened, endangered, and special concern plant species would need to be investigated at that time.

Table 4-29. SAV and Plants in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	Possible NY Listed Plants for Suffolk County[1]
	Landfill Cover/Capping	60	Possible NY Listed Plants for Suffolk County[1]
		61	Possible NY Listed Plants for Suffolk County[1]
		251	Possible CT Listed Plants[2]
		272	Possible CT Listed Plants[2]
	Brownfields & Other Redevelopment	422/423	Possible NY Listed Plants for Queens County[1]
	Habitat Restoration / Enhancement or Creation	427	Possible NY Listed Plants for Kings County[1]
		429	None documented

Sources: [1]NYNHP (2010); [2]CTDEEP (2009).

4.12 MARINE PROTECTED AREAS

4.12.1 General Long Island Sound Setting

Marine protected areas (MPAs) are regions in which restrictions have been placed on human activity to protect the natural environment, its surrounding waters and the occupant ecosystems, and any cultural or historical resources that may require preservation or management. Typical restrictions in MPAs include fishing, oil and gas mining, and tourism. Other limits may include restrictions on sonar use, development, and construction. Some fishing restrictions include “no-take” zones, which means that no fishing is allowed. In other instances, activities are restricted seasonally or temporarily to let the area recover. The International Union for Conservation of Nature defines an MPA as:

> "*… a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values*." (IUCN, 2010)

Per NOAA (2008), MPAs can address several areas of conservation (including the protection of the natural or cultural heritage) or address sustainable production. Each form of protection focuses on a slightly different concern:

- Natural Heritage: “MPAs or zones established and managed wholly or in part to sustain, conserve, restore, and understand the protected area’s natural biodiversity, populations, communities, habitats, and ecosystems; the ecological and physical processes upon which they depend; and, the ecological services, human uses and values they provide to this and future generations.” (NOAA, 2008)
- Cultural Heritage: “MPAs or zones established and managed wholly or in part to protect and understand submerged cultural resources that reflect the nation’s maritime history and traditional cultural connections to the sea.” (NOAA, 2008)
- Sustainable Production: “MPAs or zones established and managed wholly or in part with the explicit purpose of supporting the continued extraction of renewable living resources (such as fish, shellfish, plants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area’s habitat for essential aspects of their ecology or life history.” (NOAA, 2008)

The levels and types of protection applied to MPAs in the United States vary based on the type of conservation being conducted. Any MPA, or management zone within a larger MPA, can be characterized by one of six levels of protection, which will directly influence its effects on the environment and human uses. The MPAs within the study area are all either Uniform Multiple Use or Zoned Multiple Use. These protection levels are defined as follows:

- Uniform Multiple Use: “MPAs or zones with a consistent level of protection and allowable activities, including certain extractive uses, across the entire protected area” (NOAA, 2008).
- Zoned Multiple Use: “MPAs that allow some extractive activities throughout the entire site, but that use marine zoning to allocate specific uses to compatible places or times in order to reduce user conflicts and adverse impacts” (NOAA, 2008).

For example, a Natural Heritage MPA identified as the Southern Nearshore Trap/Pot (Lobster) Waters MPA is a Uniform Multiple Use protected area occurring throughout Long Island Sound and areas south along the coast to North Carolina.[3] It is managed by the NMFS through a Programmatic Species Management Plan and restricts commercial fishing activities (USACE, 2012b).

MPAs can include shoreline habitat, Federally designated sites such as national wildlife refuges (NWRs), and state-identified sites such as parks. Figure 4-52 through Figure 4-54 show MPAs in the Western, Central, and Eastern Basins of Long Island Sound. There are seven Federally designated national refuges in the study area. The largest is Silvio O. Conte National Fish and Wildlife Refuge; the most dispersed is the Stewart B. McKinney National Wildlife Refuge, which occurs several places along the coast of Connecticut. Four others are part of the Long Island National Wildlife Refuge Complex in New York: Oyster Bay, Target Rock, Elizabeth A. Morton, and Conscience Point.[4] Lastly, the Rhode Island portion of the study area includes the Block Island National Wildlife Refuge. Additional information is provided below on each national refuge.

***Silvio O. Conte National Fish and Wildlife Refuge* -** Silvio O. Conte National Fish and Wildlife Refuge covers 7.2 million acres of the Connecticut River watershed in four states: Connecticut, Massachusetts, New Hampshire, and Vermont (USFWS, 2014c). Established to conserve the abundance and diversity of native plants and animals and their habitats in the area, the Silvio O. Conte National Fish and Wildlife Refuge "uses innovative partnerships to improve conservation efforts, research important questions, foster conservation leadership and educate citizens about critical issues" (USFWS, 2014c).

***Stewart B. McKinney National Wildlife Refuge* -** The Stewart B. McKinney National Wildlife Refuge consists of 11 separate locations spread across 70 mi of Connecticut's coastline. This NWR is located in the Atlantic flyway, a major bird migration route where many bird species use different habitats for resting, feeding, and nesting. The Stewart B. McKinney National Wildlife Refuge provides this important function for many species of wading birds, shorebirds, songbirds, and terns, including the endangered roseate tern. Adjacent waters serve as wintering habitat for brant, scoters, American black duck, and other waterfowl. Overall, the Stewart B. McKinney National Wildlife Refuge encompasses over 1,000 acres of forest, barrier beach, tidal wetland, and fragile island habitats.

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[3] Rhode Island is not a part of this MPA.

[4] The U.S. Fish and Wildlife Service (USFWS) should be consulted for all national refuges listed here.

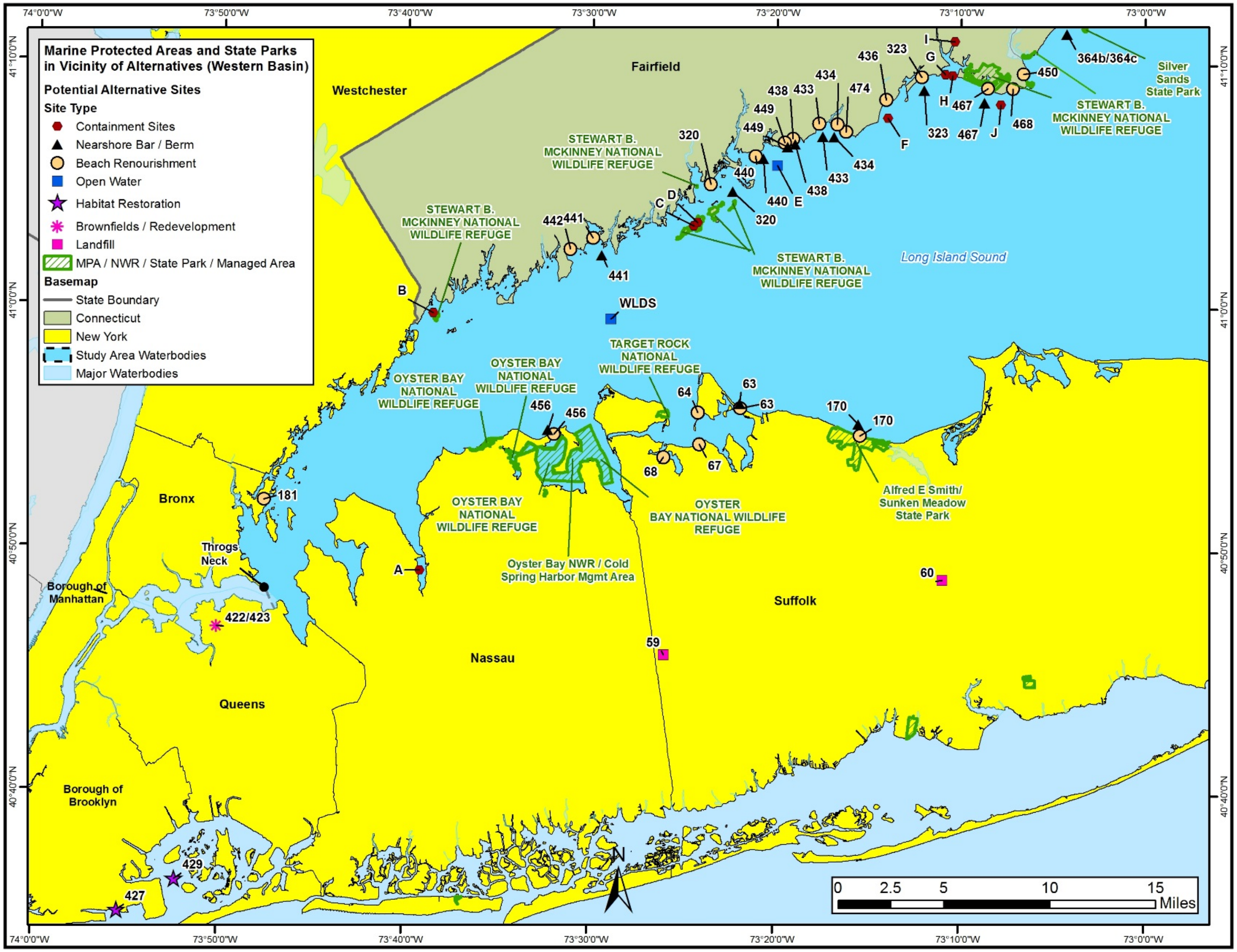

Figure 4-52. MPAs and State Parks in the Western Basin.

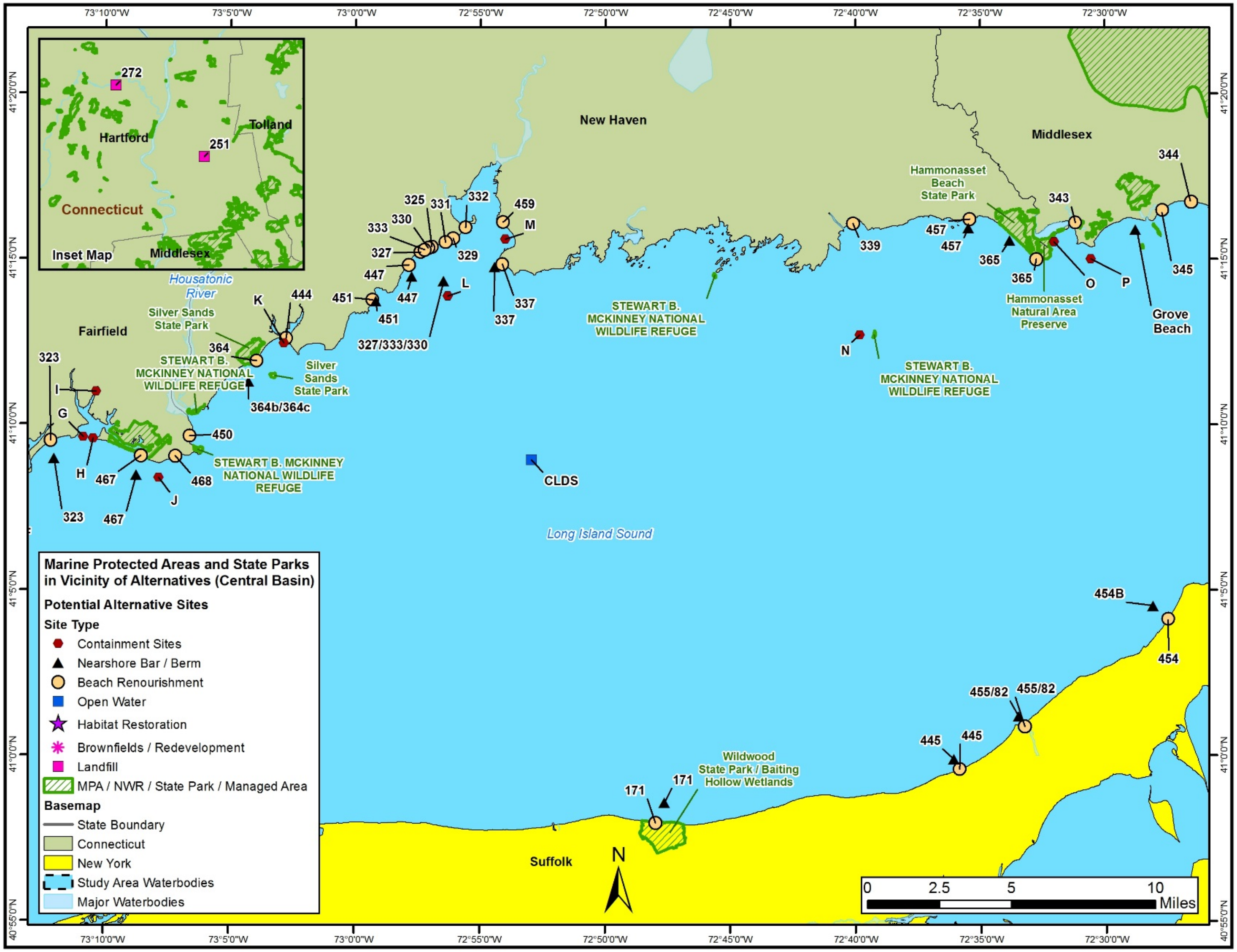

Figure 4-53. MPAs and State Parks in the Central Basin.

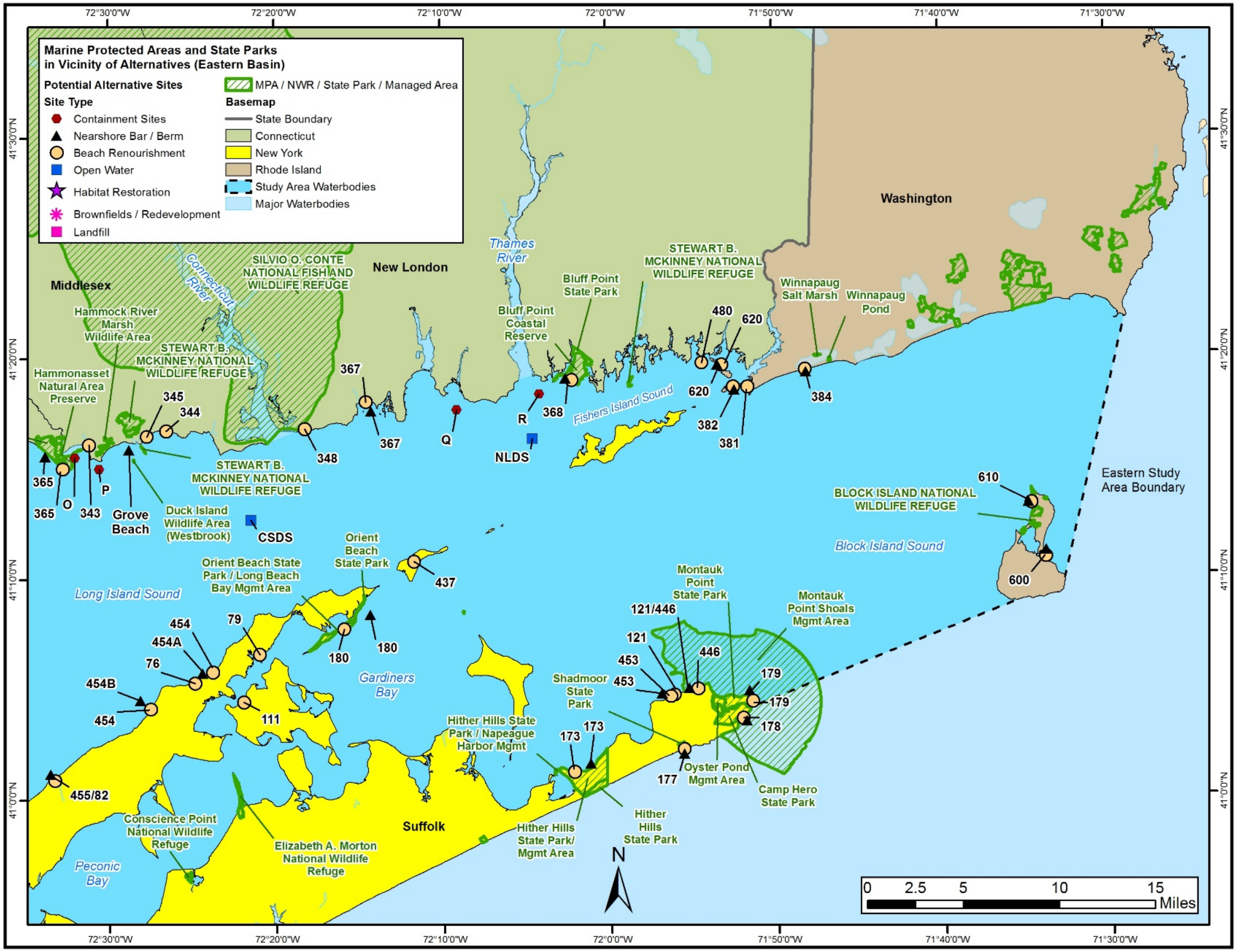

Figure 4-54. MPAs and State Parks in the Eastern Basin.

Included in the Steward B. McKinney National Wildlife Refuge are locations such as the following (USFWS, 2014d):

- The Salt Meadow Unit consists of 400 acres of salt marsh, forest, grassland, and shrubland in Westbrook, Connecticut.
- Menunketesuck Island just offshore of Salt Meadow Unit provides intertidal flats, sandbars, and shellbars to foraging migrant shorebirds.
- The Great Meadows Unit in Stratford provides feeding and nesting habitat for over 270 species of birds, contains "the most productive shellfish beds in the state", and serves as breeding and feeding grounds for several finfish species.
- The Calf Island Unit in Greenwich provides a diverse coastal habitat, which includes "tidal wetlands, intertidal flats, rocky intertidal shore, sandy beach, mixed forest, and coastal shrubland." The island provides excellent wading bird habitat and is less than 1 mi from one of the largest heron and egret rookeries in Long Island Sound.
- The Falkner Island Unit in Guilford is home to over 100 pairs of nesting Federally endangered roseate terns and over 3,500 nesting pairs of common terns. Over 200 species of birds have been recorded on or near Falkner Island.
- The Chimon Island Unit, Sheffield Island Unit, Goose Island, and the Peach Island Unit are part of the Norwalk Islands, which contain forest and shrublands that are recognized as regionally significant habitat for colonial nesting wading birds.
- The Outer Island Unit in Branford is a 5-acre island composed of granite outcroppings, boulder and cobble beaches in the intertidal zone, and small salt marshes that provide habitat for migrating and nesting birds.
- The Milford Point Unit in Milford is one of the best bird-watching areas in Connecticut, with mudflats, sand bars, and marshes to provide feeding and resting habitats for waterfowl, shorebirds, and wading birds.

Long Island National Wildlife Complex - Approximately 6,500 acres in size, the Long Island National Wildlife Refuge Complex consists of seven NWRs, two refuge sub-units and one wildlife management area (USFWS, 2013). However, only four of the NWRs are within the study area: Oyster Bay National Wildlife Refuge (Figure 4-52), Target Rock National Wildlife Refuge (Figure 4-52), Elizabeth A. Morton National Wildlife Refuge (Figure 4-54), and Conscience Point National Wildlife Refuge (Figure 4-54). Each unit is unique and provides a wildlife oasis among Long Island's urban settings. These oases are essential for the livelihood of migratory birds, threatened and endangered species, fish, and other wildlife. The strategic location of Long Island along the Atlantic flyway make them important nesting, wintering, and migratory stopover areas for hundreds of species of birds. Oyster Bay National Wildlife Refuge is the largest refuge in the Long Island National Wildlife Refuge Complex. The refuge consists of bay bottom, salt marsh, and a small freshwater wetland. Because of the sheltered nature of the bay, it is attractive as winter habitat for a variety of waterfowl species, especially diving ducks (USFWS, 2014e).

Block Island National Wildlife Refuge - Totaling 133 acres, Block Island National Wildlife Refuge is located 12 mi offshore (Figure 4-54). The refuge works closely with other conservation organizations in an effort to protect land and is an internationally recognized island of conservation. Block Island is a critical migratory bird stopover point on the Atlantic Coast, and hundreds of small ponds and fruit-bearing shrubs, including those within the refuge, provide essential water and food for more than 250 species of birds who come to rest there. Block Island is also home to 15 rare or endangered species. For these reasons, Block Island was named a "Last Great Place" by The Nature Conservancy (2014). As with all NWRs, the refuge on Block Island maintains wildlife conservation as its first priority. However, refuge beaches are open for walking, bird-watching, and, on the northern parcel, surf fishing.

In addition to the national refuges, several state parks in Connecticut, New York, and Rhode Island are listed on NOAA's MPA listing (NOAA, 2013). Table 4-30 identifies the applicable state-identified sites within the study area and the respective agencies to contact per NOAA's MPA listing as of November 2013.

4.12.2 Marine Protected Areas in the Open-Water Environment

Unconfined Open-Water Placement

No MPAs were identified at or in the vicinity of any of the four open-water sites.

Confined Open-Water Placement

No MPAs were identified at or in the vicinity of the confined open-water Alternative E (Sherwood Island Borrow Pit).

4.12.3 Marine Protected Areas in the Nearshore/Shoreline Environment

A summary of MPAs found within the influence of nearshore and shoreline placement sites is presented in Table 4-31 (see Figure 4-52 through Figure 4-54 above). Each of the MPAs that are located in close proximity to the potential placement sites is described below.

Confined Placement

In-Harbor CAD Cells

Alternatives G and H are located in close proximity to the Great Meadows Unit of the Stewart B. McKinney National Wildlife Refuge, located in Stratford, and are designated as important bird areas by the National Audubon Society. Any activities at these alternatives would need to be coordinated with the USFWS to determine whether any mitigating factors would be required so as not to impact or disturb the bird habitat in this area.

Island CDFs

Alternative B is located within the Calf Island Unit of the Stewart B. McKinney National Wildlife Refuge. Calf Island provides a diverse coastal habitat, which includes tidal wetlands, intertidal flats, rocky intertidal shore, sandy beach, mixed forest, and coastal shrubland. The island provides excellent wading bird habitat and is less than 1 mi from one of the largest heron and egret rookeries in Long Island Sound.

Table 4-30. State-Identified MPAs.

Site Name	Protection Level	Applicable Management Plan	Fishing Restrictions	Conservation Focus
Connecticut-Designated MPAs in Study Area – Under CTDEEP Jurisdiction				
Bluff Point State Park/Natural Area Preserve	Zoned Multiple Use	Site-Specific Management Plan	Recreational Fishing Restricted	Natural Heritage
Silver Sands State Park/Charles Island Natural Area Preserve	Zoned Multiple Use	No Management Plan	Recreational Fishing Restricted	Natural Heritage
Hammonasset Natural Area Preserve	Uniform Multiple Use	Site-Specific Management Plan	No Site Restrictions	Natural Heritage
Barn Island Wildlife Management Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Charles E. Wheeler Wildlife Management Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Duck Island Wildlife Management Area/Natural Area Preserve (Westbrook)	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage
East Haven Marsh Wildlife Management Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
East River Marsh Wildlife Area/ East River Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Great Harbor Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage
Great Island Wildlife Area/Roger Tory Peterson Natural Area Preserve	Uniform Multiple Use	No Management Plan	Recreational Fishing Restricted	Natural Heritage
Hager Creek Marsh Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Hammock River Marsh Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage, Cultural Heritage and Sustainable Production
Nott Island Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage
Pawcatuck River Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Quinnipiac River Marsh Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Ragged Rock Creek Marsh Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
South Cove Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Hammonasset Beach State Park	Zoned Multiple Use	No Management Plan	Recreational Fishing Restricted	Natural Heritage

Table 4-30. State-Identified MPAs (continued).

Site Name	Protection Level	Applicable Management Plan	Fishing Restrictions	Conservation Focus
West River Marsh Wildlife Area	Uniform Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage and Sustainable Production
Selden Neck State Park/Natural Area Preserve	Zoned Multiple Use	No Management Plan	No Site Restrictions	Natural Heritage
New York State-Designated MPAs in Study Area – Under New York State Office of Parks, Recreation and Historic Preservation Jurisdiction				
Hither Hills State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Montauk Point State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Napeague State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Nissequogue River State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Orient Beach State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Camp Hero State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Shadmoor State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Wildwood State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Caumsett State Historic Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Alfred E. Smith Sunken Meadow State Park	Uniform Multiple Use	MPA Programmatic Management Plan	No Site Restrictions	Natural Heritage
Rhode Island-Designated MPAs in Study Area – Under Rhode Island Department of Environmental Management				
Coastal Salt Ponds Shellfish Management Area	Uniform Multiple Use	Non-MPA Programmatic Fisheries Management Plan	Commercial and Recreational Fishing Restricted	Sustainable Production
Salt Ponds Region	Uniform Multiple Use	Site-Specific Management Plan	Commercial and Recreational Fishing Restricted	Natural Heritage
Greenwich Bay Shellfish Management Area	Uniform Multiple Use	Site-Specific Management Plan	Commercial and Recreational Fishing Restricted	Natural Heritage

Source: NOAA (2013)

Table 4-31. MPAs in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1]
Nearshore/ Shoreline Environment	In-Harbor CAD Cell	G	Stewart B. McKinney NWR is east of CAD; within 1 mi
		H	Stewart B. McKinney NWR is east of CAD; within ½ mi
		M	None documented
	Island CDF	B	Stewart B. McKinney NWR is within CDF footprint
		L	None documented
		N	Stewart B. McKinney NWR within CDF at Falkner Island
		P	Hammock River Marsh Wildlife Area north of CDF, within 1 mi
		Q	None documented
		R	Bluff Point State Park Natural Area Reserve in upland NE of CDF, within 1 mi
	Shoreline CDF	A	None documented
		C	Stewart B. McKinney NWR is within CDF footprint
		D	Stewart B. McKinney NWR is within CDF footprint
		F	None documented
		I	None documented
		J	Stewart B. McKinney NWR is adjacent to CDF; within ½ mi
		K	Silver Sands State Park/Charles Island Natural Area Preserve west of CDF; within 1 mi
		O	Hammonasset Beach State Park and Natural Area Preserve west of CDF, within 1 mi; Hammock River March Wildlife Area east of CDF, within 1 mi
	Nearshore Bar Placement/ Nearshore Berm Sites	177	Shadmoor State Park in upland shoreward of berm, within 1 mi
		178	Camp Hero State Park in upland shoreward of berm, within 1 mi
		179	Montauk Point State Park in upland shoreward of berm, within 1 mi
		121/446	Located in Montauk Point Shoals Management Area
		173	Hither Hills State Park in upland shoreward of berm, within 1 mi
		180	Orient Beach State Park in upland shoreward of berm, within 1 mi
		171	Wildwood State Park in upland shoreward of berm, within 1 mi
		170	Alfred E. Smith/Sunken Meadow State Park in upland shoreward of berm, within 1 mi
		456	Oyster Bay National Wildlife Refuge in estuary shoreward of berm, within 1 mi
		320	Stewart B. McKinney National Wildlife Refuge on island SW of berm, within 1 mi
		467	Stewart B. McKinney National Wildlife Refuge in upland shoreward of berm, within 1 mi
		364	Silver Sands State Park/ Charles Island Natural Area Preserve in upland shoreward of berm, within 1 mi
		365	Hammonasset Beach State Park and Natural Area Preserve in upland shoreward of berm, within 1 mi
		GP	Stewart B. McKinney National Wildlife Refuge in upland shoreward of berm, within 1 mi; Duck Island Wildlife Management Area/Natural Area Preserve seaward of berm, within 1 mi
		368	Bluff Point State Park/Natural Area Preserve in upland landward of berm; within 1 mi
		384	Coastal Salt Ponds Shellfish Management Area in Winnapaug Pond north of Misquamicut Beach, within 1 mi

Table 4-31. MPAs in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present[1]
		600	Adjacent to local conservation land[2]
		610	Block Island National Wildlife Refuge[2,3]
		453, 454A, 454B, 455/82, 445, 63, 441, 440, 449, 438, 433, 434, 323, 451, 447, 327/333/ 330, 337, 457, 367, 381/382, 620	None documented
	Beach Nourish-ment	365	Hammonasset Beach State Park and Natural Area Preserve in upland shoreward of beach, within 1 mi
		364	Silver Sands State Park/ Charles Island Natural Area Preserve in upland shoreward of beach, within 1 mi
		320	Stewart B. McKinney National Wildlife Refuge on island SW of beach, within 1 mi
		456	Located in the vicinity of Oyster Bay National Wildlife Refuge
		384	Coastal Salt Ponds Shellfish Management Area in Winnapaug Pond north of Misquamicut Beach, within 1 mi
		368	Bluff Point State Park/Natural Area Preserve in upland landward of beach; within 1 mi
		171	Wildwood State Park in upland shoreward of beach, within 1 mi
		173	Hither Hills State Park in upland shoreward of beach, within 1 mi
		177	Shadmoor State Park in upland shoreward of beach, within 1 mi
		178	Camp Hero State Park in upland shoreward of beach, within 1 mi
		179	Montauk Point State Park in upland shoreward of beach, within 1 mi
		170	Alfred E. Smith/Sunken Meadow State Park in upland shoreward of beach, within 1 mi
		180	Orient Beach State Park in upland shoreward of beach, within 1 mi
		446	Located in Montauk Point Shoals Management Area
		343	Located in the vicinity of Hammonasset Beach State Park
		348	Located in the vicinity of the Silvio O. Conte National Fish and Wildlife Refuge
		467	Stewart B. McKinney National Wildlife Refuge in upland shoreward of beach, within 1 mi
		600	Local conservation land[2]
		610	Adjacent to Block Island National Wildlife Refuge[2,3]
		323, 433, 434, 436, 457, 444, 451, 337, 441, 442, 450, 447, 438, 440, 449, 181, 453, 63, 454E, 454W, 455/82, 367, 445, 474, 339, 459, 480, 468, 325, 327, 329, 330, 331, 332, 333, 344, 345, 121, 64, 67, 68, 111, 76, 79, 381, 382, 437, 620	None documented

[1] USACE (2010a), (2012b), unless otherwise noted.

[2] Block Island Conservancy (2014).

[3] NOAA (2013).

Alternative N is adjacent to the Falkner Island Unit of the Stewart B. McKinney National Wildlife Refuge. Located in Guilford; the Falkner Island Unit has been designated as an important bird area by the National Audubon Society and is home to over 40 pairs of nesting Federally endangered roseate terns and over 2,000 nesting pairs of common terns. Any activities at these alternatives would need to be coordinated with the USFWS to determine whether any mitigating factors would be required so as not to impact or disturb the bird habitat in this area.

Alternative P is located within 1 mi of the Hammock River Marsh Wildlife Area. Any activities in this area would need to be coordinated with the CTDEEP (2011c).

Alternative R is located within 1 mi of the Bluff Point State Park Natural Area Reserve. Bluff Point was designated a "coastal reserve" by a special act of the Connecticut legislature in 1975 to establish the area "for the purpose of preserving its native ecological associations, unique faunal and floral characteristics, geological features and scenic qualities in a condition of undisturbed integrity" (CTDEEP, 2014f). Any activities at this site would need to be coordinated with the CTDEEP.

Shoreline CDFs

Alternatives C and D are the Norwalk Outer Harbor Islands marsh and shoreline alternatives located within or in close proximity to the Stewart B. McKinney National Wildlife Refuge. The forest and shrublands of the Norwalk Islands are recognized as regionally significant habitat for colonial nesting wading birds, vital nesting and migratory habitat for neotropical birds, and high-quality wintering grounds for waterfowl. This area provides excellent nesting habitat for herons, egrets, and ibises.

Alternative J is located within 0.5 mi of Great Meadows, which is part of the Stewart B. McKinney National Wildlife Refuge and is designated as important bird area by the National Audubon Society. Any activities at these alternatives would need to be coordinated with the USFWS to determine whether any mitigating factors would be required so as not to impact or disturb the bird habitat in this area.

Alternative K is located within 1 mi of the Silver Sands State Park/Charles Island Natural Area Preserve. Any activities at this site would need to be coordinated with the CTDEEP.

Alternative O is located within 1 mi of the Hammonasset Beach State Park and Natural Area Preserve and the Hammock River March Wildlife Area. Any activities in this area would need to be coordinated with the CTDEEP.

Beneficial Use

Nearshore Bar/Berm Placement

Berms 320, 467, and Grove Point (GP) are located within 1 mi of the Stewart B. McKinney National Wildlife Refuge. Berm 610 is located adjacent to federally protected open space that is part of the Block Island National Wildlife Refuge. Any activities at these alternatives would need to be coordinated with the USFWS to determine whether any mitigating factors would be required so as not to impact or disturb the bird habitat in this area.

Berms 364, 365, and 368 are within the vicinity of Connecticut state parks. Any activities at any of these state parks would need to be coordinated with the CTDEEP. Berm 364 is located within 1 mi of the Silver Sands State Park/Charles Island Natural Area Preserve. Berm 365 is located within 1 mi of the Hammonasset Beach State Park and Natural Area Preserve. Berm GP is within 1 mi of the Duck Island Wildlife Management Area/Natural Area Preserve. Berm 368 is located within 1 mi of the Bluff Point State Park/Natural Area.

Seven of the 15 berms in New York are located within 1 mi of a state park. The classifications for these locations are as follows (NOAA, 2008):

- Uniform Multiple Use Level of Protection
- Natural Heritage conservation

One berm (456) is located within 1 mi of Oyster Bay National Wildlife Refuge. The classification for this location is as follows (NOAA, 2008):

- Uniform Multiple Use Level of Protection
- Sustainable Production conservation

Any activities at these New York berms would need to be coordinated with the New York State Office of Parks, Recreation & Historic Preservation to ensure that the proper permits were identified and filed.

One of the berms in Rhode Island (384) is located within 1 mi of the Coastal Salt Ponds Shellfish Management Area in Winnapaug Pond. Any activities at this location would need to be coordinated with RIDEM and the RI CRMC.

Beach Nourishment

Beaches 320 and 467 are located within 1 mi of the Stewart B. McKinney National Wildlife Refuge. Beach 348 is located in the vicinity of the Silvio O. Conte National Fish and Wildlife Reserve. Beach 610 is located adjacent to federally protected open space that is part of the Block Island National Wildlife Refuge. Any activities at these alternatives would need to be coordinated with the USFWS to determine whether any mitigating factors would be required so as not to impact or disturb the habitat in this area.

Beaches 364, 365, 343, and 368 are within the vicinity of Connecticut state parks. Any activities at any of these state parks would need to be coordinated with the CTDEEP.

Seven beaches in New York are located within 1 mi of a state park. The classifications for these locations are as follows (NOAA, 2008):

- Uniform Multiple Use Level of Protection
- Natural Heritage conservation

One beach (456) is located within 1 mi of Oyster Bay National Wildlife Refuge. The classification for this location is as follows (NOAA, 2008):

- Uniform Multiple Use Level of Protection
- Sustainable Production conservation

Any activities at these New York beaches would need to be coordinated with the New York State Office of Parks, Recreation & Historic Preservation to ensure that the proper permits were identified and filed.

In addition, one beach (446) is located in the vicinity of Montauk Point Shoals Management Area, an area of significant coastal fish and wildlife habitat. Any activities at this New York beach would need to be coordinated with the New York State Department of Environmental Conservation.

One of the beaches in Rhode Island (384) is located within 1 mi of the Coastal Salt Ponds Shellfish Management Area in Winnapaug Pond. Any activities at this location would need to be coordinated with RIDEM and the RI CRMC.

4.12.4 Marine Protected Areas in Upland Environments

MPAs are relevant only at the two Habitat Restoration sites (427 and 429); all the other upland alternatives are located far from the shoreline where MPAs are typically found. There are no MPAs within 1 mi of the Habitat Restoration sites (Table 4-32).

Table 4-32. MPAs in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	None, site is located upland.
	Landfill Cover/Capping	60	None, site is located upland.
		61	None, site is located upland.
		251	None, site is located upland.
		272	None, site is located upland.
	Brownfields & Other Redevelopment	422/423	None, site is located upland.
	Habitat Restoration / Enhancement or Creation	427	None documented within 1 mi
		429	None documented within 1 mi

4.13 BIRDS

4.13.1 General Long Island Sound Setting

The coast of the Northwest Atlantic Ocean supports a large number of resident and migratory marine and coastal birds. The Long Island Sound region is important for three main groups of birds: those found primarily in open water, those found on or near coastal beaches and mudflats, and those found in tidal marshes. Regular census activities, such as winter waterfowl surveys, breeding bird surveys, and Christmas bird counts, confirm that dozens of marine and coastal bird species migrate annually through the Long Island Sound region.

Common Bird Species of Long Island Sound

Commonly seen bird species that inhabit coastal and offshore habitats of Long Island Sound are listed in Table 4-33. Not included in this list are species that rarely occur in the Sound and therefore do not typically use the area as nesting habitat or for regular foraging.

This section discusses the four groups of birds commonly occurring in the Long Island Sound region: waterfowl, colonial waterbirds, shorebirds, and raptors.

Waterfowl

Many different waterfowl species are known to occur in the study area, including bufflehead ducks, the common goldeneye, hooded- and red-breasted mergansers, the ruddy duck, the American black duck, the greater scaup, common eider, harlequin duck, surf scoter, white-winger scoter, and black scoter. Most[5] waterfowl species are migratory, breeding in the coastal waters of northern Canada and wintering along the Atlantic coast. Breeding waterfowl species in the Long Island Sound area come ashore to nest in inland regions or along the coastlines. Wintering waterfowl spend the majority of their winter foraging on the water, and many species (e.g., scaup, scoters, and eiders) are capable of diving underwater to depths of 25 to 100 ft to feed. Other species, such as mallards, widgeons, and pintails, will primarily stay in shallow intertidal and subtidal areas for feeding.

The CTDEEP conducts an annual Midwinter Waterfowl Survey as an index of long-term wintering waterfowl trends (Table 4-34). In 2014, the survey counted the highest total number of waterfowl in 10 years. Counts of puddle ducks were double the five-year average, and scaup showed an increase from 2011 (CTDEEP, 2014g).

Until 2008, the New York State Ornithological Association (NYSOA) conducted annual waterfowl counts in 10 regions, with Region 10 including all of Long Island and Long Island Sound (NYSOA, 2008) (Table 4-35). The NYSOA's counts included inland waterbodies as well as the north and south shorelines and Long Island Sound's open water and are not separated geographically.

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[5] In the Long Island Sound area, some waterfowl species are known to be year-round residents, including the mallard, Canada goose, and mute swan.

Table 4-33. Coastal and Pelagic Bird Species Found in Long Island Sound Study Area.

Species	Preferred Habitat within Study Area	Seasonal Presence in Study Area
Waterfowl, Loons, and Grebes		
Snow Goose	Coastal bays, marshes	Migratory stopover
Brant	Salt marshes, estuaries	Winter
Canada Goose	Bays, lakes, rivers, marshes	Year-round resident
Mute Swan	Bays, coastal lagoons	Year-round resident
Wood Duck	Wooded swamps, rivers	Summer
Gadwall	Salt marshes	Winter
Eurasian Widgeon	Tidal flats	Winter
American Widgeon	Marshes, ponds	Winter
American Black Duck	Marshes, coastal mudflats, estuaries	Year-round resident
Mallard	Marshes and open bays	Year-round resident
Blue-winged Teal	Marshes, shallow ponds, lakes	Summer/Migratory stopover
Northern Shoveler	Salt and brackish marshes	Migratory stopover/Winter
Northern Pintail	Salt marshes	Migratory stopover/Winter
Green-winged Teal	Marshes and ponds	Winter
Canvasback	Lakes, bays, estuaries	Winter
Redhead	Open bays	Winter
Ring-necked Duck	Wooded lakes, ponds, river	Winter
Greater Scaup	Salt water bays	Migratory stopover/Winter
Lesser Scaup	Lakes, rivers, ponds	Migratory stopover/Winter
Common Eider	Rocky coasts, coastal tundra	Winter
Surf Scoter	Ocean, large coastal bays	Migratory stopover/Winter
White-winged Scoter	Open ocean, large coastal bays	Migratory stopover/Winter
Black Scoter	Ocean and large saltwater bays	Migratory stopover/Winter
Long-tailed Duck	Open bays and inshore waters	Migratory stopover/Winter
Bufflehead	Salt water bays and estuaries	Winter
Common Goldeneye	Coastal bays and estuaries	Winter
Barrow's Goldeneye	Open bays and estuaries	Winter
Hooded Merganser	Coastal marshes and inlets	Winter/Year-round resident
Common Merganser	Lakes, rivers, salt water	Winter
Red-breasted Merganser	Open salt water	Migratory stopover/Winter
Ruddy Duck	Marshes, shallow coastal bays	Migratory stopover/Winter
Red-throated Loon	Large lakes, bays, estuaries, ocean	Winter
Common Loon	Coastal bays, ocean	Migratory stopover/Winter
Pied-billed Grebe	Salt water, unfrozen lakes and rivers	Year-round resident
Horned Grebe	Salt water, unfrozen lakes and rivers	Migratory stopover/Winter
Red-necked Grebe	Large lakes, bays, estuaries	Winter
Colonial Waterbirds (Wading Birds)		
American Bittern	Salt and brackish marshes	Summer, winter
Least Bittern	Freshwater marshes with cattails/reeds	Summer
Great Blue Heron	Lakes, ponds, rivers, marshes	Year-round resident
Great Egret	Freshwater/saltwater marshes, tidal flats	Summer
Snowy Egret	Marshes, ponds, swamps, mudflats	Summer

Table 4-33. Coastal and Pelagic Bird Species Found in Long Island Sound Study Area (continued).

Species	Preferred Habitat within Study Area	Seasonal Presence in Study Area
Little Blue Heron	Coastal thickets on islands	Summer
Tricolored Heron	Coastal ponds, salt marshes, mudflats	Summer
Cattle Egret	Near water, open fields	Summer
Green Heron	Freshwater/brackish marshes, water edge	Summer
Black-crowned Night-Heron	Marshes	Year-round resident
Yellow-crowned Night-Heron	Wooded swamps, coastal thickets	Summer
Glossy Ibis	Marshes, swamps, coastal bays/estuaries	Summer
Colonial Waterbirds (Sea Birds)		
Northern Gannet	Open water	Winter
Northern Fulmar	Open water	Winter
Sooty Shearwater	Open water	Migratory stop-over
Greater Shearwater	Open water	Migratory stop-over
Cory's Shearwater	Open water	Migratory stop-over
Colonial Waterbirds (Cormorants)		
Double-crested Cormorant	Lakes, rivers, swamps, and coasts	Year-round resident
Great Cormorant	Rocky coasts, inshore waters	Winter
Colonial Waterbirds (Gulls and Terns)		
Bonaparte's Gull	Estuarine coasts, large river mouths	Winter/Migratory stop-over
Little Gull	Coastal bays, flats, harbors, estuaries	Winter
Laughing Gull	Salt marshes	Summer
Ring-billed Gull	Salt water	Winter
Herring Gull	Lakes, rivers, estuaries, beaches	Year-round resident
Iceland Gull	Lake/river shores, ocean beaches	Winter
Glaucous Gull	Seacoasts, lakeshores	Winter
Great Black-backed Gull	Coastal beaches, estuaries, lagoons	Year-round resident
Least Tern	Sandy, pebbly beaches, river sandbars	Summer
Caspian Tern	Sandy, pebbly seacoasts	Migratory stop-over
Black Tern	Sandy coasts	Migratory stop-over
Roseate Tern	Coastal beaches, islands, inshore waters	Summer
Common Tern	Lakes, ponds, coastal beaches, islands	Summer
Forster's Tern	Salt marshes	Migratory stop-over
Royal Tern	Sandy beaches	Migratory stop-over
Black Skimmer	Sandbars, beaches, shallow bays, inlets	Summer
Shorebirds		
Greater Yellowlegs	Tidal mudflats, lake shores	Migratory stopover/Winter
Lesser Yellowlegs	Marshy ponds, lake/river shores, mudflats	Migratory stop-over
Solitary Sandpiper	Wet swampy areas and bogs	Migratory stop-over
Willet	Coastal beaches, freshwater/saltwater marshes	Summer
Spotted Sandpiper	Ponds, streams, waterways along shore	Summer
Upland Sandpiper	Open grasslands	Summer/Migratory stopover
Whimbrel	Coastal salt meadows, mudflats	Migratory stop-over

Table 4-33. Coastal and Pelagic Bird Species Found in Long Island Sound Study Area (continued).

Species	Preferred Habitat within Study Area	Seasonal Presence in Study Area
Hudsonian Godwit	Mudflats	Migratory stop-over
Ruddy Turnstone	Rocky, pebbly, sandy coasts and beaches	Winter
Red Knot	Tidal flats, rocky shores, beaches	Winter
Sanderling	Ocean beaches, sandbars, mudflats	Winter
Semipalmated Sandpiper	Coastal beaches, mudflats, salt marsh pools	Migratory stop-over
Western Sandpiper	Shores, mudflats, grassy pools	Migratory stop-over
Least Sandpiper	Open marshes, mudflats	Migratory stop-over
White-rumped Sandpiper	Mudflats, grassy pools, shores	Migratory stop-over
Baird's Sandpiper	Wet meadows, lakes and river shores	Migratory stop-over
Pectoral Sandpiper	Wet grassy areas, salt creeks/meadows	Migratory stop-over
Purple Sandpiper	Rocky coasts, promontories	Winter
Dunlin	Beaches, mudflats, sand flats	Winter
Stilt Sandpiper	Grassy pools, lake shores	Migratory stop-over
Buff-breasted Sandpiper	Short-grass fields	Migratory stop-over
Short-billed Dowitcher	Mudflats, creeks, salt marshes, estuaries	Migratory stop-over
Long-billed Dowitcher	Mudflats, marshy pools, freshwater ponds	Migratory stop-over
Wilson's Snipe	Freshwater/saltwater marshes	Winter
American Woodcock	Wet woodlands and thickets	Summer/Year-round resident
Wilson's Phalarope	Marshy pools along coast	Migratory stop-over
Black-bellied Plover	Beaches, mudflats, coastal marshes	Winter
American Golden-Plover	Coastal beaches, mudflats, prairies	Migratory stop-over
Semipalmated Plover	Beaches, mudflats, shallow marsh pools	Migratory stop-over
Piping Plover	Bare, dry, sandy areas	Summer
Killdeer	Plowed fields, short-grass prairies	Year-round resident
American Oystercatcher	Sandy beaches, mudflats, salt marsh edge	Summer
Marsh Birds		
Clapper Rail	Freshwater/saltwater marshes	Summer
King Rail	Freshwater/saltwater marshes	Summer
Virginia Rail	Freshwater/brackish marshes	Summer
Sora	Freshwater marshes, marshy ponds	Summer
Common Moorhen	Well-vegetated marshes, ponds, canals and other wetlands	Year-round resident
American Coot	Coastal bays and inlets	Winter
Raptors		
Osprey	Lakes, rivers, seacoasts	Summer
Bald Eagle	Lakes, rivers, marshes, seacoasts	Winter
Northern Harrier	Marshes, open grasslands	Year-round resident
Sharp-shinned Hawk	Any habitat	Winter
Northern Goshawk	Woodland edges, open country	Year-round resident
Red-tailed Hawk	Open country	Year-round resident
Rough-legged Hawk	Open country, marshes	Winter
Golden Eagle	Salt marshes	Winter/Migratory stop-over

Sources: EPA (2014f); CRESLI (2014a).

Table 4-34. Midwinter Waterfowl Survey Results for Major Species.

Species	2014	2013	Five Year Average
Atlantic Brant	1,100	900	1,400
Black Duck	4,800	3,100	2,700
Bufflehead	1,100	1,000	1,000
Canada Goose	7,600	4,100	3,700
Canvasback	100	100	100
Mallard	4,300	2,300	1,900
Merganser	1,100	1,300	1,200
Mute Swan	600	500	700
Long-tailed Duck	600	400	300
Common Goldeneye	1,000	500	800
Scaup	5,000	2,400	2,400

Source: CTDEEP (2014g).
Note: counts are rounded to the nearest hundred.

Table 4-35. New York State Ornithological Association's Waterfowl Count Data.

Species	2008	2007	Average 1999-2008	Average 1973-2008
Atlantic Brant	14,514	17,235	15,921	15,116
Black Duck	7,566	6,034	9,363	13,707
Bufflehead	3,209	4,065	4,394	4,605
Canada Goose	29,695	22,798	37,822	26,878
Canvasback	498	409	1,092	3,803
Mallard	8,567	8,200	10,009	9,510
Merganser[1]	4,319	5,504	5,002	4,419
Mute Swan	965	1,415	1,197	1,025
Long-tailed Duck	11,382	9,164	3,347	1,894
Common Goldeneye	1,026	1,320	1,499	1,968
Greater Scaup	8,286	36,243	14,572	17,772

Source: NYSOA (2008).
[1] Includes hooded, common, and red-breasted merganser numbers.

Colonial Waterbirds

Colonial waterbirds are characterized by the manner in which they nest (in colonies). They generally inhabit sandy or rocky islands, coastal beaches, salt marshes, bays, and estuaries. These birds have a variety of feeding techniques, ranging from wading through the water to grab fish and invertebrates to hovering over the water surface and diving into the water to catch fish. Most colonial water birds feed in the coastal areas with shallow water depths in search of small fish. Wading birds, gulls, and cormorants are more likely to be found along shoreline habitats, with wading birds in particular feeding solely in shallow water environments. Herons, egrets, and the glossy ibis nest in colonies on nearshore islands and fly to marshes to forage on small fishes and invertebrates. Gulls and cormorants will forage farther offshore than wading birds, although cormorants would probably not be found near the open-water alternative sites due to their reliance on dry resting spots. For those colonial waterbird species that breed in the Long Island Sound area, the nesting sites are typically found in scrub-shrub and woodland habitats. The Long Island Sound Study (EPA, 2014f) has collected regular nesting data for four colonial waterbird species (snowy egrets, great egrets, black-crowned night herons, and least terns). For the wading bird species, these data have shown relatively stable populations since 1998 (Table 4-36); however, there has been an overall decline in snowy egrets and the night heron since the 1970s, perhaps because of habitat loss, contaminants, or other human-related disturbances. The least tern data in 2011, after several years of general decline, was considerably higher than in the two years prior, and this higher number of terns is encouraging (although it may show up as a decrease in a neighboring state). In 2011, approximately 361 pairs of least terns nested along the shoreline in Connecticut, an increase of 401% from 2009 when there were 90 pairs. The largest number of least terns was found at Sandy Point in West Haven, where more than 400 adults were observed in May and June. In New York, the least tern population has been stable over time, including at nesting sites in Long Island Sound and other Long Island north shore sites.

The seabird species that might be found in the Long Island Sound area (see Table 4-33) do not breed in the region, do not spend much time near the shoreline, and would likely only be seen in open water far from shore while foraging.

Shorebirds

Shorebirds inhabit open beaches, tidal flats, and marshes. Although most of the shorebirds that occur along the Atlantic coast are migratory, they do not travel as far from land as pelagic birds. Shorebirds are either colonial or solitary in nesting habitat, and some species breed in upland areas. The Long Island Sound shoreline is important habitat for a number of beach-nesting species as well as for non-breeding shorebirds during migration. Piping plovers, least terns, American oystercatcher, and black skimmers can all be found nesting on beaches and in other coastal habitats of the Sound. Non-breeding shorebird species, such as sanderlings, purple sandpipers, and ruddy turnstones, can be seen foraging in the wet sand of beaches in the Sound or on rocky shores and jetties. As the tide comes in and some species are displaced from foraging, the concentration of shorebird species at high tide roosts can surge.

The Long Island Sound Study (EPA, 2014f) has been keeping nesting pair data on piping plovers since 1990, with Connecticut data being available only since 2000 (Table 4-36).

Raptors

Raptors are birds of prey that are classified as hunting birds that search for food while in flight. Many species of raptors forage along the coast, particularly the osprey, which almost exclusively eats fish. Raptors generally nest and perch in the upland habitat of tall trees to survey their area and use the shoreline and open ocean for feeding on fish, other birds, and small mammals. The northern harrier, red-tailed hawk, and bald eagle are all present near the Long Island Sound shoreline.

While New York and Connecticut officials had been annually tracking osprey nesting numbers, their numbers had rebounded to such an extent (from a low of 298 in 1984 to 896 17 years later) official nest counts are no longer recorded (Table 4-36).

Table 4-36. Nesting Pairs in Connecticut and New York (including Long Island Sound).

Species	**1998**	**2001**	**2004**	**2007**	**2010**	**2011**
Snowy Egret[1]	693	627	826	608	552	
Great Egret[1]	728	813	945	867	1230	
Black-crowned Night Heron[1]	1637	1443	1714	1363	1591	
Least Tern	447[2]	1,003	706	838	1,119	1,315
Piping Plover	21[2]	101	125	128	127	125
Osprey[3]	858	896				

Source: EPA (2014f).

[1] 2011 nesting data for the three wading bird species are not available.

[2] 1998 least tern and piping plover counts are from Connecticut only.

[3] Osprey recovery has led to the species no longer being endangered. State officials stopped tracking nesting numbers in 2002.

Threatened and Endangered Bird Species of the Long Island Sound Region

The USFWS and the states of Connecticut, New York, and Rhode Island keep records of Federal or state threatened or endangered species of birds. Table 4-37 lists the federal and state threatened and endangered birds and species of special concern that have been recorded in these three states and may occur within the study area.

Table 4-37. Federal and State Threatened or Endangered Bird Species in the Long Island Sound Study Area.

Species	Habitat[1]	Endangered Species Act			
		Federal Status	CT Status	NY Status	RI Status
Roseate Tern	Coastal, salt bays, estuaries, oceans	E	E	E	E/H
Piping Plover	Sand beaches, Tidal flats	T	T	E	T
Bald Eagle	Coasts, Rivers,	T	T	T	T
Acadian Flycatcher	Deciduous forests, Ravines, Swampy woods, beech groves	NA	NA	NA	C
American Bittern	Marshes	NA	E	C	E
American Kestrel	Open country, Farmland, Wood edges, Dead trees	NA	T	NA	NA
American Oystercatcher	Coastal beaches, Tidal flats	NA	NA	NA	C
Barn Owl	Woodlands, Groves, Farms, Cliffs	NA	E	NA	E
Bicknell's Thrush	Forest; Shrub[2]	NA	NA	C	NA
Black Rail	Tidal marshes, coast, grassy marshes	NA	E	E	NA
Black Skimmer	Ocean beaches, Salt bays, Tidewater	NA	NA	C	NA
Black Tern	Marshes, Coastal waters	NA	NA	E	NA
Blackburnian Warbler	Woodlands, Conifers in summer	NA	NA	NA	T
Black-crowned Night Heron	Marshes, Shores	NA	NA	NA	C
Black-throated Blue Warbler	Undergrowth of deciduous and mixed woodlands	NA	NA	NA	T
Blue-winged Teal	Marshes	NA	NA	NA	C
Cattle Egret	Marshes, Farms, Highway edges	NA	NA	NA	C
Cerulean Warbler	Deciduous forests, especially in river valleys	NA	NA	C	E
Clapper Rail	Salt marshes, rarely brackish	NA	NA	NA	C
Cliff Swallow	Open to semi-open land, Farms, Cliffs, River bluffs,	NA	NA	NA	H
Common Loon	Coastal waters	NA	NA	C	NA
Common Moorhen (Common Gallinule)	Freshwater marshes	NA	E	NA	H
Common Nighthawk	Open country, Open pine woods	NA	NA	C	C
Common Tern	Ocean, Bays, Beaches, Small Islands	NA	NA	T	NA
Coopers Hawk	Broken woodlands, River groves	NA	NA	C	C
Dark-eyed Junco	Conifer and mixed woods; Open woods, undergrowth, roadsides, brush in winter	NA	NA	NA	C
Eskimo Curlew (Nearly Extinct)	Shores, Mud flats, Marshes	NA	NA	E	NA
Gadwall	Marshes	NA	NA	NA	C

Table 4-37. Federal and State Threatened and Endangered Bird Species in the Long Island Sound Study Area (continued).

Species	Habitat[1]	Endangered Species Act			
		Federal Status	CT Status	NY Status	RI Status
Glossy Ibis	Marshes, Swamps	NA	NA	NA	C
Golden Eagle	Open country	NA	NA	E	NA
Gold-winged Warbler	Open woodlands, Brushy clearings, Undergrowth	NA	NA	C	H
Grasshopper Sparrow	Grassland, Hayfields, Prairies	NA	E	C	T
Great Blue Heron	Marshes, Swamps, Shores, Tidal flats	NA	NA	NA	C
Great Egret	Marshes, Shores, Mud flats	NA	T	NA	C
Green-winged Teal	Marshes	NA	NA	NA	C
Henslow's Sparrow	Weedy fields	NA	NA	T	H
Hooded Merganser	Rivers	NA	NA	NA	C
Horned Lark	Prairies, Open fields, Airports, Shores	NA	T	C	C
King Rail	Freshwater and brackish marshes, swamps; Salt marshes in winter	NA	E	T	C
Least Bittern	Freshwater marshes	NA	T	T	T
Least Tern	Beaches, Bays, Large Rivers	NA	T	T	T
Little Blue Heron	Marshes, Swamps, Shores	NA	NA	NA	C
Loggerhead Shrike	Semi-open country with lookout posts, trees, scrub	NA	NA	E	NA
Long-eared Owl	Woodlands, Thickets, Conifer groves	NA	E	NA	C
Marsh Wren	Marshes	NA	NA	NA	C
Northern Goshawk	Northern forests; Deciduous woodlands in winter	NA	NA	C	C
Northern Harrier	Marshes, Fields	NA	E	T	E
Northern Parula Warbler	Humid woods	NA	NA	NA	T
Northern Saw-whet Owl	Forests, Conifers, Groves	NA	NA	NA	C
Osprey	Rivers, Coasts	NA	NA	C	C
Peregrine Falcon	Mainly open country (mtn to coasts)	NA	E	E	E
Pied-billed Grebe	Marshes; Salt bays in winter	NA	NA	NA	E
Pileated Woodpecker	Conifer, Mixed, and hardwood forests, Woodlots	NA	NA	NA	C
Prothonotary Warbler	Wooded swamps	NA	NA	NA	C
Purple Martin	Farms, Open or semi-open country, often near water	NA	T	NA	NA
Red-headed Woodpecker	Groves, Farm country, Orchards, Shade trees, Large scattered trees	NA	E	C	NA
Red-shouldered Hawk	Woodlands, Wooded rivers, Timbered swamps	NA	NA	C	NA
Seaside Sparrow	Salt marshes	NA	NA	C	C
Sedge Wren	Grassy marshes, Sedgy meadows	NA	E	T	NA
Sharp-shinned Hawk	Woods; Thickets	NA	E	C	H
Short-eared Owl	Prairies, Marshes (freshwater and saltwater), Dunes	NA	T	E	NA
Snowy Egret	Marshes, Swamps, Shores, Tidal flats	NA	T	NA	C

Table 4-37. Federal and State Threatened and Endangered Bird Species in the Long Island Sound Study Area (continued).

Species	Habitat[1]	Endangered Species Act			
		Federal Status	CT Status	NY Status	RI Status
Sora	Freshwater marshes, wet meadows, Salt marshes in winter	NA	NA	NA	C
Spruce Grouse	Coniferous forests[2]	NA	NA	E	NA
Upland Sandpiper	Grassy prairies, Open meadows, Fields	NA	E	T	E
Vesper Sparrow	Meadows, Field, Prairies, Roadsides	NA	E	C	H
Whip-poor-will	Leafy woodlands	NA	NA	C	NA
White-throated Sparrow	Forest[2]	NA	NA	NA	C
Willet	Marshes, Wet meadows, Mud flats, Beaches	NA	NA	NA	C
Winter Wren	Woodland underbrush, Conifer forests in summer	NA	NA	NA	C
Worm-eating Warbler	Dry wooded hills, Undergrowth, Ravines	NA	NA	NA	C
Yellow-breasted Chat	Brushy tangles, Briars, Thickets	NA	E	C	NA
Yellow-crowned Night Heron	Marshes, Streams	NA	NA	NA	C

Sources: USFWS (2014f), CTDEEP (2014e), NYSDEC (2014c), RIDEM (2006).

[1] Peterson (1980), unless otherwise noted.

[2] Cornell University (2014).

E – Endangered; T – Threatened; C – Special concern or concern; H – Historical; NA – not listed as of the publication of this PEIS.

4.13.2 Birds in the Open-Water Environment

Unconfined Open-Water Placement

The numbers of bird species that could potentially be found within the influence of the open-water sites are summarized in Table 4-38.

Table 4-38. Number of Bird Species Found in Open-Water Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS	No specific data available
		CLDS	No specific data available
		CSDS	No specific data available
		NLDS	No specific data available
	Confined Open-Water Placement	E	22 species documented within 1 mi

Source: USACE (2012a).

Alternatives WLDS, CLDS, CSDS, and NLDS are located in areas of water depths of between 44 and 188 ft. These areas are each located far from the closest land mass. Therefore, wading birds, shorebirds, and marsh birds are unlikely to be found at these locations. No direct observations or specific data have been documented for any of the four sites. However, seabirds, waterfowl, colonial waterbirds, and raptors could all possibly use these alternative areas for resting and/or foraging.

Confined Open-Water Placement

Twenty-two bird species were documented within 1 mi of Alternative E (Sherwood Island Borrow Pits).

4.13.3 Nearshore/Shoreline Environment

The numbers of bird species that could be potentially found within the influence of nearshore and shoreline placement sites are summarized in Table 4-39.

Confined Placement

There are 17 Confined Placement alternative sites. Many of these sites have a large variety of bird species occurring within 1 mi (Table 4-39). Threatened or endangered birds that use sandy beaches or coastal marshes may be found in these areas or adjacent to the areas proposed as shoreline CDFs.

Beneficial Use

Nearshore Bar/Berm Placement

There are 39 total nearshore Bar/Berm Placement alternative sites. Many of these sites have a large variety of bird species occurring within 1 mi (Table 4-39).

Beach Nourishment

There are 67 total beach nourishment alternative sites. Many of these sites have a large variety of bird species occurring within 1 mi (Table 4-39). Three of the beaches are listed as having observed nesting behavior of piping plovers and terns at the specific beach. Several other threatened and endangered bird species may also use the beaches for nesting or feeding habitat.

Table 4-39. Number of Bird Species in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present[a]
Nearshore/Shoreline Environment	**In-Harbor CAD Cell**	G	26 species are documented within 1 mi
		H	55 species are documented within ½ mi
		M	7 species are documented within 1 mi
	Island CDF	B	17 species are documented within 1 mi
		L	5 species are documented within 1 mi
		N	6 species are documented within 1 mi
		P	6 species are documented within 1 mi
		Q	6 species are documented within 1 mi
		R	9 species are documented within 1 mi

Table 4-39. Number of Bird Species in the Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[a]
	Shoreline CDF	A	58 species are documented within 1 mi
		C	24 species are documented within 1 mi
		D	21 species are documented within 1 mi
		F	1 species are documented within 1 mi
		I	26 species are documented within 1 mi
		J	27 species are documented within 1 mi
		K	14 species are documented within 1 mi
		O	17 species are documented within 1 mi
	Nearshore Bar Placement/ Nearshore Berm Sites	177	55 species are documented within 1 mi
		178	48 species are documented within 1 mi
		179	48 species are documented within 1 mi
		121/446	61 species are documented within 1 mi
		453	60 species are documented within 1 mi
		173	72 species are documented within 1 mi
		180	68 species are documented within 1 mi
		454A	56 species are documented within 1 mi
		454B	53 species are documented within 1 mi
		455/82	54 species are documented within 1 mi
		445	51 species are documented within 1 mi
		171	53 species are documented within 1 mi
		170	54 species are documented within 1 mi
		63	54 species are documented within 1 mi
		456	53 species are documented within 1 mi
		441	53 species are documented within 1 mi
		320	29 species are documented within 1 mi
		440	22 species are documented within 1 mi
		449	6 species are documented within 1 mi
		438	6 species are documented within 1 mi
		433	Shorebird species are documented within 1 mi
		434	Shorebird species are documented within 1 mi
		323	Shorebird species are documented within 1 mi
		467	26 species are documented within 1 mi
		364B/C	8 species are documented within 1 mi
		451	5 species are documented within 1 mi
		447	7 species are documented within 1 mi
		327/333/330	5 species are documented within 1 mi

Table 4-39. Number of Bird Species in the Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[a]
		337	10 species are documented within 1 mi
		457	10 species are documented within 1 mi
		365	17 species are documented within 1 mi
		GP	13 species are documented within 1 mi
		367	11 species are documented within 1 mi
		368	9 species are documented within 1 mi
		381/382	18 species are documented within 1 mi
		384	18 species are documented within 1 mi
		600	10 species are documented within 1 mi[b]
		610	33 species are documented within 1 mi[b]
		620	12 species, including waterfowl, gulls, shorebirds, roseate tern, Piping plover and least tern
	Beach Nourishment	323	No data available
		433	Shorebirds are documented in the vicinity
		434	Shorebirds are documented in the vicinity
		436	No data available
		365	10 species documented influence of the site; 4 osprey nests within 1 mi
		457	No data available
		364	Shorebirds and wading birds are documented in the vicinity
		444	Shorebirds and wading birds are documented in the vicinity; 4 species of waterfowl are documented in the vicinity
		451	5 species are documented within 1 mi
		337	10 species are documented within 1 mi
		320	Wading birds are documented in the vicinity; 4 species of waterfowl are documented in the vicinity
		441	5 species of waterfowl are documented in the vicinity
		442	No data available
		450	7 species of waterfowl are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		447	3 species of waterfowl are documented in the vicinity
		438	6 species are documented within 1 mi
		440	Shorebirds are documented in the vicinity; 5 species of waterfowl are documented in the vicinity
		449	6 species documented within 1 mi
		181	53 breeding species within 3 mi
		453	52 species are documented in the vicinity

Table 4-39. Number of Bird Species in the Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[a]
		63	54 species are documented in the vicinity
		456	70 species are documented in the vicinity
		454E	36 species are documented in the vicinity
		454W	39 species are documented in the vicinity
		455/82	54 species are documented in the vicinity
		384	18 species are documented within 1 mi
		367	3 species of waterfowl are documented in the vicinity
		368	9 species are documented within 1 mi
		171	53 species are documented within 1 mi
		173	72 species are documented within 1 mi
		177	55 species are documented within 1 mi
		178	48 species are documented within 1 mi
		179	48 species are documented within 1 mi
		170	54 species are documented within 1 mi
		180	49 species are documented within 1/10 mi
		445	51 species are documented within 1 mi
		446	61 species are documented within 1 mi
		343	18 species are documented within 1 mi; 4 osprey nests within 1 mi
		474	Shorebirds are documented in the vicinity
		339	6 species are documented in the vicinity
		459	7 species of waterfowl are documented in the vicinity
		348	10 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		480	Shorebirds and waterfowl are documented in the vicinity; 11 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		467	Shorebirds are documented in the vicinity; 23 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		468	Least terns are documented nesting in the vicinity
		325	Shorebirds and wading birds are documented in the vicinity; 3 species of waterfowl are documented in the vicinity
		327	Shorebirds and wading birds are documented in the vicinity; 3 species of waterfowl are documented in the vicinity
		329	Shorebirds and wading birds are documented in the vicinity; 7 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity

Table 4-39. Number of Bird Species in the Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[a]
		330	Shorebirds and wading birds are documented in the vicinity; 3 species of waterfowl are documented in the vicinity
		331	Shorebirds and wading birds are documented in the vicinity; 3 species of waterfowl are documented in the vicinity
		332	Shorebirds and wading birds are documented in the vicinity; 11 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		333	Shorebirds and wading birds are documented in the vicinity; 3 species of waterfowl are documented in the vicinity
		344	Shorebirds are documented in the vicinity
		345	Wading birds are documented in the vicinity
		121	61 species documented within 1 mi
		64	58 species documented in the vicinity
		67	37 species documented in the vicinity
		68	46 species documented in the vicinity
		111	46 species documented in the vicinity
		76	56 species documented within 1 mi
		79	55 species documented in the vicinity
		381	Waterfowl are documented in the vicinity; 8 species are documented in the vicinity
		382	Waterfowl are documented in the vicinity; 8 species are documented in the vicinity; Piping plover and least terns are documented nesting in the vicinity
		437	50 breeding species within 3 mi
		600	Shorebirds are documented in the vicinity; Wading birds are documented in the vicinity; Sea ducks are documented in the vicinity
		610	Shorebirds are documented in the vicinity; 9 species are documented in the vicinity
		620	8 species, including waterfowl, gulls, and roseate terns

Sources: [a]USACE (2012a), (2012b); USGS (2014b); NOAA (2014k).
[b]RIGIS (2014b).

4.13.4 Upland Environment

The numbers of bird species that could be potentially found in the vicinity of upland alternative sites are summarized in Table 4-40.

Confined Placement

Landfill Placement

Sixty-one (61) breeding bird species have been documented within 3 mi of the Landfill Placement Alternative 59 (Table 4-40).

Beneficial Use

Landfill Capping/Cover

Fifty (50) breeding bird species have been documented within 3 mi of Landfill Capping/Cover alternative 60 (Blydenburgh Road Landfill Complex), and 44 breeding species have been documented within 3 mi of alternative 61 (Town of Brookhaven Landfill) (Table 4-40). There are no data on the occurrence of bird species for the other two Landfill Capping/Cover alternatives (Sites 251 and 272).

Brownfields and Other Redevelopment

Forty-eight (48) breeding bird species have been documented within 3 mi of the Flushing Airport Wetlands and Uplands redevelopment site (Site 422/423) (Table 4-40).

Habitat Restoration/Enhancement or Creation

Fifty (50) breeding bird species have been documented within 3 mi of the Plumb Beach Habitat Restoration/Federal Shore Protection Project site (Site 427) (Table 4-40). Seventy-nine (79) breeding bird species have been documented within 3 mi of the Jamaica Bay Marsh Islands Habitat Restoration site (Site 429).

Table 4-40. Number of Bird Species Found in Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present
Upland Environment	**Landfill Placement**	59	61 breeding species within 3 mi
	Landfill Cover/Capping	60	50 breeding species within 3 mi
		61	44 breeding species within 3 mi
		251	No bird data available
		272	No bird data available
	Brownfields & Other Redevelopment	422/423	48 breeding species within 3 mi
	Habitat Restoration / Enhancement or Creation	427	50 breeding species within 3 mi
		429	79 breeding species within 3 mi

Source: USGS (2014b).

4.14 MARINE MAMMALS AND MARINE REPTILES

4.14.1 General Long Island Sound Setting

Long Island Sound provides habitat for several marine mammals (e.g., whales, dolphins, and seals) and marine reptiles (e.g., sea turtles). This section discusses marine mammals and marine reptiles that may potentially be found in the open water, nearshore areas, and beach areas present within the study area. Section 4.16 discusses the potential for threatened or endangered wildlife (including reptiles) to be present in upland environments located within the study area. Sections 4.10 and 4.13 discuss threatened or endangered fish and birds that could occur within the study area.

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972 (MMPA), which was reauthorized in 1994. The MMPA established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters. The term “take” is statutorily defined to mean “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” The moratorium also prohibits the importation of marine mammals and marine mammal products into the United States. The NMFS has responsibilities under MMPA that include monitoring populations of marine mammals to ensure sustainability. If a population falls below its optimum level, it can be designated as “depleted,” and a conservation plan may then be developed to guide research and management actions necessary to restore the population to healthy levels.

Endangered and threatened species are protected under the Federal ESA of 1973, 16 U.S.C. §§ 1531 et seq., and under individual state laws, whereas species listed as “special concern” are protected only by state law. An endangered species is one whose overall survival in a particular region or locality is in jeopardy because of loss or change in habitat, overall exploitation by humans, predation, adverse interspecies competition, or disease. Unless an endangered species receives protective assistance, extinction may occur. Threatened or rare species are those with populations that have become notably decreased due to development of any number of limiting factors leading to a deterioration of the environment. A species may also be considered as a species of “special concern.” These may be any native species for which a welfare concern or risk of endangerment has been documented within a state (NYSDEC, 2014c).

Section 7 of the ESA (P.L. 93-205) requires that every Federal agency ensure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any Federally endangered or threatened species or result in the destruction or adverse modification of any critical habitat of such species. The USACE, as the lead Federal agency for this PEIS, is mandated by Section 7 of the ESA to consult with the U.S. Department of Commerce (via NMFS) and the Secretary of Interior (via USFWS) to determine if any Federally protected species may be affected by the project. This consultation may include preparation of a Biological Assessment to determine whether the proposed action is likely to result in adverse effects to threatened or endangered species. Consultations were conducted during the designation of open-water placement sites (the CLDS and the WLDS). If additional open-water placement sites are designated for the placement of dredged material, additional consultations will be necessary to provide NMFS and USFWS with project-specific information on dredged material placement amounts and duration.

In addition, consultation with state agencies will be necessary for state-listed species. New York, Connecticut, and Rhode Island state threatened or endangered species lists are frequently updated and should be reviewed during the development of project-specific NEPA documents for a project-specific determination. Links to each state's threatened or endangered species lists are provided below.

- Connecticut threatened or endangered species by taxonomic group http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323488&deepNav_GID=1628
- Connecticut threatened or endangered species by county http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323474&deepNav_GID=1628
- New York threatened or endangered species http://www.dec.ny.gov/animals/7494.html
- Rhode Island threatened or endangered animals http://www.rinhs.org/wp-content/uploads/ri_rare_animals_2006.pdf
- Rhode Island threatened or endangered plants http://www.rinhs.org/wp-content/uploads/ri_rare_plants_2007.pdf

The marine mammals and marine reptiles that may be found in the study area, including threatened or endangered species, are provided in Table 4-41. Brief life history descriptions of these species are provided below.

Whales

In general, whales and other marine mammals are not frequently seen in the study area, especially Long Island Sound. However, incidental sightings in the study area have resulted in the inclusion of several species on the endangered species list for Connecticut, New York, and Rhode Island (CTDEEP (2014h); NYSDEC (2014c); USFWS (2014g)). Humpback whales have been occasionally noted in eastern Long Island Sound (Institute for Sustainable Energy, 2003) (RI CRMC, 2010). During the summer months, humpback, finback, and minke whales migrate to the waters south of Long Island to feed on the plankton and on small, shrimp-like creatures called euphausiids or krill that are plentiful near the surface of the ocean. Foraging whales may enter Long Island Sound, including dredged material placement sites; however, use of alternative sites would be on an incidental basis only and limited seasonally.

Humpback Whale

Humpback whales occur in all major oceans of the world (NMFS, 1991). Increased sightings in the Chukchi Sea recently suggest that the species range is expanding farther into Arctic waters in response to climate change-related factors. Until the early 20th century, humpback whales were an important commercial species throughout most of its range, including New England waters (Allen, 1916), and some taking of the species occurred in northwest Atlantic waters until the mid-1950s. The International Convention for the Regulation of Whaling (adopted in 1946) afforded the North Atlantic population of humpback whales full protection in 1955 (Best, 1993). Humpback whales were assigned endangered species status in the United States in 1970

(USFWS, 1986). The best abundance estimate currently available for humpbacks in the Gulf of Maine is 823 whales for the period 2006-2010, with a population of 335 whales from a survey conducted in June through August 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013).

Table 4-41. Marine Mammals and Marine Reptiles Found in the Long Island Sound Study Area.

Species	Endangered Species Act Federal Status	 CT Status	 NY Status	 RI Status	MMPA
Whales					
humpback whale (*Megaptera novaeangliae*)	E	E	E	E	Yes
fin whale (*Balaenoptera physalus*)	E	E	E	E	Yes
right whale (*Eubalaena glacialis*)	E	E	E	E	Yes
sperm whale (*Physeter catadon*)	E	E	E	NA	Yes
blue whale (*Balaenoptera musculus*)	E	E	E	NA	Yes
long-finned pilot whales (*Globicephala melas*)	NA	NA	NA	NA	Yes
minke whale (*Balaenoptera acutorostrata*)	NA	NA	NA	NA	Yes
Dolphins and Porpoise					
bottlenose dolphin (*Tursiops truncatus*)	NA	NA	NA	NA	Yes
common dolphin (*Delphinus delphis*)	NA	NA	NA	NA	Yes
harbor porpoise (*Phocoena phocoena*)	NA	NA	NA	NA	Yes
Atlantic white-sided dolphins (*Lagenorhynchus acutus*)	NA	NA	NA	NA	Yes
Seals					
harbor seal (*Phoca hispida*),	NA	NA	NA	NA	Yes
gray seal (*Haliochoerus grypus*)	NA	NA	NA	NA	Yes
harp seal (*Phoca groenlandica*)	NA	NA	NA	NA	Yes
hooded seal (*Cystophora cristata*)	NA	NA	NA	NA	Yes
Reptiles					
loggerhead sea turtle (*Caretta caretta*)	T	T	T	T	NA
green sea turtle (*Chelonia mydas*)	T	T	T	NA	NA
leatherback sea turtle (*Dermochelys coriacea*)	E	E	E	E	NA
Atlantic Ridley sea turtle (*Lepidochelys kempii*)	E	E	E	E	NA
hawksbill sea turtle (*Eretmochelys imbricata*)	E	E	E	E	NA
diamondback terrapin (*Malaclemys terrapin*)	NA	NA	NA	E	NA

E – Endangered
T – Threatened
NA – not listed as of the publication of this PEIS

The humpback whale is a migratory species that spends the summer in highly productive northern latitude feeding grounds (40° to 75° N latitude) (NMFS, 1991). Humpback whales regularly visit the waters of southern New England, including the deeper, continental shelf areas of Massachusetts and Rhode Island, where they are present in greatest abundance between June and September. One of the primary feeding grounds is Stellwagen Bank, located off the eastern coast of Massachusetts. Most whales are found in areas where their primary food sources occur in large numbers and can be easily located. Humpback whales are the top carnivores in a relatively simple food chain consisting of phytoplankton, zooplankton, small forage fish (e.g., sand eels, herring), and crustaceans. Humpback whales may potentially migrate through the eastern part of the project area en route to feeding grounds in the north, including the Bay of Fundy, and to tropical breeding grounds in the south. Humpbacks are regularly found in the New York Bight and are the most frequently observed whales on whale-watching trips originating in New York. In addition, they can be observed for extended periods in June through September feeding on fish shoals in Long Island Sound, Gardiner's Bay, and Block Island Sound (CRESLI, 2014b).

Fin Whale

Fin whales are present in all major oceans of the world, from the Arctic to the tropics, with greatest numbers in temperate and boreal latitudes (Evans, 1987). Fin whales were identified as endangered throughout their range in 1970. Because of their high cruising speed, fin whales were not harvested commercially in large numbers until other species, such as slow-moving right whales, were depleted and whalers developed high-speed boats (Leatherwood, et al., 1976). A fishery for this species existed in Nova Scotia from 1964 to 1972 (Mitchell, 1974), and commercial harvesting of fin whales elsewhere in the world continued at least into the early 1990s. For the western North Atlantic fin whale population, the most recent estimate of abundance is 1,595, based on a survey conducted in June through August 2011 from North Carolina to the Lower Bay of Fundy (Waring, et al., 2013). This is considered to be an extremely conservative estimate due to the fin whale's extended distribution and poorly understood population structure.

Fin whales are commonly seen on the continental shelf in waters less than 328 ft deep and are present year round in the vicinity of Long Island (CRESLI, 2014c). New England waters are important summer feeding grounds for fin whales, and the species is most abundant off of the Massachusetts coast along the 130- to 165-ft depth contour, particularly in the Great South Channel east of Cape Cod, across Stellwagen Bank, and northeastward to Jeffreys Ledge (north of Cape Ann, Massachusetts) (Hain, et al., 1992). During the fall and winter, the majority of these whales migrate south to wintering grounds offshore of the Delmarva Peninsula and the Outer Banks of North Carolina (Winn (1982); EPA (1988)). Other individuals concentrate at the mid-shelf region east of New Jersey as well as areas on Stellwagen Bank and Georges Bank. Juveniles will return to the same feeding areas they first visited with their mothers year after year (Seipt, et al. (1990); Clapham & Seipt (1991)). The fin whales' preferred feeding grounds in the coastal areas (130- to 165-ft depth contour) imply that these whales may be found in the eastern areas of Long Island Sound, particularly in January through March (CRESLI, 2014c).

Right Whale

The northern right whale was a prime target of early whale fisheries along the coast of the eastern United States from the 1600s through the early 1900s, due to its coastal distribution, slow swimming speed, high oil yield, and characteristic of floating when dead (Brown (1986); Aguilar (1987)). Due to intense exploitation, it is now the rarest of the large whales and is in danger of extinction. The northern right whale was classified as endangered in 1970 (35 FR 8495). Three areas have been designated as critical habitat for the northern right whale: the Great South Channel, Cape Cod Bay, and southeastern U.S. waters 13 nmi offshore from the Alameda River, Georgia, to Sebastian Inlet, Florida.

Generally, northern right whales are found along the east coast of North America (Winn, 1982). Some female right whales have been observed to migrate more than 1,600 nmi from their northern feeding grounds to the southern calving/wintering grounds (Knowlton, et al., 1992). Even though some New England waters are important feeding and nursery grounds for right whales, this species is rarely seen in the project area, which is inshore of migration paths. Right whales are generally found in areas where their primary food sources, including copepods and krill, are concentrated.

The most significant ongoing human impacts to right whales are collisions with vessels and entanglement in fishing gear (NMFS (2005), Pettis (2013)). Other anthropogenic factors potentially contributing to the slow recovery of the northern right whale population include pollution, oil and gas exploration, seabed mining, wastewater discharges, dredged material placement, and a general increase in coastal activities (including noise) along the U.S. east coast (NMFS (2005); Pettis (2013); Steinback, et al. (1999); EPA (1993)). The interaction of climate change trends and periodic disturbances (e.g., North Atlantic Oscillation) on physical oceanography and the abundance and spatial distribution of zooplankton prey could also be an important factor (Greene, et al. (2003); Greene & Pershing (2000), (2004)).

The western North Atlantic population will be considered “recovered” when it reaches 60% to 80% of its pre-exploitation number (NMFS, 2005), or about 7,000 animals. The 2001 population estimate was 291 individuals (Kraus, et al., 2001), and NMFS calculated a minimum population size of 444 right whales for the period 2006-2010 (Waring, et al., 2013). The cessation of whaling and the implementation of the MMPA (1972) and the ESA (1973) appear to be enabling the population of northern right whales to increase, but at a very slow rate. Demographic features documented in northern right whale population such as highly variable calf production, an increase in calving interval in reproductive females, and a significant decline in calf survival rates could all be contributing to the lack of substantial recovery (Reeves, et al., 2001). A number of potential factors, including low genetic diversity (inbreeding), nutrition, contaminants, and disease, are the focus of ongoing research into the reproductive dysfunction of northern right whales compared to more stable populations (including the Southern Hemisphere right whale) (Reeves, et al., 2001).

Sperm Whale

Sperm whales are generally found on the continental shelf edge, over the continental slope, and into mid-ocean regions. They are listed as endangered under the ESA. Their offshore distribution is more commonly associated with the Gulf Stream edge and other features as suggested by Waring, et al. (1993). NMFS provides an abundance estimate of 1,593 sperm whales from a survey conducted in July through August 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013).

The sperm whale is the deepest diver of the great whales; it can descend to depths of over 3,300 ft and stay submerged for over an hour. Average dives are 20 to 50 minutes long to a depth of 980 to 1,970 ft (ACS, 2014a). In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the distribution shifts northward to east of Delaware and Virginia and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. There are reports of sperm whale in the area of Block Canyon on the continental slope south of Long Island, located approximately 100 mi south of the study area (CETAP (1982); Scott & Sadove (1997)). In summer, the sperm whale distribution in the northwest Atlantic Ocean is similar to the spring, but also includes areas east and north of Georges Bank and onto the continental shelf off New England. In the fall, sperm whales tend to migrate on the continental shelf south of New England. The main food source of the sperm whale is medium-sized deep water squid, but it also feeds on species of fish, skate, octopus, and smaller squid.

Blue Whale

The blue whale, the earth's largest living mammal, was hunted for oil from 1900 until 1966, when the International Whaling Commission banned all hunting of blue whales and gave them worldwide protection (ACS, 2014b). Blue whales are listed as endangered. The blue whale population in the western North Atlantic was estimated by Mitchell (1974) to be in the low hundreds. Recovery has been extremely slow, and only in the last few years have there been signs that their numbers may be increasing (NMFS, 1998). There are no confirmed records of mortality or serious injury to blue whales in the U.S. Atlantic waters with the exception of one ship strike event that is assumed to have occurred in the North Atlantic Ocean.

The distribution of the blue whale in the western North Atlantic generally extends from the deep waters of the Arctic to at least mid-latitude oceanic waters. They are most frequently sighted in the waters off eastern Canada (NMFS, 2002a), with occasional visits to the U.S. Atlantic waters south to Florida and the Gulf of Mexico. The preferred water depth and habitat of the blue whale has not been documented, but due to their enormous size and ability to dive deeply, they are not expected to be found in Long Island Sound. The blue whale is thought to feed almost exclusively on krill.

Long-finned Pilot Whale

The long-finned pilot whale, protected under MMPA, is the most familiar pilot whale because of its global distribution, general abundance, and yearly strandings. The North Atlantic subspecies ranges from North Carolina northward to Davis Strait in Canada. Pilot whales spend winter and spring in the vicinity of the continental slope, typically congregating in high-density groups. In summer and fall they move inshore, following squid and mackerel populations. These whales forage mainly at water depths of 600 to 1,650 ft, although they can almost certainly forage deeper if necessary (Reeves, et al., 2002). There are at least 12,000 long-finned pilot whales in the western North Atlantic (Waring, et al., 2013).

Minke Whale

The minke whale, protected under MMPA, is a fast swimmer, capable of reaching speeds of 16 to 21 knots (18 to 24 mph) (ACS, 2014c). They primarily feed on small schooling fish (capelin, cod, herring, pollock) or krill, and may eat copepods in some areas. These whales can occur in polar, temperate, and tropical waters, but are more common in cooler waters at higher latitudes. They can be found in both coastal/inshore and oceanic/offshore areas. An abundance estimate of 2,591 minke whales was based on a survey conducted in July through August 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013).

Dolphins and Porpoises

The Riverhead Foundation for Marine Research and Protection's Sighting Program has identified, and verified by photo, harbor porpoises and bottlenose dolphins throughout the study area, especially Long Island Sound, since 1997 (The Riverhead Foundation, 2014a). All species of dolphins and porpoises are protected under MMPA.

Bottlenose Dolphin

The bottlenose dolphin is commonly found in groups or herds and is often associated with pilot whales and other cetacean species. It is between 6 and 12 ft long and uses high-frequency echolocation to locate and capture prey. The individuals of the inshore population are smaller and lighter in color, while offshore animals are larger and darker and have smaller flippers. The inshore animals prey on benthic invertebrates and fish, while offshore animals feed on pelagic squid and fish. In 2006, NMFS implemented the Bottlenose Dolphin Take Reduction Plan to reduce the serious injury and mortality of bottlenose dolphins incidental to nine U.S. commercial fisheries. The plan requires modifications of fishing practices for small, medium, and large-mesh gillnet fisheries. The status of the stock is currently unknown (Waring, et al., 2013) because there are insufficient data to determine population trends for this stock. Bottlenose dolphins are routinely observed off the southern coast of Long Island during years when water temperatures are warmer than normal, and rare sightings in the study area have been reported. One event in 2009 identified 100 individuals in Huntington Harbor, located in western Long Island Sound and lasting more than a week (Durham, 2009).

Common Dolphin

The abundance and distribution of the common dolphin vary based on oceanographic conditions. They typically prefer the oceanic and offshore environments, where they can dive to at least 650 ft to feed on fish or squid, but they can also occur on the continental shelf and closer to shore when following their prey. They are usually found in large social groups averaging hundreds of individuals. They will often approach ships to "bowride" for long periods of time. They are commonly found as incidental "take" in fishing gear, such as longlines, driftnets, gillnets, and trawls. An abundance estimate of 67,191 common dolphins was based on a survey conducted in July through August 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013).

Similar to the bottlenose dolphin, this species is not a regular visitor to the study area; however, the occasional pod siting or stranding report indicates that the presence of this species cannot be ruled out. For instance, a mass stranding of common dolphin occurred in an East Hampton cove in 2007 (NYWDAL, 2014).

Atlantic White-sided Dolphin

The Atlantic white-sided dolphin often associates with, and also probably feeds on, small schooling fish and squid with fin whales, humpback whales, and long-finned pilot whales. Atlantic white-sided dolphins are typically considered to be an oceanic species, primarily on

Stellwagen Bank and Jeffreys Ledge, but will actively search for mackerel closer to shore in early spring. NMFS provides an abundance estimate of 48,816 Atlantic white-sided dolphins based on a survey conducted in 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013).

This species is a rare visitor to waters of the study area, and sightings are most likely limited to the extreme eastern section (i.e., area of Rhode Island and Stonington, Connecticut) (Institute for Sustainable Energy, 2003).

Harbor Porpoise

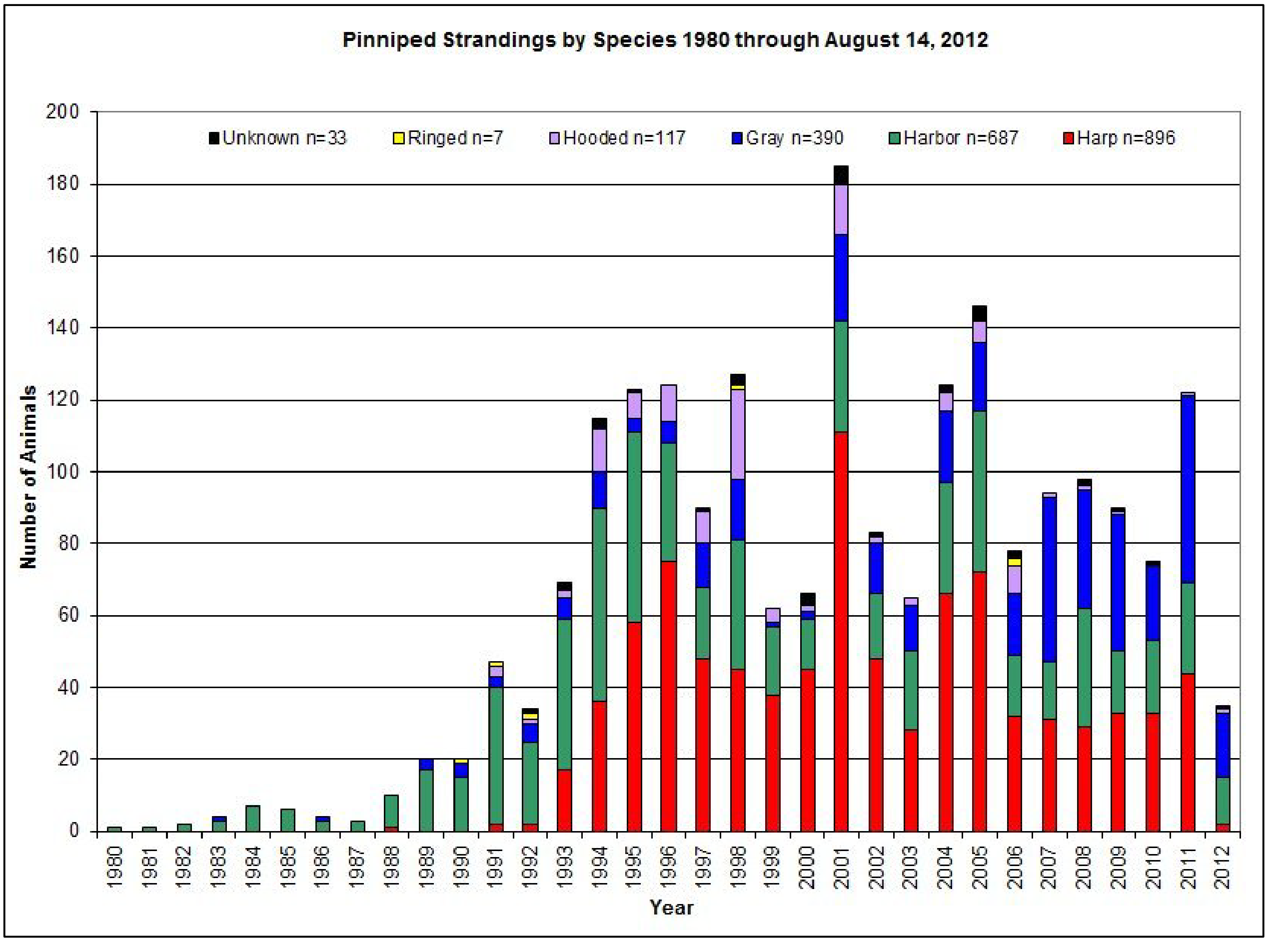
The harbor porpoise is the smallest cetacean (maximum total length of 5 ft) in the western North Atlantic Ocean. It is most commonly found in bays, estuaries, and harbors (Reeves, et al., 2002). As the common name implies, the harbor porpoise is found primarily near shore in shallow waters, bays, and harbors. When in the open ocean (and deeper areas of Long Island Sound), harbor porpoises are typically observed alone or in groups of two to five individuals. They are normally seen only briefly and partially as they roll at the surface to breathe (Reeves, et al., 2002). Harbor porpoise feed on schooling fish less than 16 inches long, such as herring, capelin, sprat, and silver hake. Most of their food is found near the seafloor, but they also forage in the water column. Calves often ingest small crustaceans during the early phases of weaning (Reeves, et al., 2002). NMFS provides an abundance estimate of 79,883 harbor porpoise from a survey conducted in July through August 2011 from North Carolina to the lower Bay of Fundy (Waring, et al., 2013). Harbor porpoise occurrence in the study area is highly seasonal, with the majority of combined sightings, strandings, and by-catch records between 1,850 and 2,007 in winter (20%) and spring (70%), respectively (Kenney, 2013).

Seals

Harbor, grey, harp, and hooded seals can be found in coastal inshore waters of the project area (Institute for Sustainable Energy, 2003), although the latter two species are anticipated to occur in study area waters only incidentally. The Riverhead Foundation for Marine Research and Preservation has conducted both winter and spring seal surveys since 1997. These surveys have documented increases in harbor seals and gray seals in the waters around Long Island, especially at haul-out sites (Latimer, et al., 2014).

Seals arrive in the study area in the fall, peak in abundance in the winter, and leave in late spring, heading to northern waters of New England and Canada. Recent data suggest that the seals are staying in the Long Island Sound area year-round (Latimer, et al., 2014). Seal numbers in Long Island Sound have increased from hundreds of animals in the early 1990s to thousands of animals in the winter of 2011 (Latimer, et al., 2014).

Figure 4-55 shows the number of seals that have stranded in Long Island Sound from 1980 through August 14, 2012, by species. The highest number of strandings occurred in 2001, which included a significant number of harp seal strandings that particular year. The total number of seal strandings from 2002 to 2011 ranged from 65 to 145 per year (Figure 4-55).



Source: The Riverhead Foundation (2014b).

Figure 4-55. Seal Strandings by Species, 1980 through August 14, 2012.

Harbor Seal

The harbor seal, also known as the common seal, is found throughout coastal waters of the Atlantic Ocean from Canada to New York and adjoining seas above 30° N latitude (Waring, et al., 2001). Harbor seals have been reported in Long Island Sound year-round, as well as more than 20 mi upriver of the mouth of major river/estuaries along the Connecticut River (Institute for Sustainable Energy, 2003). This species occurs in highest numbers within the study area from November through May and can be observed along the Connecticut coast from Stonington to Greenwich. Harbor seals live in temperate coastal habitats and use rocks, reefs, and beach as haul-out locations and pupping sites. They haul-out onto rocks or beaches to rest, regulate body temperature, interact, give birth, and avoid predators. Harbor seals eat a variety of prey consisting of cod, herring, mackerel, squid, flounder, green crabs, mussels, and whiting (Sadove & Cardinale, 1993). The vast majority of the population migrates to the northern waters of New Hampshire, Maine, and Canada in the spring for the pupping season; however, Little Gull Island (northeast of Gardiner's Bay) is a breeding rookery for both harbor and gray seals (CRESLI, 2014d).

Gray Seal

Gray seals are generally found in coastal waters. When on land, they inhabit rocky coasts and islands, sandbars, and icebergs. Surveys conducted by the Riverhead Foundation for Marine Research and Preservation indicate that this species has increased in abundance within the study area since 1997 (Latimer, et al., 2014). A previously unknown grey seal rookery on Little Gull Island in Long Island Sound was identified in 2006 (CRESLI, 2014e). Previously, the nearest grey seal pupping area was thought to be in Nantucket Sound, on Muskeget Island, west of Nantucket Island.

Gray seals are opportunistic feeders, consuming 4% to 6% of their body weight per day. They typically eat fish, crustaceans, squid, octopus, and occasionally seabirds. When hunting, gray seals use the entire water column – from the water surface to the seafloor as deep as 1,500 ft; they can hold their breath for over one hour. They have been observed feeding on cod when sighted along the coast and are often sighted with harbor seals (Sadove & Cardinale, 1993). They typically haul out onto rocky islands or sandy shores.

Harp Seal

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans. Starting in approximately 1990, harp seals have been sighted in the winter and spring months at the extreme southernmost reach of its range from mid-Atlantic waters through New England (Waring, et al., 2001). Long Island Sound is within the migratory range of harp seals during winter and spring, and thus there is a potential for this species to occur within the study area. They typically haul out onto beaches to rest. In the last decade, numbers of sightings and strandings of harp seal have been increasing, with a maximum number in 2001 (Figure 4-55) (The Riverhead Foundation, 2014b). For centuries, humans have been the main threat to harp seals. Human-caused mortalities have occurred from various sources, including boat strikes, fishing gear, power plant entrainment, harassment, and shooting. Harp seals dive to maximum depths of 1,200 ft for a general duration of approximately 16 minutes. They eat a variety of fish and invertebrates but mainly focus on small fish such as capelin, arctic and polar cod, and invertebrates such as krill.

Hooded Seal

Hooded seals are typically found in the North Atlantic and Arctic Oceans. They are abundant in these areas during the mating season, which begins in late winter and lasts through April. In the summer and fall, they are migratory and can wander as far south as Florida and the Caribbean. In the study area, they haul out in rocky or sandy habitats. The hooded seal is an unsocial species and is more aggressive and territorial than other seals, migrating and remaining alone for most of the year except during mating season. Hooded seal pups are weaned between 3 to 5 days, the shortest time of any known mammal. Hooded seals usually dive for food at depths from 325 to 2,000 ft for 15 minutes, but they are also capable of diving to over 3,200 ft for up to an hour. Adult hooded seals feed on squid, starfish, mussels, and fish such as halibut, redfish, cod, capelin, and herring.

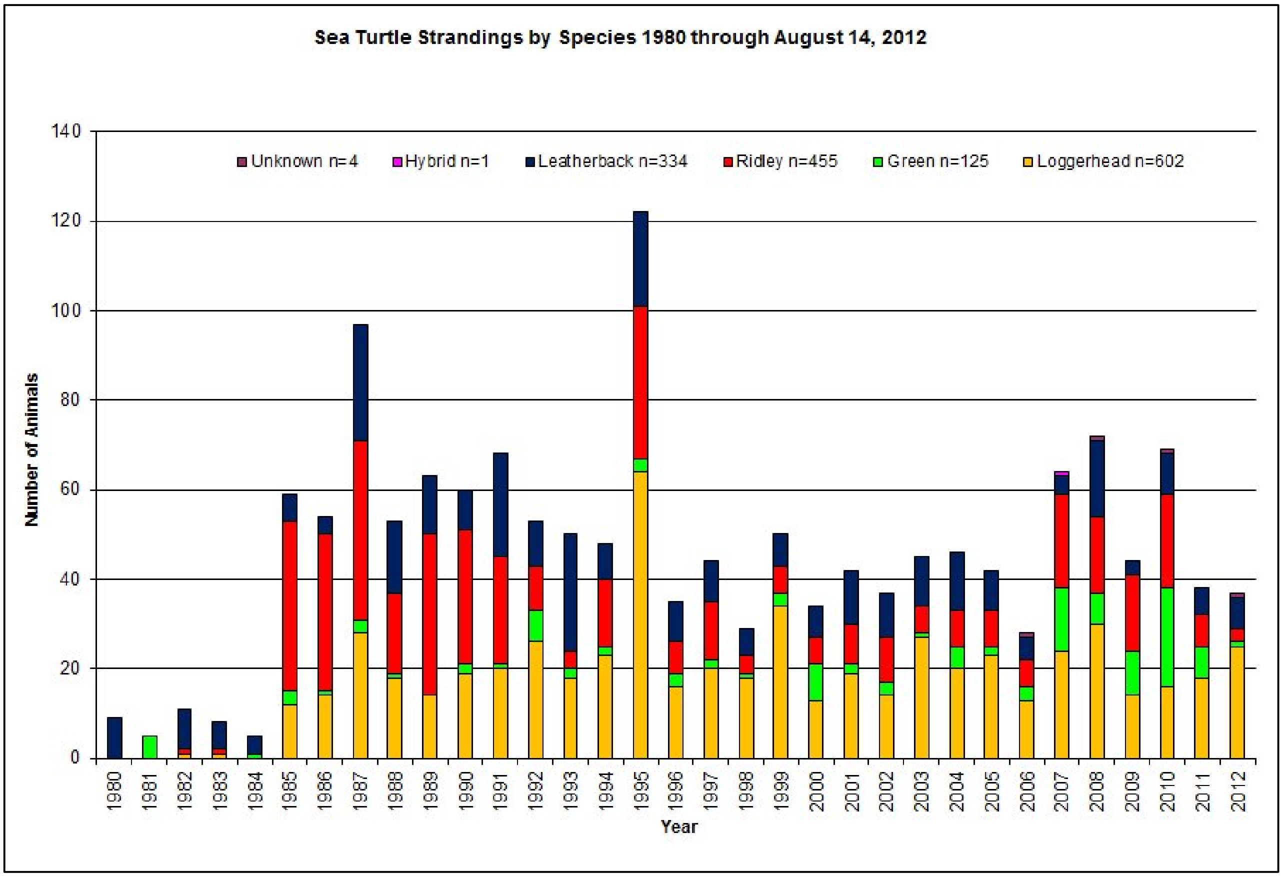
Reptiles

Five species of sea turtles and the diamondback terrapin, which lives most of its life in brackish water, are covered in this section. The Riverhead Foundation on Long Island and the Mystic Aquarium in Connecticut have both recorded sea turtle strandings since 1980. Sea turtles are highly migratory and are often found throughout the world's temperate oceans (NOAA, 1995), including the study area. No sea turtle species has been reported as using the study area for nesting. Sea turtles generally begin to appear in the eastern bays and estuaries during late spring or summer. They remain in the area throughout the summer, beginning their southward or offshore migration from New York waters in mid-October. If these animals do not leave early enough in the fall, they can become cold-stunned (hypothermic) and wash up on the beaches around New York and New England (Latimer, et al., 2014). Cold stunning of sea turtles is a major problem for the loggerhead, green, and Atlantic Ridley sea turtles, with the latter being most affected historically. These animals wash up on north-facing beaches of Long Island Sound (Latimer, et al., 2014). Figure 4-56 shows the number of strandings recorded per species each year (The Riverhead Foundation, 2014b).

The coastal waters of New York provide an important habitat for juvenile Atlantic Ridley, green, and loggerhead turtles and adult-sized leatherbacks. Hawksbill turtles are only an incidental visitor to Long Island Sound; therefore Long Island Sound is not considered important habitat to the Hawksbill turtle. Additional information on the five sea turtles found in the study area is provided below.

Atlantic Ridley Sea Turtle

The Atlantic Ridley sea turtle is the smallest of the sea turtles and the most endangered sea turtle in the world (NRC (1990); Carr & Mortimer (1980); NMFS (2001a)). This turtle is found mainly in the Gulf of Mexico; however, juveniles migrate north along the Atlantic seaboard during the summer. Most of the turtles that visit the study area are juveniles, averaging 9.8 to 11.8 inches in length (NMFS, 1988). More Ridley turtles are observed in the coastal waters of New York and southern Massachusetts than anywhere else in the northeast (Lazell (1980); Morreale and Standora (1992)). Important habitats include Long Island Sound, Block Island Sound, and Gardiners Bay (Sadove & Cardinale, 1993). In Long Island Sound, where crustaceans represent more than 80% of the diet, nearly all feeding takes place on or near the bottom in shallow water (Morreale & Standora (1992), (1993); Burke, et al. (1994)). Young Ridleys consume several species of crabs, including spider crabs, lady crabs, and rock crabs (Morreale and Standora, (1992), (1993)).



Source: The Riverhead Foundation (2014b).

Figure 4-56. Sea Turtle Strandings by Species, 1980 through August 14, 2012.

Loggerhead Sea Turtle

The loggerhead sea turtle is listed as threatened throughout its range under the ESA (NMFS, 2002b). It is the most common and seasonally abundant turtle in inshore coastal waters of the Atlantic (NMFS and USFWS (1991a)). Sub-adult loggerhead turtles migrate northward in the spring and become abundant in coastal waters off New York, where they are encountered in Long Island Sound during the summer (Henwood and Stuntz (1987); Keinath, et al. (1987); Morreale, et al. (1989); Shoop and Kenney (1992)). The loggerhead has two distribution patterns: one group of mainly juveniles is found in bays and within the study area; the second group is more oceanic and is generally found along the south shore of Long Island and up to 40 mi offshore (Sadove & Cardinale, 1993). The dominant prey of the loggerhead turtle is the spider crab, but other crabs (e.g., horseshoe, green, and portunid) are consumed as well (Sadove & Cardinale, 1993). Abundance estimates of loggerheads along the U.S. Atlantic coast are difficult to estimate due to the short time turtles spend on the surface where they can be observed.

Leatherback Turtle

The leatherback turtle is the largest and most distinctive of living sea turtles and is listed as endangered throughout its range (NMFS, 2001b). Leatherbacks reach a length of 59 to 67 inches straight line carapace length (SLCL) (large outstretched front flippers may span 106 inches in an adult) and a weight of 441 to 1,543 lbs. Compared to other sea turtles, leatherbacks are more widely distributed as adults in temperate and boreal waters throughout the world. Their wide distribution is directly related to endothermy, which allows them to survive and feed in colder temperate waters than other sea turtles can tolerate (Frair, et al. (1972); Standora, et al. (1984)). Leatherback turtles are the second most common turtle along the eastern seaboard of the United States and the most common north of the 42°N latitude. Long Island Sound supports one of the largest populations on the Atlantic Coast during the summer and early fall (Lazell (1980); Shoop & Kenney (1992)). Adults migrate extensively throughout the Atlantic basin in search of jellyfish and other gelatinous zooplankton, such as salps, ctenophores, and siphonophores (Limpus, 1984). Although leatherback turtles are pelagic feeders, they can dive to considerable depths (extending 1,312 ft, within an average of 197 ft) in search of food (Eckert, et al. (1986), (1989)). During the summer, they move into fairly shallow coastal waters (but rarely into bays), apparently following their preferred jellyfish prey. Because they are a largely oceanic, pelagic species, estimates of their population status and trends have been difficult to obtain.

Green Turtle

The green turtle is the largest of the hard-shelled sea turtles. Adult green turtles reach lengths of 36 to 43 inches SLCL and weights of up to 397 lbs (NMFS, 2001c). It is listed as threatened throughout its range, except for breeding populations in Florida and the Pacific coast of Mexico, which are listed as endangered (NMFS, 2001c). These turtles were once very abundant throughout shallow coastal waters in tropical and subtropical climates; their rapid decline in the 20th century is attributed, in part, to heavy predation by humans on its eggs, erosion and fortification of nesting beaches, use of off-road vehicles on beaches, and the capture of adults for food and shell products (Thompson (1988); NMFS (2001c)). During the summer, small numbers of green turtles may venture as far north as the New York Bight and New England, where some become cold–stunned each year by falling water temperatures in the fall and winter (Burke, et al. (1992); Morreale, et al. (1992)).

Green turtles are the only species of sea turtle that is a strict herbivore as an adult. They feed in shallow coastal waters on sea grasses and marine algae; they are abundant wherever these plants are abundant. Sub-adult green turtles are occasionally observed in the late summer feeding on seagrass beds in the Chesapeake Bay (Barnard, et al., 1989) and along the shores of southern Long Island (Burke, et al., 1992). In waters around Long Island, green turtles feed primarily on algae, followed by the seagrass *Zostera marina* (Burke, et al., 1992). Green turtles are affected by both natural and anthropogenic disturbances to shoreline habitat and offshore waters throughout their range in U.S. waters (NMFS and USFWS, 1991b). Green turtles are relatively rare visitors north of Virginia, and the strandings records reflect this. An occasional green turtle is stranded in the study area, usually as a result of cold–stunning (Morreale, et al., 1992). Green turtles seem to be particularly vulnerable to entanglement in fishhooks, monofilament line, and fishing nets.

Hawksbill Sea Turtle

The hawksbill sea turtle is a small to medium-sized sea turtle, slightly larger than the Ridley turtle. Adult nesting females have a carapace length of about 24 to 37 inches SLCL and weigh about 176 lbs (NMFS, 2001d). The hawksbill turtle is a tropical and subtropical species, inhabiting warm waters of the Atlantic, Pacific, and Indian Oceans (NMFS, 2001d). In U.S. territorial waters, hawksbills occur along the Gulf of Mexico coast, Gulf and Atlantic coast of Florida, Puerto Rico, and in the U.S. Virgin Islands. Hawksbill turtles are listed as endangered throughout their range worldwide. Their decline is attributed largely to hunting pressure for their valuable shells (NMFS, 2001d). Like most sea turtles, hatchling hawksbills are pelagic for a period of one to several years. When the juveniles reach a carapace length of about 8 to 10 inches, they return to coastal waters to feed and grow as sub-adults (NMFS, 2001d). There have been a few reports of hawksbills in the western Atlantic Ocean as far north as Cape Cod (Bleakney (1965); Lazell (1980)) and Virginia (Musick, 1979).

Diamondback Terrapin

The diamondback terrapin is listed as endangered in Rhode Island. It is native to the brackish coastal swamps of the eastern and southern United States. They typically live in the very narrow strip of coastal habitats, which can include beach environments. They are well adapted to the nearshore marine environment, allowing them to survive in a variety of salinities. Their strong webbed hind feet make them strong swimmers, and their strong jaws allow them to crush shells of prey, such as clams and snails. Diamondback terrapins nest on land, but otherwise spend much of their time in the tidal marsh area.

4.14.2 Marine Mammals and Reptiles in the Open-Water Environment

A summary of marine mammals and marine reptiles potentially found within the influence of the open-water sites is presented in Table 4-42.

Table 4-42. Marine Mammal and Marine Reptiles in Open-Water Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1]
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS	20 species possibly in the area
		CLDS	20 species possibly in the area
		CSDS	20 species possibly in the area
		NLDS	20 species possibly in the area
	Confined Open-Water Placement	E	20 species documented within 1 mi

Source: [1] EPA (2004).

Unconfined Open-Water Placement

Each of the marine mammals described above may be found at any of the unconfined open-water alternative sites (WLDS, CLDS, CSDS, and NLDS). The seal species usually migrate into Long Island Sound in the fall, peak in the winter, and leave in the spring, but they can also be found year round. The various species of dolphins and porpoises are typically offshore, but they may travel into Long Island Sound in pursuit of prey in the summer. Use of the alternative sites by whales would be on an incidental basis only. The incidental occurrence of Atlantic Ridley, loggerhead, leatherback, green, and hawksbill sea turtles in the Long Island Sound area indicates that there is a slight chance that they may inhabit or travel through part of each alternative site during the summer and fall. However, the frequency would be quite low during the colder months of winter and spring when most turtles are cold-stunned by water temperatures.

Confined Open-Water Placement

Each of the marine mammals described above has the potential to travel into Long Island Sound as far as Containment Site Alternative E (Sherwood Island Borrow Pit); however, use of the alternative sites by whales would be on an incidental basis only. Seals are more likely to be present during the fall, winter, and spring months, but they may be found year-round. The various species of dolphins and porpoises are typically offshore species, but they may travel into Long Island Sound in pursuit of prey.

4.14.3 Nearshore/Shoreline Environment

A summary of marine mammals and marine reptiles that are potentially found within the influence of nearshore and shoreline placement sites is presented in Table 4-43.

Confined Placement

Marine mammal species listed above may potentially be found in this area where the water depth is sufficient to support that particular species (Table 4-43).

In-Harbor CAD Cells

Alternatives G and H are located in relatively shallow water (approximately 15 ft deep), and Alternative M is located less than 0.5 mi from the shoreline in water depths ranging from 10 to 30 ft below MLW. The larger marine mammals, such as whales, will avoid these types of areas with high boat traffic in the Bridgeport Harbor channel and New Haven channel. The smaller marine mammals (seals and dolphins) and sea turtles could occur in the vicinity of these alternatives, depending on prey availability.

For the three In-Harbor CAD Cell locations, nine marine mammal species were documented within 1 mi of each of the sites, and threatened or endangered habitat was documented at nearshore and upland areas within 0.5 to 1 mi from the CAD cell location (USACE, 2012a). There are no state-identified locations of threatened or endangered species in the vicinity of Alternatives G and H – Bridgeport Outer Harbor West and Southeast (USACE, 2012a). Alternative M – Morris Cove – is located approximately 0.2 mi from state-identified locations of threatened or endangered species located on the northern shoreline (USACE, 2012a).

Island CDFs

The six island CDF locations (Alternatives B, L, N, P, Q, and R) are located in varying water depths from 8 to 32 ft. Five of the six island CDF locations are within 1 mi of shoreline; Alternative N is located 4 mi from Guilford Harbor. The larger marine mammals, such as whales, will generally avoid these types of areas with shallow water depths. The smaller marine mammals (seals and dolphins) and sea turtles are possible in this area if a food source is available (Table 4-43).

Table 4-43. Marine Mammals and Marine Reptiles in Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1]
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	9 species documented within 1 mi
		H	9 species documented within 1 mi
		M	9 species documented within 1 mi
	Island CDF	B	11 species documented within 1 mi
		L	9 species documented within 1 mi
		N	10 species documented within 1 mi
		P	9 species documented within 1 mi
		Q	9 species documented within 1 mi
		R	9 species documented within 1 mi
	Shoreline CDF	A	3 species documented within 1 mi
		C	9 species documented within 1 mi
		D	9 species documented within 1 mi
		F	9 species documented within 1 mi
		I	4 species documented within 1 mi
		J	9 species documented within 1 mi
		K	9 species documented within 1 mi
		O	9 species documented within 1 mi
	Nearshore Bar Placement/ Nearshore Berm Sites	177	7 species documented
		178	11 species documented within 1 mi
		179	12 species documented within 1 mi
		121/446	10 species documented within 1 mi
		453	10 species documented within 1 mi
		173	10 species documented within 1 mi
		180	11 species documented within 1 mi
		454A	11 species documented within 1 mi
		454B	10 species documented within 1 mi
		455/82	10 species documented within 1 mi
		445	10 species documented within 1 mi
		171	4 species documented within 1 mi
		170	4 species documented within 1 mi
		63	4 species documented within 1 mi
		456	4 species documented within 1 mi
		441	10 species documented within 1 mi
		320	9 species documented within 1 mi
		440	9 species documented within 1 mi
		449	9 species documented within 1 mi
		438	9 species documented within 1 mi

Table 4-43. Marine Mammals and Marine Reptiles in Nearshore/Shoreline Environments (continued).

Environment	Alternative Type	Alternative ID	Resources Present[1]
		433	9 species documented within 1 mi
		434	9 species documented within 1 mi
		323	9 species documented within 1 mi
		467	9 species documented within 1 mi
		364	9 species documented within 1 mi
		451	9 species documented within 1 mi
		447	9 species documented within 1 mi
		327/333/330	9 species documented within 1 mi
		337	9 species documented within 1 mi
		457	9 species documented within 1 mi
		365	9 species documented within 1 mi
		GP	9 species documented within 1 mi
		367	9 species documented within 1 mi
		368	7 species documented within 1 mi
		381/382	7 species documented within 1 mi
		384	7 species documented within 1 mi
		600	11 species documented within 1 mi
		610	11 species documented within 1 mi
		620	3 species documented within 1 mi
	Beach Nourishment	323, 433, 434, 436, 457, 364, 457, 364, 444, 451, 337, 441, 442, 450, 447, 438, 440, 449, 181, 456, 454E, 454W, 455/82, 384, 367, 171, 173, 177, 170, 180, 474, 339, 459, 348, 480, 467, 468, 325, 327, 329, 330, 331, 332, 333, 344, 345, 121, 64, 67, 68, 111, 76, 79, 381, 382, 437, 610, 620, 365, 320, 453, 63, 368, 178, 179, 445, 446, 343, 600	N/A

Sources: [1] USACE (2012a), (2012b).

Shoreline CDFs

The eight shoreline CDF locations (Alternatives A, C, D, F, I, J, K, and O) are generally located in shallow water (ranging from 0 to 30 ft of water) and are placed specifically to be adjacent to an existing shoreline. The larger marine mammals, such as whales, will usually avoid these types of areas due to the shallow water depths. The smaller marine mammals (seals and dolphins) and sea turtles are possible in this area if a food source is available. In addition, the diamondback terrapin can potentially be found in brackish waters in the vicinity of coastal marshes or estuaries within the study area.

Alternative I is located in an industrial, urban ship channel and is not likely to have marine mammals, reptiles, or threatened or endangered species located in the area. Alternatives K and O are located adjacent to a shipping channel that may discourage all but the most tolerant marine mammals (e.g., harbor seal); however, sea turtles could be present, depending on the availability of prey (e.g., crabs or, in the case of the green turtle, SAV).

Beneficial Use

Nearshore Bar/Berm Placement

The nearshore berms are located along the 15-ft depth contour immediately seaward of the target beaches. The 15-ft contour was assumed to be the shallowest location accessible for a typical shallow-draft, split-hull hopper dredge or scow likely to perform dredging work. The larger marine mammals, such as whales, are expected to avoid areas between land and the 15-ft contour due to the shallow nature of these areas. The smaller marine mammals (seals and dolphins) and sea turtles are possible in this area if a food source is available (green sea turtles feed on SAV).

Beach Nourishment

The four species of seals (particularly harbor and gray seal) may potentially be found along beaches during haul-out periods. The diamondback terrapin can potentially be found in any coastal marsh or estuarine habitat adjacent to beaches. There are no documented records of sea turtle nesting within the study area; however, individual sea turtles that are cold-stunned and disoriented likely use beaches during periods of lower water temperatures or in late season.

4.14.4 Upland Environment

Marine mammals are not applicable to the upland alternative sites. See Section 4.16 for a discussion of terrestrial mammals, reptiles, and threatened or endangered species in upland areas.

4.15 WETLANDS

Wetlands are transitional zones between terrestrial and aquatic systems (Dreyer & Niering, 1995). The term "wetlands," as defined in the Federal Code of Regulations (CFR) (33 CFR § 328.3), refers to "those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." They can be classified according to general similarities in hydrology, geomorphology, chemistry, and biology (Cowardin, et al., 1979). Three types of wetland systems are present within the study area: estuarine, palustrine, and riverine. Estuarine wetlands are located near coastal areas along the shoreline, including salt marsh, brackish marsh, and tidal flats. Palustrine wetlands are nontidal inland freshwater wetlands dominated by trees, shrubs, and emergent herbaceous plants which include forested swamps, scrub-shrub swamps, wet meadow, and marsh. Riverine wetlands are rivers, streams, brooks, and creeks.

Classifications and Regulations of Wetlands

Wetlands are classified and regulated differently by the Federal government and each state. Wetland types vary from state to state and are based on each state's regulatory definition (discussed further in Section 5.15.1). Section 404 of the CWA defines wetlands as "waters of the United States." Wetlands under Federal jurisdiction have three essential characteristics: hydrophytic vegetation (wetland plants), hydric soils (wetland soils), and wetland hydrology. The discharge of dredged or fill materials into waters of the United States is regulated pursuant to Section 404 of the CWA. A permit cannot be granted under Section 404 until a water quality certification, or waiver of certification, has been issued pursuant to CWA Section 401. Section 401 gives the EPA review authority over issuance of Section 404 permits, although Section 401 allows the states to assume the authority for water quality review. In addition, each state also has its own state wetland permitting requirements.

Jurisdictional wetlands within the study area have not been delineated to date as part of this project. For planning purposes, information on mapped wetlands was gathered from available state online Geographic Information System (GIS) information sources and in the figures presented in the following documents:

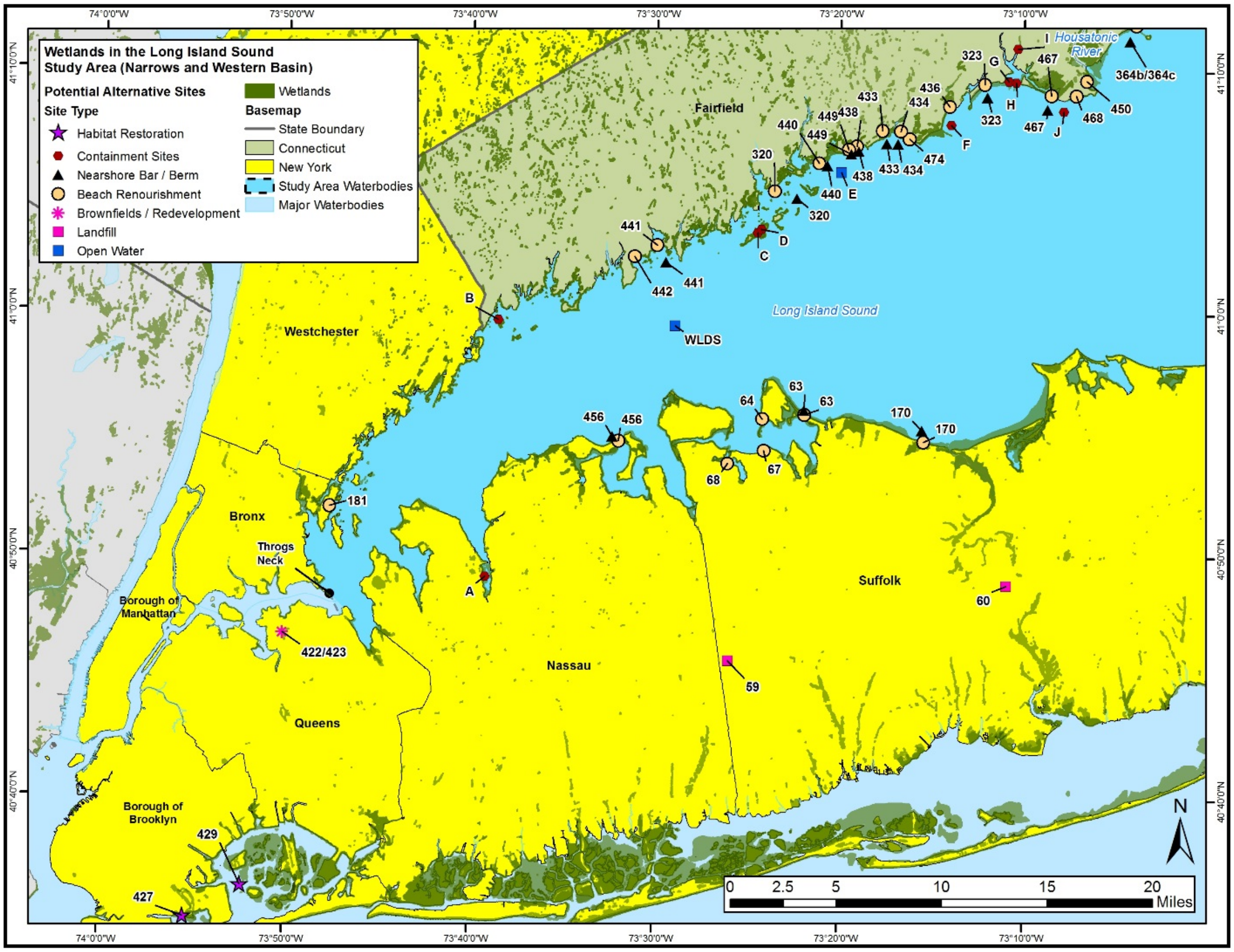
- *Upland, Beneficial Use, and Sediment Dewatering Site Investigation, Phase 2* (USACE, 2010a)
- *Long Island Sound Dredged Material Management Plan (LIS DMMP) Investigation of Potential Nearshore Berm Sites for Placement of Dredged Materials* (USACE, 2012b)

These documents, which depict the proposed alternative site locations and incorporate state GIS data through 2010 and updated state GIS data through 2014, were used to update the presence or absence of wetlands for this PEIS. These GIS-based maps are not definitive with regard to the presence or absence of wetlands; the presence or absence of wetlands must be evaluated and field verified under a project-specific environmental review for each alternative and location selected.

4.15.1 General Long Island Sound Setting

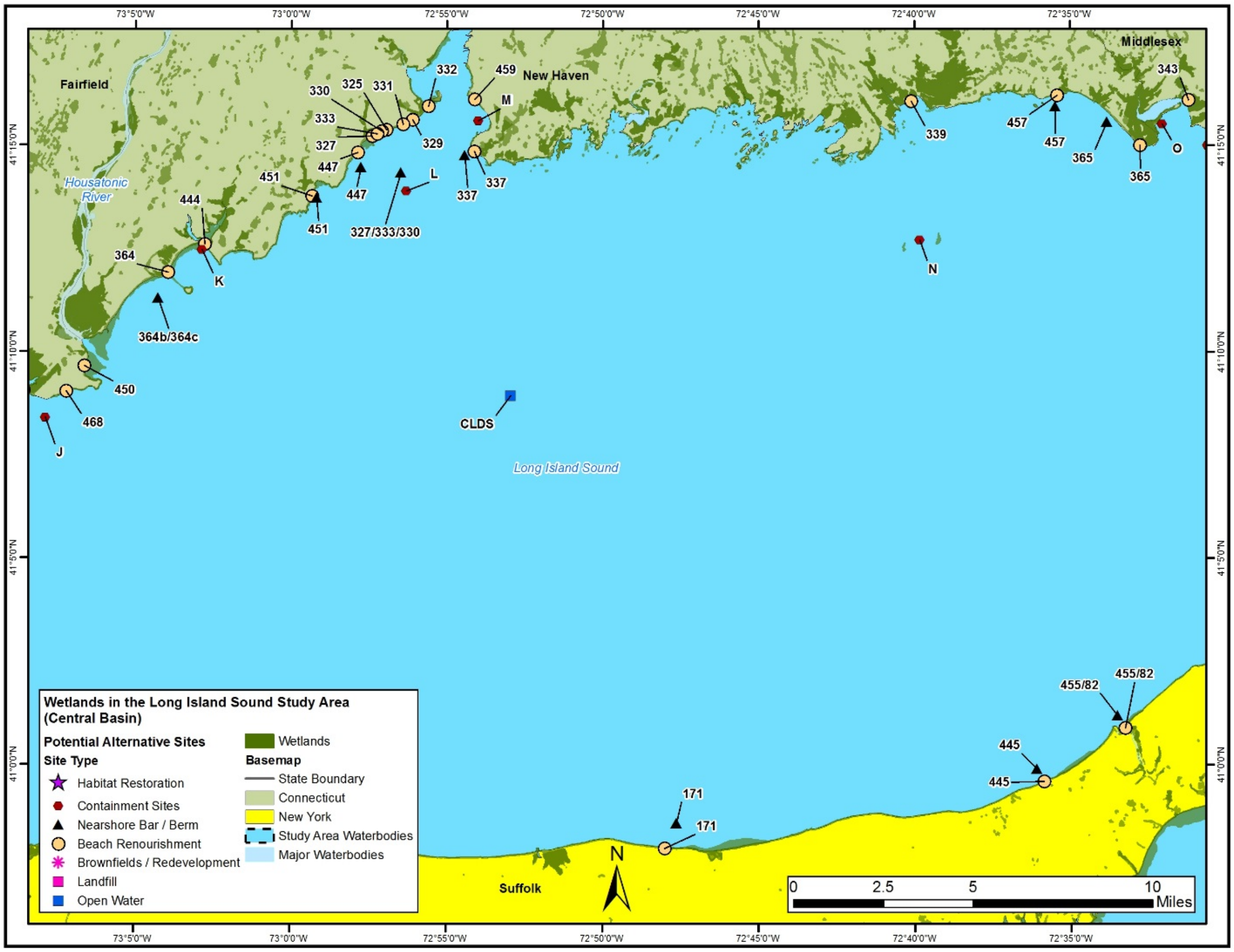
Inland and coastal wetlands are present in the areas of Connecticut and New York contiguous to Long Island Sound and in portions of Rhode Island's Washington County contiguous with Block

Island Sound and its southern coast (Figure 4-57, Figure 4-58, and Figure 4-59). Coastal estuarine wetlands are located along the shorelines, coastal embayments, and mouths of coastal rivers that are influenced by the tides (tidal wetlands). Coastal wetlands include tidal and brackish salt marshes (in Connecticut and New York); coastal shoals, bars and intertidal mudflats (in New York); and shoreline features including beaches (in Rhode Island). Inland palustrine wetlands within the study area include forested swamp, scrub-shrub swamp, marsh, and wet meadow. Riverine wetlands are located within inland areas.



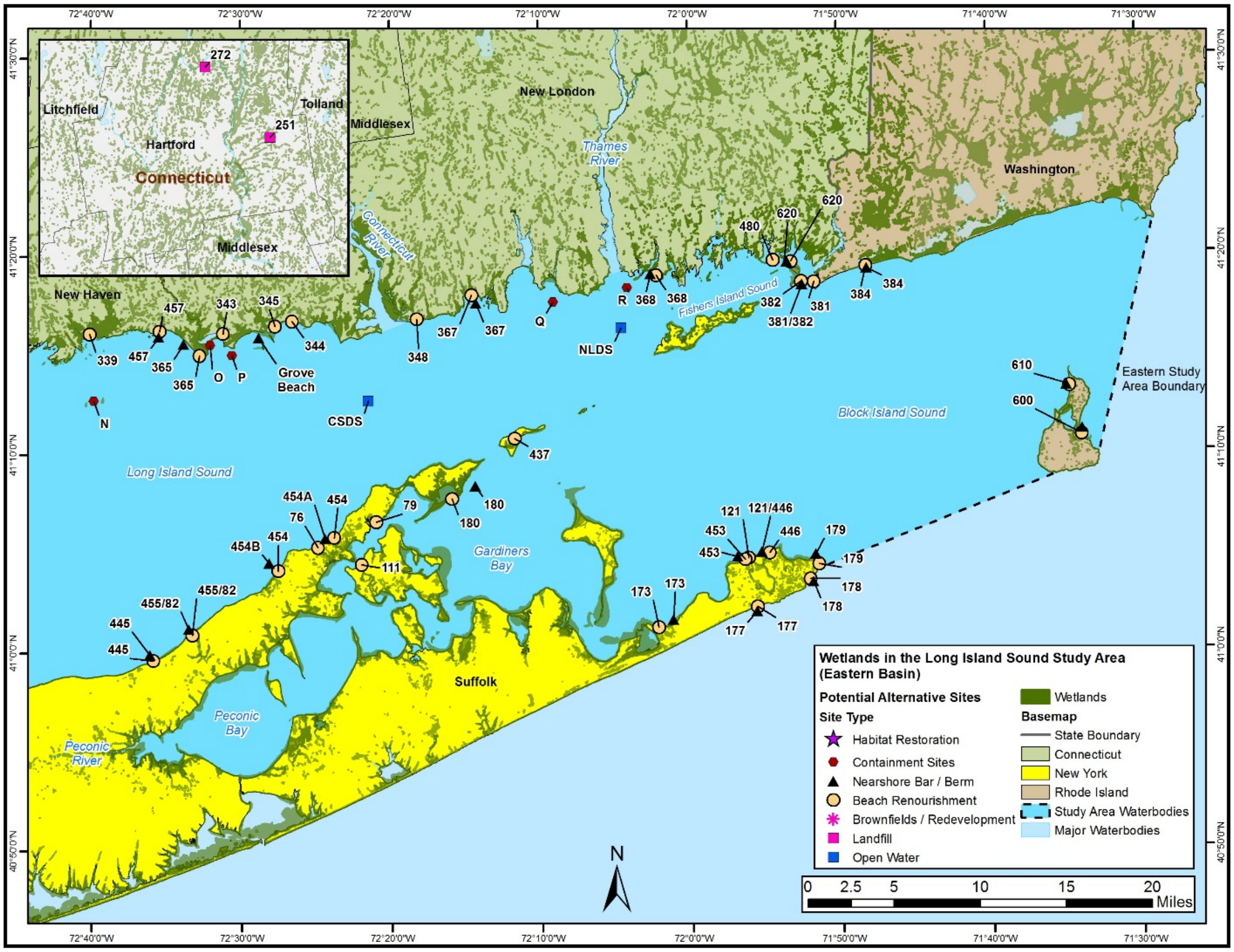
Sources: CTDEEP (2014i); NYSDEC (2014d), (2014e); RIGIS (2014c).

Figure 4-57. Wetlands in the Long Island Sound Study Area (Western Basin).



Sources: CTDEEP (2014i), NYSDEC (2014d), (2014e); RIGIS (2014c).

Figure 4-58. Wetlands in the Long Island Sound Study Area (Central Basin).



Sources: CTDEEP (2014i) NYSDEC (2014d), (2014e); RIGIS (2014c).

Figure 4-59. Wetlands in the Long Island Sound Study Area (Eastern Basin).

Coastal Wetlands

The occurrence of tidal wetlands is determined by the geology and resulting topography of Long Island Sound and its shoreline. The most common tidal coastal wetland in Long Island Sound is salt marsh (Dreyer & Niering, 1995). Salt marshes are estuarine wetlands that consist of salt-tolerant grasses and emergent plant communities that experience regular and periodic flooding by tides. Species within these communities include salt meadow cordgrass (*Spartina patens*), saltwater cordgrass (*Spartina alterniflora*), black grass (*Juncus gerardii*), and spike grass (*Distichlis spicata*) (Warren, et al., 2009). Saltwater cordgrass is dominant in the low marsh zone, which is flooded twice daily by the tides. This zone occurs along the seaward edges, creeks, and ditches of the wetland. Black grass, spike grass, and salt meadow cordgrass occur on the higher elevations of the marsh known as the high marsh zone, which is irregularly flooded. The upland border zone of the wetland, flooded only several times a month, contains plants such as switchgrass (*Panicum virgatum*) and marsh elder (*Iva frutescens*) (Warren, et al., 2009).

The shoreline in western Long Island Sound tends to be more suitable to the formation of tidal marshes than the shoreline of central and eastern Long Island Sound (Benoit, et al., 2003) due to the Sound's glacial history. As the last glacier retreated from the Long Island Sound basin, a recessional moraine was deposited along the coastal plain of Long Island's north shore. In the western section of Long Island, the moraine is set back farther from the shore, and the shoreline follows the edge of the ancient coastal plain (Benoit, et al., 2003). Varying depths of marsh peat and sediments (deep and shallow) form tidal salt marshes. The deep marshes of the Connecticut coast vary from approximately 16 ft thick west of the Connecticut River to approximately 6 ft thick east of the Connecticut River to Westerly, Rhode Island (Hill & Shearin, 1970).

Brackish tidal marshes occur in embayments and tidal rivers where the waters of Long Island Sound are significantly diluted by freshwater. The salt content of the soil typically ranges between 0.5 and 18 ppt (parts per trillion) (oligohaline to mesohaline), and wetland vegetation is dominated by emergent plants.

Freshwater tidal marshes occur in areas where the tide rises and falls but the waters have salt concentrations less than 0.5 ppt due to limited mixing with salt water. Technically, these marshes are not considered a part of the estuary. Freshwater tidal marshes typically have 25 to 40 species growing in the intertidal area, and 60 to 100 species in sections of the marsh that are flooded infrequently (Odum, et al., 1984). Freshwater tidal marshes comprise only a small percentage of Long Island Sound wetlands and are not present within any alternative sites within the study area.

Tidal wetlands are important ecologically because they have high nutrient and primary productivity; function as nursery areas for larvae and juveniles of many marine species that are important prey for valuable commercial and recreational fish species; provide habitat, nesting, feeding, and refuge areas; and provide part of the base of the aquatic food web in Long Island Sound. Wetlands are also important in the storage of floodwaters and provide protection from flooding.

Within Long Island Sound there have been efforts to restore wetlands to healthy and productive ecosystems. The Long Island Sound Restoration Act (33 U.S.C. 1269) supports various programs to restore and preserve ecosystems including wetland restoration. Since the 1970s, Connecticut has restored over 1,500 acres of salt marsh (Dreyer & Niering, 1995). New York has also initiated and implemented tidal wetland restoration. Additional information related to wetland restoration in the study area is provided in Sections 4.15.3 and 4.15.4.

Tidal flats are unvegetated wet areas of mud or sand that do not contain rooted plants, are subject to tidal flooding, and are exposed by receding tidal water. They occur along the shoreline and typically border marsh areas and beaches. Tidal flats consist of a mixture of silt, clay, sand, and organic material.

Inland Wetlands

Inland freshwater wetlands are classified based on plant types and include forested swamp, scrub-shrub swamp, emergent freshwater marsh, and wet meadow. These wetland plant communities are dominant throughout the formerly glaciated land areas adjacent to Long Island Sound (Tiner, 2011). Inland freshwater wetlands are important ecologically because they provide valuable resources such as groundwater supply and fisheries and wildlife habitat. They also provide important functions such as flood control and storm damage prevention.

Forested swamps are wetland areas dominated by woody vegetation, including trees 20 ft or taller. Red maple (*Acer rubrum*) swamps are the most common type of forested wetland, with other trees species also interspersed in the canopy of the swamp (Metzler & Tiner, 1991). Forested swamps can be temporarily flooded or have groundwater at or near the surface for portions of the year.

Scrub-shrub swamps are dominated by woody vegetation, including shrubs less than 20 ft tall. Scrub-shrub swamps include shrubs, young trees, and trees or shrubs that are small or stunted due to environmental conditions. Shrub swamps are shrub-dominated wetlands that are either seasonally or temporarily flooded. They typically are found in flat areas in which the water table is at or above the soil surface for most of the year.

Emergent freshwater marshes and wet meadows are dominated by grasses and herbaceous grass-like plants, including sedges and rushes. Emergent freshwater marshes are usually flooded; wet meadows generally have saturated soil. The most common marshes in the study area are dominated by cattail (*Typha* spp.) and common reed (*Phragmites australis*).

Wetland Data Sources by State

State GIS based wetlands data discussed for each state below were obtained and used to identify wetlands within the study area. Information on wetlands in the study area that are associated with specific dredged material placement alternative sites is provided in Sections 4.15.2 through 4.15.4.

Connecticut

Connecticut wetlands data were obtained online as an ArcGIS shapefile from the CTDEEP "Tidal Wetlands 1990s" data layer and the "Inland Wetland Soils" data layer (CTDEEP, 2014i). These data layers show all mapped tidal wetlands and inland wetlands across the state of Connecticut. The tidal wetlands mapping was compiled by the State of Connecticut, Office of Long Island Sound Programs (OLISP) using two sources: the 1994 Ramsar Tidal Wetlands Mapping and the 1995 OLISP Tidal Wetlands Mapping. The tidal wetland boundaries are not regulatory boundaries, but rather a guide to the location of tidal wetlands throughout the state. The data layer shows the presence/absence of tidal wetlands but does not provide information on type of tidal wetland.

In Connecticut, tidal wetlands are "those areas which border on or lie beneath tidal waters, such as, but not limited to banks, bogs, salt marshes, swamps, meadows, flats, or other low lands subject to tidal action, including those areas now or formerly connected to tidal waters, and whose surface is at or below an elevation of 1 ft above local extreme high water; and upon which may grow or be capable of growing some, but not necessarily all, of a list of specific plant species" (see CGS Section 22a-29(2) for a complete list of species) (CGS Section 22a-29).

Inland wetlands in Connecticut are defined by soil type: poorly drained, very poorly drained, alluvial, and floodplain.

New York

For New York, online data for tidal wetlands were obtained from the New York State GIS Clearinghouse. The data were obtained as a shapefile titled "Tidal Wetlands – NYC and Long Island", produced by NYSDEC (2014d). This data layer represents the most recent digital mapping of tidal wetlands for the study area and was produced by NYSDEC by digitizing the official 1974 tidal wetlands inventory maps.

Tidal wetlands in New York are defined as "those areas which border on or lie beneath tidal waters, such as, but not limited to, banks, bogs, salt marsh, swamps, meadows, flats or other low lands subject to tidal action, including those areas now or formerly connected to tidal waters; all banks, bogs, meadows, flats and tidal marsh subject to such tides, and upon which grow or may grow some or any of the following: salt hay (*Spartina patens* and *Distichlis spicata*), black grass, saltworts (*Salicornia* spp.)" (see Article 25 of Environmental Conservation Law [ECL] Section 25-0103.1 for additional listed species not provided here) (ECL, Article 25).

Categories of tidal wetlands in New York are as follows:

- Intertidal marsh – The vegetated tidal wetland zone lying generally between average high and low tidal elevations in saline waters.
- High marsh – The normal uppermost tidal wetland zone usually dominated by salt meadow cordgrass and spike grass. This zone is periodically flooded by spring and storm tides.
- Coastal shoals, bars, and mudflats – The tidal wetland zone that at high tide is covered by saline or fresh tidal waters, at low tide is exposed or is covered by water to a maximum depth of approximately 1 ft, and is not vegetated.
- Fresh marsh – The tidal wetland zone found primarily in the upper tidal limits of riverine systems where significant freshwater inflow dominates the tidal zone.
- Dredged spoil – All areas of fill material.
- Formerly connected – The tidal wetland zone in which normal tidal flow is restricted by man-made causes.

Freshwater wetlands in New York are defined as lands and waters of the state of an area at least 12.4 acres, as shown on the state's freshwater wetlands map, which contain any or all of the following: lands and submerged lands commonly called marshes, swamps, sloughs, bogs, and flats supporting aquatic or semi-aquatic vegetation [see Article 24 of ECL Section 24-0107.1 for additional definition not provided here] (ECL, Article 24).

Freshwater wetland data in New York were obtained from the Cornell University Geospatial Information Repository website. The data were obtained as a shapefile titled "Freshwater Wetlands", produced by NYSDEC (2014e). NYSDEC based the data layer on the official New York State Freshwater Wetlands Maps (and updates) as described in Article 24-0301 of the ECL. The wetland lines indicate the approximate location of the actual boundaries of the wetlands. The data layer shows the presence or absence of freshwater wetlands; it does not provide information on type of wetland.

New York protects state-regulated wetlands by surrounding each tidal wetland by a 300-ft Adjacent Area; each freshwater wetland is surrounded by a 100-ft Adjacent Area.

Rhode Island

Wetland data in Rhode Island were obtained online from the Rhode Island GIS (RIGIS). The shapefile "Wetlands of Rhode Island" was produced by RIGIS using aerial photography from 1988 (RIGIS, 2014c).

Categories of wetlands in the study area in Washington County, Rhode Island, are associated with coastal and inland areas. They include the following shoreline features (as defined by the Rhode Island Coastal Resources Management Program):

- Coastal wetlands – Salt marsh, brackish marsh, or freshwater wetlands contiguous to salt marsh. Salt marshes are regularly flooded and inundated by salt water.
- Coastal beach – Unconsolidated sand, gravel, or cobbles, usually unvegetated sediment sometimes subject to wave action. Beaches extend from MLW landward to an upland rise.
- Barrier beach – Composed of sand and/or gravel, extending parallel to the coast and separated from the mainland by a coastal pond, tidal waterbody, or coastal wetland.
- Rocky shore – Shorelines comprised of bedrock ledge or boulder-strewn areas, extending from below MLW to above the mean high water mark.

Freshwater wetlands in Washington County include swamp, marsh, bog, pond, river, riverbank, stream, floodplain, area of land within 50 ft (perimeter wetland), and areas subject to flooding.

4.15.2 Wetlands in the Open-Water Environment

Unconfined/Confined Open-Water Placement

Wetlands are not applicable to these alternative sites because they are located in open water, not wetland areas.

4.15.3 Wetlands in the Nearshore/Shoreline Environment

Nearshore/shoreline alternative sites that contain wetlands are summarized in Table 4-44. GIS-based data (shapefiles) were used to evaluate the site alternatives. The presence or absence of resources is also noted in Table 4-44.

Previously prepared reports (EPA (2004); EPA and USACE (2004); USACE (2010a), (2012b)) were reviewed and the findings updated with more-recent data associated with current GIS-based data. Wetlands resources potentially occur near several Island and Shoreline CDFs, numerous nearshore bar/berm sites, and numerous beach nourishment sites.

Island CDF Alternative Site B (Greenwich Captain Harbor) and Shoreline CDF Alternative Sites C and D (Norwalk Outer Harbor Islands) and O (Clinton Harbor) contain tidal wetlands. Shoreline CDF Alternative Site A (Hempstead Harbor) contains intertidal marsh, coastal shoals, bars, and mudflats.

Approximately 21 nearshore bar/berm alternative sites contain tidal wetlands that are either located shoreward or on the landward side of a barrier beach within a 1-mi radius of the site. It should be noted that sites containing wetlands on the landward side of a barrier beach were previously not considered within the influence of the site (USACE, 2012b).

Approximately 22 identified beach sites in New York contain tidal wetlands (coastal shoals, bars, mudflats) on the beach; tidal wetlands directly adjacent to and offshore of the beach, with a 300-ft state-regulated Adjacent Area; or freshwater wetlands, with a 100-ft Adjacent Area associated with the beach. In Rhode Island, the three beaches (Alternative Sites 381, 382, and 384) are state-regulated shoreline features and are considered wetlands. No wetlands are associated with the beach nourishment site alternatives in Connecticut (i.e., no beach nourishment sites intersect with GIS-based mapped wetlands).

According to the Long Island Sound Study (EPA, 2014g), wetland restoration activities have been completed within close proximity to some portions of the study area. Additional potential restoration sites have also been identified near some portions of the study area. Tidal wetland restoration has been completed within close proximity to beach nourishment Site 348 (White Sands Beach), Site 365 (Hammonasset Beach State Park), Site 368 (Bluff Point), and Site 429 (Jamaica Bay Marsh Islands). Potential beach, dune, and tidal wetland restoration locations have also been identified by the Long Island Sound Study in close proximity to beach nourishment Site 332 (Sandy Point), Site 467 (Long Beach), and Site 468 (Russian Beach).

Table 4-44. Wetland Resources in the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Wetlands Present
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	No
		H	No
		M	No
	Island CDF	B	Tidal Wetlands
		L	No
		N	No
		P	No
		Q	No
		R	No
	Shoreline CDF	A	Tidal Wetlands (intertidal marsh, shoals, bars, mudflats)
		C	Tidal Wetlands
		D	Tidal Wetlands
		F	No
		I	No
		J	No
		K	No
		O	Tidal Wetlands
	Nearshore Bar Placement/	177, 178, 454A, 441, 449, 438, 433, 434, 323, 451, 447, 327/333/330, 337,	No

Table 4-44. Wetland Resources in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Wetlands Present
	Nearshore Berm Sites	457, 381/382, 600, 610, 620	
		179, 121/446, 453, 173, 180, 454B, 455/82, 445, 171, 170, 63	Tidal Wetlands[a] (shoals, bars, mudflats)
		456	Tidal Wetlands [a] (intertidal marsh, shoals, bars, mudflats)
		320, 440	Tidal Wetlands[b]
		467, 364, 365, GP, 367, 368, 384,	Tidal Wetlands[c]
	Beach Nourish-ment	323, 433, 434, 365, 364, 320, 441, 442, 450, 438, 440, 449, 181, 368, 343, 467, 327, 332	No[d]
		436, 457, 444, 451, 337, 447, 454E, 367, 474, 339, 459, 348, 480, 468, 325, 329, 330, 331, 333, 344, 345, 67, 76	No
		453, 63, 454W, 455/82, 171, 173, 170, 180, 445, 121, 64, 68, 79	Tidal Wetlands[e] (shoals, bars, mudflats)
		456, 179, 446, 437, 620	Tidal Wetlands (shoals, bars, mudflats)
		384, 381, 382	Shoreline Feature (Beach)
		177, 178, 111	Adjacent Area of Freshwater Wetland[f]
		600, 610	Estuarine/Marine Tidal Wetlands

Sources: CTDEEP (2014i); NYSDEC (2014d), (2014e); RIGIS (2014c); USACE (2010a), (2012b).

Notes:

[a] Nearshore areas shoreward of site within a 1-mi radius mapped as tidal wetlands.

[b] Portions of islands within a 1-mi radius mapped as tidal wetlands.

[c] Tidal wetlands mapped on landward side of barrier beach within a 1-mi radius, but not within influence of site.

[d] If CTDEEP (2014i) GIS-based wetlands data (polygons) did not intersect with the specific beach renourishment area previously presented in the report *Upland, Beneficial Use, and Sediment Dewatering Site Investigation, Phase 2* (USACE, 2010a), then a "No" was entered. Previously, USACE evaluated entire "parcels;" therefore the 2010 Phase 2 document included wetlands on the entire parcel, regardless of whether the wetlands were located within the footprint of the alternative site. Therefore, the 2010 Phase 2 report depicted many additional sites that had wetlands present since the wetlands were located somewhere on the parcel, although not necessarily within the footprint of the beach of the proposed renourishment sites.

[e] If NYSDEC (2014d) GIS-based data for shoals, bars, and tidal flats were mapped directly offshore of specific beach renourishment sites, then wetlands were considered to be present since the exact boundary of those tidal wetlands has not been determined in the field and there is also a state-regulated 300-ft Adjacent Area associated with those tidal wetlands, which has permitting requirements.

[f] If NYSDEC (2014e) GIS-based data for freshwater wetlands with the state-regulated 100-ft Adjacent Area were mapped within 100 ft from a site, then 100-ft Adjacent Areas were considered to be present (even though wetlands are not currently located on the beach), because the 100-ft Adjacent Area extends onto the beach.

4.15.4 Upland Environment

Upland alternative sites that contain wetlands are summarized in Table 4-45 as drawn from *Upland, Beneficial Use, and Sediment Dewatering Site Investigation, Phase 2* (USACE, 2010a) and updated with more-recent GIS-based data (shapefiles). The presence or absence of resources is noted in Table 4-45. Based on wetland datasets from New York, Connecticut, and Rhode Island, there is potential for wetlands resources to occur near Brownfields/Redevelopment and Habitat Restoration sites. Wetlands resources have also been mapped near Landfill Capping/Cover Alternative Site 272 (Windsor-Bloomfield Landfill), where wetlands were identified near the northern edge of the parcel. Brownfields/Redevelopment Alternative Sites 422/423 (Flushing Airport Wetlands/Uplands) contain inland freshwater wetlands. Habitat Restoration Alternative Sites 427 (Plumb Beach) and 429 (Jamaica Bay Marsh Islands) contain tidal wetlands (intertidal marsh, coastal shoals, bars, and mudflats). No specific Upland CDFs or Innovative Technology sites have been identified to date.

According to the USACE New York District (USACE, 2014b), tidal wetland restoration has been completed within portions of Sites 427 (Plumb Beach) and 429 (Jamaica Bay Marsh Islands). In addition, feasibility for additional restoration at these sites is currently ongoing.

Table 4-45. Wetland Resources in the Upland Environment.

Environment	Alternative Type	Alternative ID	Wetlands Present
Upland Environment	**Landfill Placement**	59	No
	Landfill Cover/Capping	60	No
		61	No
		251	No
		272	Freshwater Wetlands
	Brownfields & Other Redevelopment	422/423	Freshwater Wetlands
	Habitat Restoration / Enhancement or Creation	427	Tidal Wetlands (intertidal marsh, shoals, bars, mudflats)
		429	Tidal Wetlands (intertidal marsh, shoals, bars, mudflats)

Sources: CTDEEP (2014i); NYSDEC, (2014d), (2014e); RIGIS (2014c); USACE, (2010a).

4.16 TERRESTRIAL WILDLIFE AND THREATENED AND ENDANGERED SPECIES

4.16.1 General Long Island Sound Setting

Coastal wildlife habitats within the study area consist of shoreline features such as beaches, dunes, salt marshes, and tidal flats, while inland habitat areas consist of coastal grasslands, shrublands, and woodlands. Many of these habitat areas are fragmented by human development. This section analyzes existing data relative to terrestrial wildlife and threatened and endangered species in the study area.

Terrestrial Wildlife in the Study Area

Terrestrial wildlife species found in the States of Connecticut, New York, and Rhode Island include terrestrial mammals, terrestrial reptiles and amphibians (including those that are dependent on freshwater ecosystems for portions of their lifecycle), and inland freshwater mollusks and other invertebrates. Fish, bird, and marine mammal and reptile species are discussed separately in this PEIS (Sections 4.10, 4.13, and 4.14).

Connecticut

Key terrestrial habitats in the State of Connecticut include upland areas characterized by upland forests, upland woodland and shrub, upland herbaceous, and unique and man-made habitats, while coastal portions of the State are dominated by beachshore, coastal bluffs and headlands, coastal grasslands, coastal woodland/shrubland, coastal shrublands and heaths, coastal bluffs and headlands, and offshore islands (CTDEEP, 2005).

Upland forests account for 60% of the vegetation cover type in Connecticut. Representative examples include Housatonic State Forest in the northwest corner of the state and Meshomasic State Forest in central Connecticut. Upland woodland and shrub habitats include red cedar glades and pitch pine/scrub oak woodlands. Representative examples include West Rock Ridge State Park in Hamden and Wharton Brook State Park in Wallingford. Upland herbaceous habitats include grassy glades and balds, sand plains and warm season grasslands, and sparsely vegetated sand and gravel areas. Representative examples include Sleeping Giant State Park in Hamden, Clarkhurst Wildlife Management Area within George Dudley Seymour State Park in Haddam, and Talcott Mountain State Park, Simsbury. Unique and man-made habitats share elements with one or more habitats, including caves, traprock ridges, and urban habitat. Representative examples include West Rock Ridge State Park in Hamden and man-made habitats throughout the Connecticut River Valley. Intensively managed habitats include early successional habitat, cool season grasslands, and early successional shrublands and forests. These habitats are distributed statewide and include abandoned fields, power line rights-of-way, abandoned beaver flowages, and where timber harvests or other habitat management activities maintain the vegetative growth stages. Representative examples include Topsmead State Forest in Litchfield and Hunters Mountain Block in Naugatuck State Forest in Naugatuck.

Terrestrial wildlife may be found throughout these key upland habitats. Wildlife species include common generalist mammals such as gray squirrels (*Sciurus carolinensis*), raccoons (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus)*, coyote (*Canis latrans*), red fox (*Vulpes vulpes*), black bear (*Ursus americana*), and various bat species (Chiroptera); and herpetofauna, including copperheads (*Agkistrodon contortrix*), garter snakes (*Thamnophis sirtalis*), various generalist frogs (Anura), and turtles (Testudines); along with invertebrates such as butterflies and moths (Lepidoptera).

Coastal dunes are found adjacent to low energy beaches along Long Island Sound. Habitats in these areas typically include vegetation such as beach grass (*Ammophila breviligulata*), switchgrass (*Panicum virgatum*), beach plum (*Prunus maritime*), and bayberry (*Morella pensylvanica*). Representative examples are Meigs Point in Clinton and Bushy Point Beach in Groton.

Coastal shrublands include dry coastal headlands and dry to moist coastal or maritime forests that are exposed to wind and salt spray effects. Typical trees of coastal shrublands include pitch pine (*Pinus rigida*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), and sassafras (*Sassafras albidum*). Coastal shrubland understory or groundcover typically includes bayberry, beach plum, flowering dogwood (*Cornus florida*), and switchgrass. Representative examples are Meigs Point in Clinton and Hammonassett Natural Area.

Coastal bluffs and headlands include cliffs and escarpments that border Long Island Sound. They can be composed of either consolidated rock (headlands) or unconsolidated sediments (bluffs and escarpments), such as glacial till, with the slope and rate of erosion dependent on the substrate and exposure to wave action. Although many of these areas have been altered by human disturbance, some natural areas exist. The vegetation can be variable, including coastal woodlands of oak and pitch pine; shrublands of bayberry, huckleberry (*Gaylussacia baccata*), arrowwood (*Viburnum dentatum*), and red cedar (*Juniperus virginiana*); or grasslands maintained by mowing.

Terrestrial wildlife may be found throughout these key coastal habitats. Wildlife species include common generalist mammals such as gray squirrels (*Sciurus carolinensis*), raccoons (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus)*, coyote (*Canis latrans*), red fox (*Vulpes vulpes*), black bear (*Ursus americana*), and various bat species (Chiroptera); and herpetofauna such as copperheads (*Agkistrodon contortrix*), garter snakes (*Thamnophis sirtalis*), various generalist frogs (Anura), and turtles (Testudines).

Offshore islands provide an important refuge for colonial-nesting herons and for beach and island ground-nesting birds seeking refuge from predators that feed on nestlings and eggs (e.g., raccoons, foxes, and domestic cats). The lack of terrestrial mammal species is the essence of this critical habitat for birds. Representative examples include Falkner Island, Menunketesuck Island, Charles Island, Great Captain's Island, Cockenoe Island and the Norwalk Islands.

Ghost crabs (*Ocypode quadrata*) are common invertebrates that inhabit these coastal sandy areas. Wildlife associated with these coastal natural communities may include snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), bullfrogs (*Lithobates catesbeianus*), green frogs (*Lithobates clamitans*), northern water snakes (*Nerodia sipedon*), eastern cottontail (*Sylvilagus floridanus*), black-tailed jackrabbit (*Lepus californicus*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), red fox(*Vulpes vulpes*), raccoon (*Procyon lotor*), mink (*Mustela vison*), striped skunk (*Mephitis

mephitis), and white-tailed deer (*Odocoileus virginianus*) (DeGraaf & Yamasaki, 2001). Least shrew (*Cryptotis parva*) is a state endangered species that is vulnerable to the fragmentation of available habitat that is common among the coastal beaches in the study area (CTDEEP, 2014j).

New York

Terrestrial habitats within the New York State segment of the study area include maritime beach, maritime dune, maritime shrubland, and maritime heathland (Reschke, 1990). The maritime beach is a sparsely vegetated community on unstable sand, gravel, or cobble ocean shores above mean high tide where the shore is modified by wave and wind erosion associated with storms. Ghost crabs are common invertebrates in this habitat, and common terrestrial mammals such as raccoons, white-footed mouse, and eastern cottontail may be encountered in this community. Representative examples include Napeague Beach and Orient Beach.

Maritime dune communities are dominated by grasses and low shrubs which occur on active and stabilized dunes along the Atlantic coast. This community consists of an assortment of vegetation patches and is indicative of past disturbances such as sand deposition, erosion, and dune migration. The composition and structure of the vegetation is variable depending on dune stability, amounts of sand deposition and erosion, and distance from the ocean. Representative examples include Nepeague Dunes and Fire Island National Seashore. Wildlife that inhabit maritime dune complexes include the white-footed mouse, eastern hognose snake (*Heterodon platirhinos*), and Fowler’s toad (*Bufo fowleri*).

The maritime shrubland communities occur on seaside bluffs and headlands that are exposed to offshore winds and salt spray. This community typically occurs as a tall shrubland (7 to 10 ft), but may include areas under 3 ft in height; it also includes areas with shrubs up to 13 ft tall forming a shrub canopy in shallow depressions. These low areas within the tall shrubland areas may faintly grade into shrub swamp if soils are sufficiently wet. Representative examples occur on Montauk Point. Commonly encountered terrestrial wildlife include white-tailed deer, red foxes, and various moles.

The maritime heathland is a dwarf shrubland community that occurs on rolling outwash plains and moraines of the glaciated portion of the Atlantic coastal plain, near the ocean and within the influence of offshore winds and salt spray. This community is dominated by low heath or heath-like shrubs that collectively have greater than 50% cover. Common wildlife such as snapping turtles, painted turtles, green frogs and bull frogs, northern water snakes, raccoons, and Virginia opossums (*Didelphis virginiana*) may occupy this community. This community intergrades with maritime grassland, and the communities may meld together in a mosaic. A representative example includes Montauk Mountain.

Rhode Island

The natural Rhode Island communities and habitats that are expected to be associated with the study area include maritime beaches and the maritime dunes. The maritime beach is a sparsely vegetated community that occurs on unstable sand, gravel, or cobble seashores above mean high tide and in overwash zones, where the shore is altered by storm waves and wind erosion. Vegetation may be lacking or ephemeral due to the instability of substrates and resulting erosion. Characteristic plants include sea-rocket (*Cakile edentula*), orach (*Atriplex patula*), seabeach sandwort (*Honkenya peploides* var. *robusta*), common saltwort (*Salsola kali*), and seabeach knotweed (*Polygonum glaucum*). The maritime beach community co-occurs with the marine intertidal sand/gravel beach, which is below the tide line. Commonly encountered terrestrial wildlife include feral cats (*Felis catus*), Norway rats (*Rattus norvegicus*), white-footed mouse, and Block Island meadow vole (*Microtus pennsylvanicus provectus*). These communities are distributed along the southern Rhode Island coastal shores and Block Island.

The maritime dune community is usually dominated by beach grass (*Ammophila breviligulata*), beach heather, and low shrubs on sand dunes upgradient and inland of maritime beaches. Vegetation occurs in patches as a result of past disturbances, including erosion, sand deposition, and dune migration. The composition and structure of the vegetation is dependent on dune stability, degree of deposition and magnitude of erosion, and distance from the ocean. This community is distributed on barrier beaches along the south shore of Rhode Island and Block Island. Representative examples include Moonstone Beach, Roger Wheeler Beach, Goosewing Beach, and Little Compton.

Three distinct dune ecosystems (referred to as associations) are grouped into the maritime dune community: the beach grass dune association, the beach heather dune association, and the dune shrub association. The beach grass dune association is a sparse to densely vegetated grass-dominated community on the active portions of primary dunes where sand shifting is the greatest. Along with beach grass, characteristic species include beach-pea (*Lathyrus japonicus*), seaside goldenrod (*Solidago sempervirens*), sandy sedge (*Carex silicea*), and several non-native species including dusty-miller (*Artemisia stellariana*) and sand rose (*Rosa rugosa*), while switchgrass may be dominant in patches. The non-native strain of phragmites (*Phragmites australis*) also invades this community, often becoming established first in adjacent water bodies and wetlands and spreading by rhizomes into open uplands.

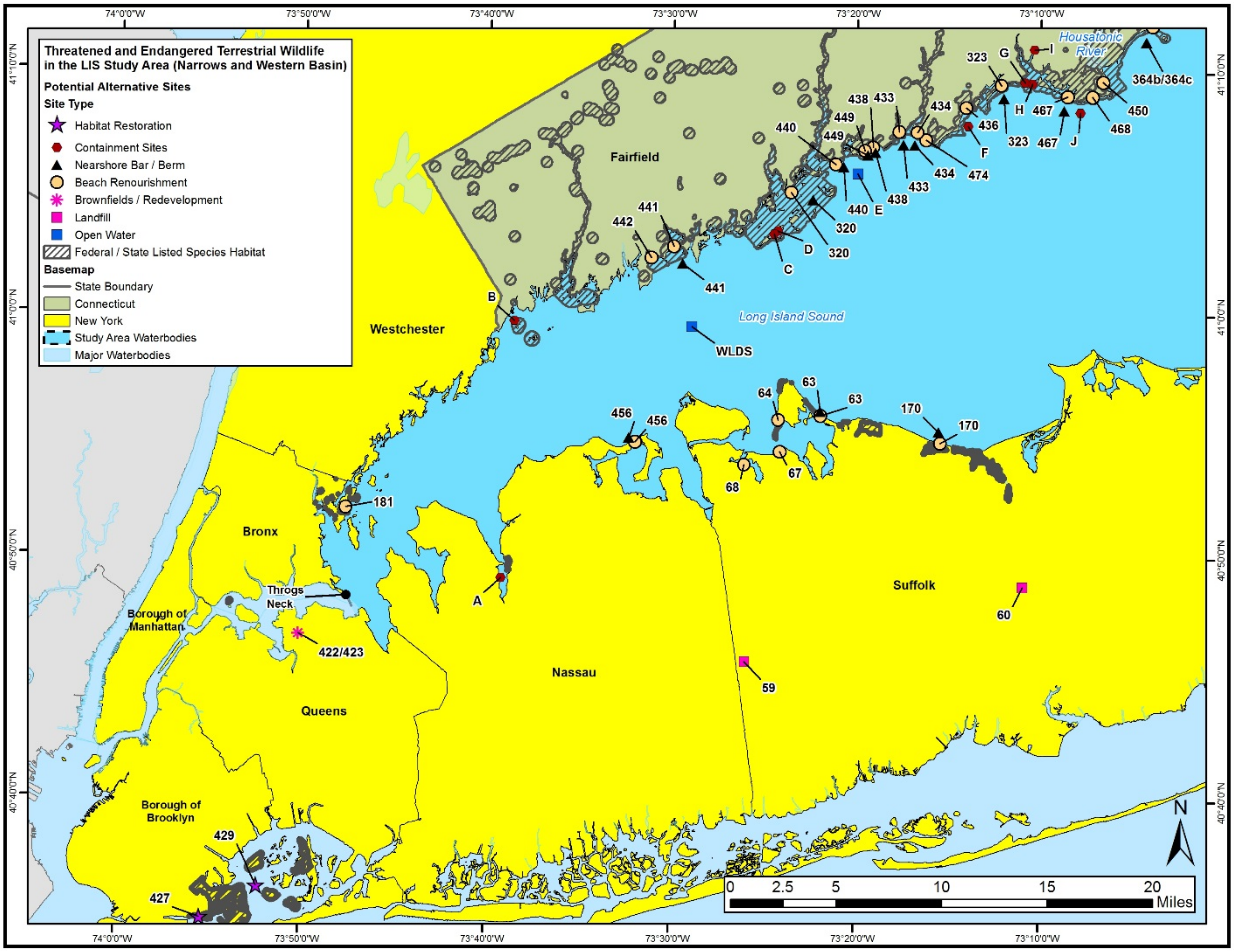
The beach heather dune association is dominated by dwarf shrubs or perennial forbs on the more stabilized portions of primary and secondary dunes where sand shifting is reduced. Characteristic species include beach heather (*Hudsonia tomentosa*), bearberry (*Arctostaphylos uva-ursi*), jointweed (*Polygonella articulata*), and beach pinweed (*Lechea maritima).*

The dune shrub association, and least likely to be associated with the study area, is dominated by medium height woody vegetation in the somewhat protected areas of sandy maritime dunes and atop coastal bluffs. Vegetation includes northern bayberry, beach-plum, and poison ivy (*Toxicodendron radicans*). The non-native sand rose has become naturalized in this setting, sometimes crowding out native species (Enser & Lundgren, 2006).

Tiger beetles (*Cincindela* spp.) and ghost crabs are notable invertebrate residents of these dune associations, and the Federally threatened piping plover (*Charadrius melodus*) nests in the maritime beach community and feeds below the tide line. In addition, common species encountered in the Rhode Island portion of the study area may include snapping turtles, painted turtles, bullfrogs, green frogs, northern water snakes, Virginia opossum, eastern cottontail, white-footed mouse, meadow vole, raccoon, red fox, and white-tailed deer.

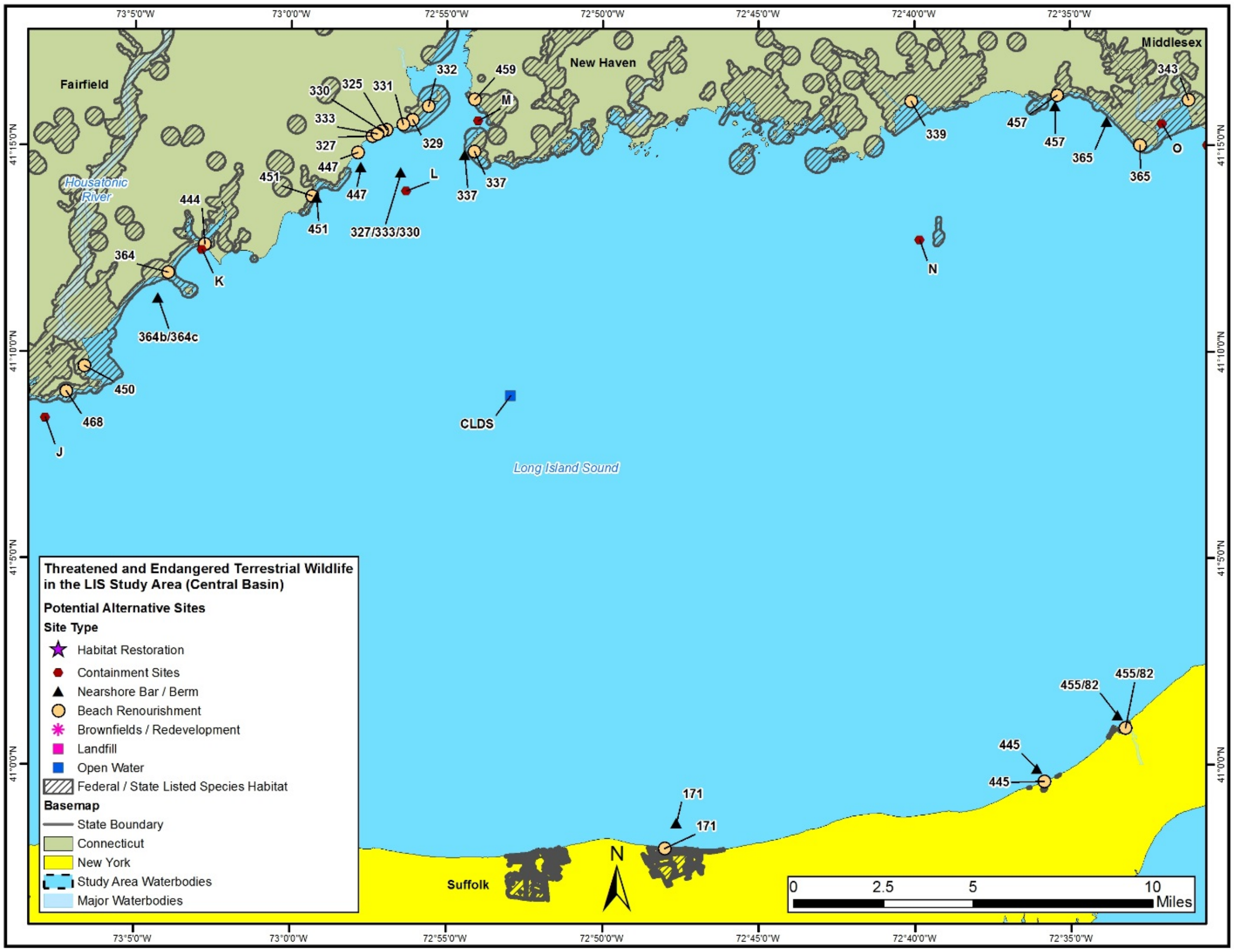
Federal and State Threatened and Endangered Species

This section summarizes Federally listed threatened or endangered terrestrial wildlife species as well as state-listed species and designations for the States of Connecticut, New York, and Rhode Island. The Federally listed and state-listed fish, bird, and marine mammal / marine reptile species are discussed separately in this PEIS (Sections 4.10, 4.13, and 4.14). This section focuses on terrestrial mammals such as bats, terrestrial reptiles and amphibians (including those that are dependent on freshwater ecosystems for portions of their lifecycle), and inland freshwater mollusks and other invertebrates. The locations of habitat for these species are shown on Figure 4-60 through Figure 4-62.



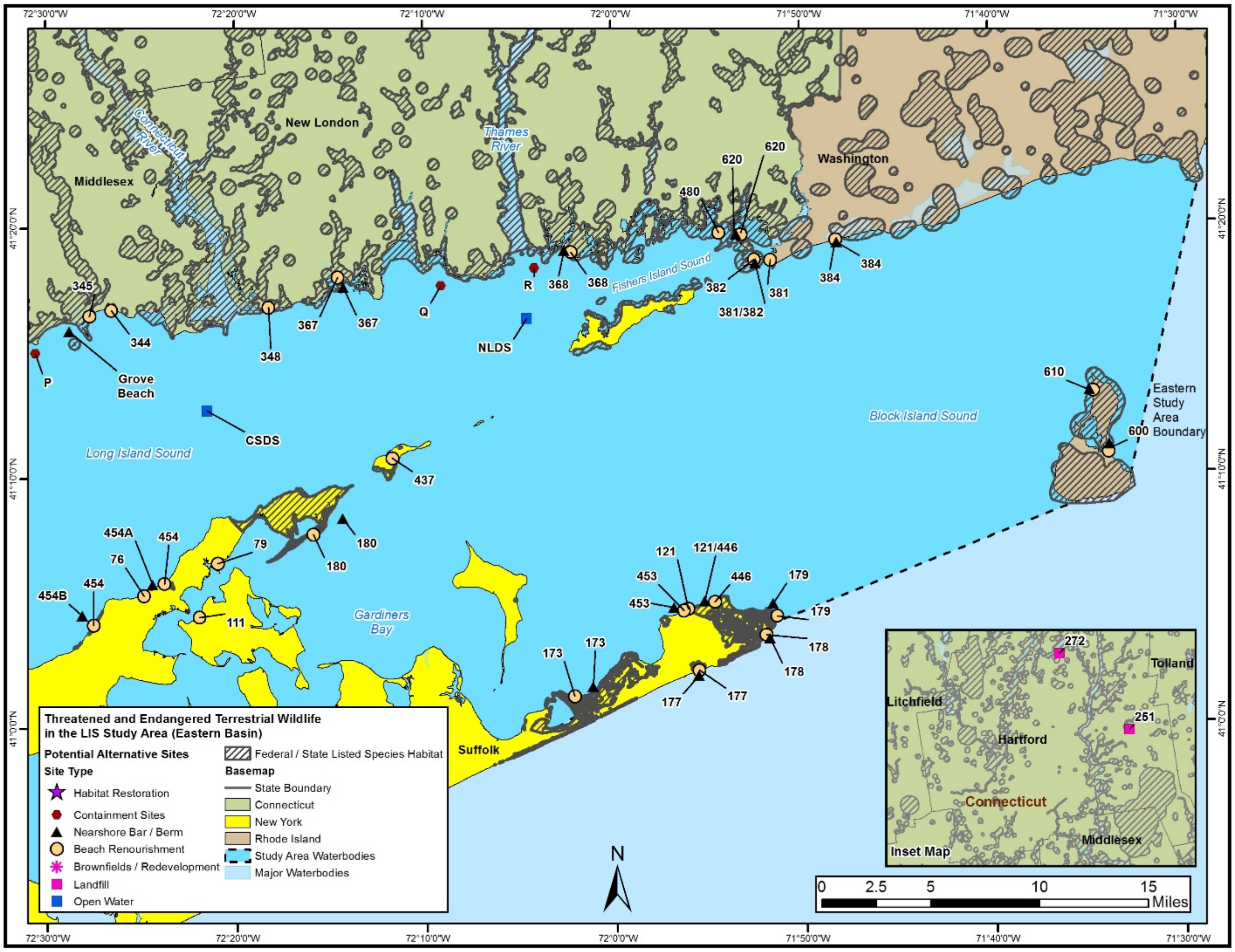
Sources: USFWS (2014g); NYSDEC (2010c); CTDEEP (2014k); RIGIS (2014d).

Figure 4-60. Federal- and State-listed Terrestrial Wildlife Habitat in the Long Island Sound Study Area (Western Basin).



Sources: USFWS (2014g); NYSDEC (2010c); CTDEEP (2014k); RIGIS (2014d).

Figure 4-61. Federal- and State-listed Terrestrial Wildlife Habitat in the Long Island Sound Study Area (Central Basin).



Sources: USFWS (2014g); NYSDEC (2010c); CTDEEP (2014k); RIGIS (2014d).

Figure 4-62. Federal- and State-listed Terrestrial Wildlife Habitat in the Long Island Sound Study Area (Eastern Basin).

Federal and State Regulations

Threatened and endangered species are protected under the Federal ESA, 16 U.S.C. §§ 1531 et seq., and under state law, while species listed as "special concern" or "concern" are protected only by state law. An endangered species is one whose overall survival in a particular region or locality is in jeopardy as a result of loss or change in habitat, overall exploitation by humans, predation, adverse interspecies competition, or disease. Unless an endangered species receives protective assistance, extinction may occur. Threatened or rare species are those with populations that have notably decreased due to any number of limiting factors that lead to deterioration of the population. A species may also be considered as a species of "special concern." These may be any native species for which a welfare concern or risk of endangerment has been documented within a particular state (USFWS, 2014g). In addition, certain states also identify "historical species," which are native species that have been previously documented for the state but which are currently unknown to occur.

Due to the mobility and migratory patterns of terrestrial wildlife, information on the use of specific sites by terrestrial mammals, reptiles, amphibians, and invertebrates is not well studied or available for the proposed alternatives. This evaluation focuses on identifying species relevant to the general Long Island Sound study area and determining the likelihood of their occurrence. Project-specific EISs will need to further evaluate the impact at individual sites.

Connecticut

Under the Connecticut ESA (CGS, Section 26-303), the overall goal is to conserve, protect, restore, and enhance any endangered or threatened species and their essential habitat. Endangered species are any native species documented by biological research and inventory to be in danger of extirpation throughout all or a significant portion of its range within the state, and any species determined to be an endangered species pursuant to the Federal ESA. Threatened species are any native species documented by biological research and inventory to be likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range within the state, and any species determined to be a threatened species pursuant to the Federal ESA. Species of special concern are any native non-harvested wildlife species documented by scientific research and inventory to have a naturally restricted range or habitat in the state, to be at a low population level, to be in such high demand by humans that its unregulated taking would be detrimental to the conservation of its population, or to have been extirpated from the state. Habitat locations for Connecticut were obtained as an ArcGIS shapefile from the CTDEEP Natural Diversity Database Areas layer (CTDEEP, 2014k).

New York

The obligation of NYSDEC, under New York ECL Section 11-0535 (the state ESA), is to protect endangered and threatened species and their habitat through regulations promulgated under the Endangered and Threatened Species Regulations at 6 NYCRR Part 182. Endangered species are any native species in imminent danger of extirpation or extinction in New York State. Threatened species are any native species likely to become an endangered species within the foreseeable future in New York State. Special concern species are any native species for which a welfare concern or risk of endangerment has been documented in New York State. Estimated habitat and ranges of rare species in New York were derived from the New York Natural Heritage polygons in Edinger, et al. (2002).

Rhode Island

The Rhode Island State ESA, Title 20 of the General Laws of the State of Rhode Island, states, in part (20-37-3): “No person shall buy, sell, offer for sale, store, transport, export, or otherwise traffic in any animal or plant or any part of any animal or plant whether living or dead, processed, manufactured, preserved or raw if such animal or plant has been declared to be an endangered species by either the United States secretaries of the Interior or Commerce or the Director of the Rhode Island Department of Environmental Management.” State endangered species are native species in imminent danger of extinction from Rhode Island. State threatened species are native species likely to become state endangered in the future if current trends in habitat loss or other detrimental factors remain unchanged. A state concern species is a native species not considered to be state endangered or state threatened at the present time, but is listed due to various factors of rarity or vulnerability or both. State historical species are native species that have been documented for the state during the last 100 years, but which are currently unknown to occur. Rhode Island Natural Heritage Areas were used for this analysis, which represents estimated habitat and ranges of rare species and noteworthy natural communities in Rhode Island (RIGIS, 2014d).

Federal and State Listed Species

In general, Federally listed and state-listed terrestrial mammals, reptiles, amphibians, and invertebrates are not likely to be present in the nearshore/shoreline environment with the exception of some of the beach renourishment alternatives and selected upland environment alternatives. Species profiles were evaluated, utilizing several online and written publications; these publications included DeGraaf and Yamasaki (2001), NYSDEC (2010c), (2014f); CTDEEP (2014j), (2014k), (2014l), (2014m); RIDEM (2006); RIGIS (2014d)), for Federally listed and state-listed terrestrial mammals, terrestrial reptiles and amphibians, Federally listed invertebrates, and Federally listed freshwater mollusks and other invertebrate species. However, the entire list of both Federally listed and state-listed mollusks and other invertebrates was tabulated. The USACE (2010a) and USACE (2012b) documents, as well as current GIS shapefiles, were utilized.

Results of the screening process for the likely occurrence of threatened and endangered terrestrial mammals and of reptile and amphibian species are tabulated in Table 4-46 and Table 4-47. The applicable site alternatives associated with the upland environment include landfill capping, of which only one site, the Windsor-Bloomfield Landfill in Connecticut, has an associated Natural Diversity Database Area. Based on that evaluation, these species include the least shrew (*Cryptotis parva*), New England cottontail (*Sylvilagus transitionalis*), eastern worm snake (*Carphophis amoenus)*, eastern mud turtle (*Kinosternon subrubrum)*, and eastern spadefoot toad (*Scaphiopus holbrookii)*. Table 4-48 and Table 4-49 present freshwater invertebrates (including mollusks) that are both Federally listed and state-listed and their corresponding status designations.

Table 4-46. Federal Threatened and Endangered Terrestrial Mammals and State Designations for Connecticut, New York, and Rhode Island.

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
gray wolf (*Canis lupus*)	Endangered	Special Concern	Endangered	NA
puma; mountain lion, cougar (*Puma concolor*)	Endangered	Special Concern	Endangered	NA
Indiana bat (*Myotis sodalist*)	Endangered	NA	Endangered	NA
southern bog lemming (*Synaptomys cooperi*)	NA	Special Concern	NA	Concern
Canada lynx (*Lynx canadensis*)	NA	NA	Threatened	NA
small-footed bat (*Myotis leibii*)	NA	Special Concern	NA	NA
New England cottontail (*Sylvilagus transitionalis*)	NA	Special Concern	NA	Concern
smoky shrew (*Sorex fumeus*)	NA	NA	NA	Concern
least shrew (*Cryptotis parva*)	NA	See source note[e]	NA	NA
water shrew (*Sorex palustris*)	NA	NA	NA	Concern
bobcat (*Lynx rufus*)	NA	NA	NA	State Threatened
eastern woodrat* (*Neotoma magister*)	NA	Special Concern	Endangered	NA
silver-haired bat (*Lasionycteris noctivagans*)	NA	Special Concern	NA	NA
red bat (*Lasiurus borealis*)	NA	Special Concern	NA	NA
hoary bat (*Lasiurus cinereus*)	NA	Special Concern	NA	NA

Sources: [a]USFWS (2014g); [b]CTDEEP (2014l); [c]NYSDEC (2014c); [d]RIGIS (2014d); [e]CTDEEP (2014k).
* Believed extirpated.

Table 4-47. Federal Threatened and Endangered Freshwater and Terrestrial Reptiles and Amphibians, and State Designations for Connecticut, New York, and Rhode Island.

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
northern bog turtle (*Glyptemys muhlenbergii*)	Threatened	Endangered	Endangered	NA
timber rattlesnake (*Crotalus horridus*)	NA	Endangered	Threatened	State Historical
eastern hognose snake (*Heterodon platyrhinos*)	NA	Special Concern	Special Concern	Concern
smooth green snake (*Liochlorophis vernalis*)	NA	Special Concern	NA	NA
eastern ribbon snake (*Thamnophis sauritus*)	NA	Special Concern	NA	Concern
black rat snake (*Elaphe obsoleta*)	NA	NA	NA	Concern
five-lined skink (*Eumeces fasciatus*)	NA	Threatened	NA	NA
wood turtle (*Glyptemys insculpta*)	NA	Special Concern	Special Concern	Concern/Protected
eastern box turtle (*Terrapene carolina carolina*)	NA	Special Concern	Special Concern	Protected
mud turtle (*Kinosternon subrubrum*)	NA	NA	Endangered	NA
Blanding's turtle (*Emydoidea blandingii*)	NA	NA	Threatened	NA
spotted turtle (*Clemmys guttata*)	NA	NA	Special Concern	Protected
eastern spiny softshell turtle (*Apalone spinifera*)	NA	NA	Special Concern	NA
queen snake (*Regina septemvittata*)	NA	NA	Endangered	NA
Massasauga rattlesnake (*Sistrurus catenatus*)	NA	NA	Endangered	NA
fence lizard (*Sceloporus undulatus*)	NA	NA	Threatened	NA
worm snake (*Carphophis amoenus*)	NA	NA	Special Concern	Concern
Jefferson salamander "complex" (*Ambystoma jeffersonianum*)	NA	Special Concern	Special Concern	NA
blue-spotted salamander –diploid- (*Ambystoma laterale)*	NA	Endangered	NA	NA
blue-spotted salamander -"complex"- (*Ambystoma laterale*)	NA	Special Concern	Special Concern	NA
northern spring salamander (*Gyrinophilus porphyriticus*)	NA	Threatened	NA	Concern
northern slimy salamander (*Plethodon glutinosus*)	NA	Threatened	NA	NA
northern leopard frog (*Rana pipiens*)	NA	Special Concern	NA	Concern
eastern spadefoot (*Scaphiopus holbrookii*)	NA	Endangered	Special Concern	State Endangered

Sources: [a]USFWS (2014g); [b]CTDEEP (2014l); [c]NYSDEC (2014c); [d]RIGIS (2014d).

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island.

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Coastal heathland cutworm (*Abagrotis nefascia benjamini*)	NA	Threatened	NA	NA
Puritan tiger beetle (*Cicindela puritana*)	Threatened	Endangered	NA	NA
Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*)	Threatened	Special Concern	Threatened	State Historical
American burying beetle (*Nicrophorus americanus*)	Endangered	Special Concern	Endangered	Federally Endangered
Karner blue butterfly (*Lycaeides melissa samuelis*)	Endangered	NA	Endangered	NA
Barrens dagger moth* (*Acronicta albarufa)*	NA	Special Concern	NA	NA
Noctuid moth* (*Acronicta lanceolaria*)	NA	Special Concern	NA	Concern
Ground beetle (*Agonum darlingtoni*)	NA	Special Concern	NA	NA
Ground beetle (*Agonum mutatum*)	NA	Special Concern	NA	NA
Spotted dart moth (*Agrotis stigmosa*)	NA	Special Concern	NA	NA
Ground beetle (*Amara chalcea*)	NA	Special Concern	NA	NA
Common roadside skipper (*Amblyscirtes vialis*)	NA	Endangered	NA	NA
Noctuid moth (*Anarta luteola*)	NA	Endangered	NA	NA
Tusked sprawler (*Anthopotamus verticis*)	NA	Special Concern	NA	NA
Apamea moth (*Apamea burgessi*)	NA	Special Concern	NA	NA
Apamea moth (*Apamea inordinata*)	NA	Special Concern	NA	NA
Apamea moth (*Apamea lintneri*)	NA	Special Concern	NA	NA
New Jersey tea inchworm (*Apodrepanulatrix liberaria*)	NA	Threatened	NA	NA
Short-lined chocolate (*Argyrostrotis anilis*)	NA	Special Concern	NA	NA
Tabanid fly (*Atylotus ohioensis*)	NA	Special Concern	NA	NA
Ground beetle (*Badister transversus*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion carinula*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion lacunarium*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion planum*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion pseudocautum*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion quadratulum*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion semicinctum*)	NA	Special Concern	NA	NA
Ground beetle (*Bembidion simplex*)	NA	Special Concern	NA	NA
Affable bumblebee (*Bombus affinis*)	NA	Special Concern	NA	NA
Ashton's bumblebee* (*Bombus ashtoni*)	NA	Special Concern	NA	NA
Yellowbanded bumblebee (*Bombus terricola*)	NA	Special Concern	NA	NA

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island (continued).

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Bombardier beetle (*Brachinus cyanipennis*)	NA	Special Concern	NA	NA
Bombardier beetle (*Brachinus fumans*)	NA	Special Concern	NA	NA
Bombardier beetle (*Brachinus medius*)	NA	Special Concern	NA	NA
Bombardier beetle (*Brachinus ovipennis*)	NA	Special Concern	NA	NA
Bombardier beetle (*Brachinus patruelis*)	NA	Special Concern	NA	NA
Northern metalmark (*Calephelis borealis*)	NA	Endangered	NA	NA
Henry's elfin (*Callophrys henrici*)	NA	Special Concern	Special Concern	NA
Hessel's hairstreak (*Callophrys hesseli*)	NA	Endangered	NA	NA
Frosted elfin (*Callophrys irus*)	NA	Threatened	NA	NA
Hoary elfin* (*Callophrys polios*)	NA	Special Concern	NA	NA
Sparkling jewelwing (*Calopteryx dimidiate*)	NA	Threatened	NA	NA
Ground beetle* (*Calosoma wilcoxi*)	NA	Special Concern	NA	NA
Ground beetle* (*Carabus serratus*)	NA	Special Concern	NA	NA
Ground beetle* (*Carabus sylvosus*)	NA	Special Concern	NA	NA
Ground beetle (*Carabus vinctus*)	NA	Special Concern	NA	NA
Herodias underwing (*Catocala herodias gerhardi*)	NA	Endangered	NA	NA
Precious underwing moth* (*Catocala pretiosa pretiosa*)	NA	Special Concern	NA	NA
Appalachian blue (*Celastrina neglectamajor*)	NA	Threatened	NA	NA
Noctuid moth (*Chaetaglaea cerata*)	NA	Special Concern	NA	NA
Harris' checkerspot* (*Chlosyne harrisii*)	NA	Special Concern	NA	NA
Silvery checkerspot* (*Chlosyne nycteis*)	NA	Special Concern	NA	NA
Pine barrens tiger beetle (*Cicindela formosa generosa*)	NA	Special Concern	NA	State Threatened
Tiger beetle (*Cicindela hirticollis*)	NA	Special Concern	NA	State Threatened
Dune ghost tiger beetle (*Cicindela lepida*)	NA	Endangered	NA	NA
Tiger beetle (*Cicindela marginata*)	NA	Special Concern	NA	State Threatened
Dark-bellied tiger beetle (*Cicindela tranquebarica)*	NA	Special Concern	NA	State Threatened
Regal moth* (*Citheronia regalis*)	NA	Special Concern	NA	State Historical
C9 Lady beetle* (*Coccinella novemnotata)*	NA	Special Concern	NA	NA
Tiger spiketail (*Cordulegaster erronea)*	NA	Threatened	NA	NA
Noctuid moth* (*Cucullia speyeri)*	NA	Special Concern	NA	NA
False heather underwing (*Drasteria graphica atlantica)*	NA	Threatened	NA	NA

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island (continued).

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Imperial moth* (*Eacles imperialis imperialis)* (moth)	NA	Special Concern	NA	NA
Atlantic bluet (*Enallagma doubledayi)* (damselfly)	NA	Threatened	NA	NA
Little bluet (*Enallagma minusculum)* (damselfly)	NA	Special Concern	NA	NA
Scarlet bluet (*Enallagma pictum)* (damselfly)	NA	Special Concern	Threatened	Concern
Macropis cuckoo bee (*Epeoloides pilosula)* (bee)	NA	Endangered	NA	NA
Sleepy duskywing (*Erynnis brizo)* (butterfly)	NA	Threatened	NA	Concern
Horace's duskywing (*Erynnis horatius)* (butterfly)	NA	Special Concern	NA	NA
Columbine duskywing (*Erynnis lucilius)* (butterfly)	NA	Endangered	NA	NA
Mottled duskywing* (*Erynnis martialis)* (butterfly)	NA	Special Concern	Special Concern	NA
Persius duskywing (*Erynnis persius persius)* (butterfly)	NA	Endangered	NA	NA
Scrub euchlaena (*Euchlaena madusaria)* (moth)	NA	Special Concern	NA	NA
Noctuid moth (*Eucoptocnemis fimbriaris)* (moth)	NA	Special Concern	NA	NA
Morrison's mosaic (*Eucosma morrisoni)* (moth)	NA	Threatened	NA	NA
Brown-bordered geometer (*Eumacaria latiferrugata)* (moth)	NA	Special Concern	NA	NA
Two-spotted skipper (*Euphyes bimacula)* (butterfly)	NA	Threatened	NA	NA
Sedge skipper (*Euphyes dion)* (butterfly)	NA	Special Concern	NA	NA
Noctuid moth (*Euxoa pleuritica)* (moth)	NA	Special Concern	NA	NA
Violet dart moth (*Euxoa violaris)* (moth)	NA	Threatened	NA	NA
Pitcher plant moth (*Exyra fax)* (moth)	NA	NA	NA	NA
Pink streak (*Faronta rubripennis)* (moth)	NA	Special Concern	NA	NA
Ground beetle (*Geopinus incrassatus)* (beetle)	NA	Threatened	NA	NA
Mustached clubtail (*Gomphus adelphus)* (dragonfly)	NA	Threatened	NA	NA
Harpoon clubtail (*Gomphus descriptus)* (dragonfly)	NA	Threatened	NA	NA
Midland clubtail (*Gomphus fraternus)* (dragonfly)	NA	Threatened	NA	NA
Rapids clubtail (*Gomphus quadricolor)* (dragonfly)	NA	Threatened	NA	NA

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island (continued).

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Cobra clubtail (*Gomphus vastus)* (dragonfly)	NA	Special Concern	NA	NA
Skillet clubtail (*Gomphus ventricosus)* (dragonfly)	NA	Special Concern	NA	NA
Horse fly (*Goniops chrysocoma*) (fly)	NA	Special Concern	NA	NA
Phyllira tiger moth (*Grammia phyllira)* (moth)	NA	Endangered	NA	NA
Bog tiger moth (*Grammia speciosa)* (moth)	NA	Endangered	NA	Concern
Ground beetle (*Harpalus caliginosus)* (beetle)	NA	Special Concern	NA	NA
Ground beetle (*Harpalus eraticus*) (beetle)	NA	Special Concern	NA	NA
Ground beetle (*Helluomorphoides praeustus bicolor*) (beetle)	NA	Helluomorphoides praeustus bicolor	NA	NA
Slender clearwing (*Hemaris gracilis*) (moth)	NA	Threatened	NA	NA
Buck moth (*Hemileuca maia maia*) (moth)	NA	Endangered	NA	Concern
American rubyspot (*Hetaerina americana*) (damselfly)	NA	Threatened	NA	NA
Horse fly (*Hybomitra frosti*) (fly)	NA	Threatened	NA	NA
Horse fly (*Hybomitra longiglossa*) (fly)	NA	Endangered	NA	NA
Horse fly (*Hybomitra luridus*) (fly)	NA	Special Concern	NA	NA
Horse fly (*Hybomitra trepida*) (fly)	NA	Special Concern	NA	NA
Horse fly (*Hybomitra typhus*) (fly)	NA	Special Concern	NA	NA
Hop vine borer moth* (*Hydraecia immanis*) (moth)	NA	Special Concern	NA	NA
Blue corporal dragonfly (*Ladona deplanata*) (dragonfly)	NA	Special Concern	NA	NA
Noctuid moth (*Lepipolys perscripta*) (moth)	NA	Special Concern	NA	NA
Crimson-ringed whiteface (*Leucorrhinia glacialis*) (dragonfly)	NA[a]	Threatened	NA	State Threatened
Lemmer's noctuid moth* (*Lithophane lemmeri*) (moth)	NA	Special Concern	NA	NA
Pale green pinion moth* (*Lithophane viridipallens*) (moth)	NA	Special Concern	NA	Concern
Yellow-horned beaded lacewing (*Lomamyia flavicornis*) (beetle)	NA	Special Concern	NA	NA
Black lordithon rove beetle* (*Lordithon niger*) (beetle)	NA	Special Concern	NA	Concern
Ground beetle (*Loxandrus vulneratus*) (beetle)	NA	Special Concern	NA	NA
Bog copper (*Lycaena epixanthe*) (butterfly)	NA	Special Concern	NA	Concern
Bronze copper (*Lycaena hyllus*) (butterfly)	NA	Special Concern	NA	NA

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island (continued).

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Fringed loosestrife oil-bee (*Macropis ciliate*) (bee)	NA	Special Concern	NA	NA
Eastern cactus-boring moth (*Melitara prodenialis*) (moth)	NA	Special Concern	NA	NA
Newman's brocade (*Meropleon ambifuscum*) (moth)	NA	Special Concern	NA	NA
Tabanid fly (*Merycomyia whitneyi*) (fly)	NA	Special Concern	NA	NA
Barrens metarranthis moth (*Metarranthis apiciaria*) (moth)	NA	Endangered	NA	NA
Syrphid fly* (*Mixogaster johnsoni*) (fly)	NA	Special Concern	NA	NA
Ground beetle (*Nebria lacustris lacustris*) (beetle)	NA	Special Concern	NA	NA
Ground beetle* (*Omophron tesselatum*) (beetle)	NA	Special Concern	NA	NA
Dune oncocnemis (*Oncocnemis riparia*) (moth)	NA	Special Concern	NA	NA
Ground beetle* (*Panagaeus fasciatus*) (beetle)	NA	Special Concern	NA	NA
Pitcher plant borer (*Papaipema appassionata*) (moth)	NA	Endangered	NA	Concern
Hops-stalk borer moth* (*Papaipema circumlucens*) (moth)	NA	Special Concern	NA	NA
Seaside goldenrod stem borer (*Papaipema duovata*)	NA	Special Concern	NA	NA
Columbine borer (*Papaipema leucostigma*) (moth)	NA	Threatened	NA	State Historical
Maritime sunflower borer moth* (*Papaipema maritime*) (moth)	NA	Special Concern	NA	NA
Culvers root bore moth* (*Papaipema sciata*) (moth)	NA	Special Concern	NA	NA
Mayfly (*Paraleptophlebia assimilis*) (dunn mayfly)	NA	Special Concern	NA	NA
Lanced phaneta (*Phaneta clavana*) (mayfly)	NA	Threatened	NA	NA
Labrador tea tentiform leafminer (*Phyllonorycter ledella*) (moth)	NA	Endangered	NA	NA
Gray comma* (*Polygonia progne*)	NA	Special Concern	NA	NA
Common sanddragon (*Progomphus obscurus*) (dragonfly)	NA	Threatened	Special Concern	Concern
Pink sallow (*Psectraglaea carnosa*) (moth)	NA	Threatened	NA	NA
Annointed sallow moth* (*Pyreferra ceromatica*) (moth)	NA	Special Concern	NA	NA
Aureolaria seed borer (*Rhodoecia aurantiago*) (moth)	NA	Special Concern	NA	NA
Soldier fly (*Sargus fasciatus*) (fly)	NA	Special Concern	NA	NA
Eyed brown (*Satyrodes eurydice*) (butterfly)	NA	Special Concern	NA	NA

Table 4-48. Federal Endangered Invertebrates and State Designations for Connecticut, New York, and Rhode Island (continued).

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Ground beetle* (*Scaphinotus elevates*) (beetle)	NA	Special Concern	NA	NA
Ground beetle (*Scaphinotus viduus*) (beetle)	NA	Special Concern	NA	NA
Noctuid moth (*Schinia spinosae*) (moth)	NA	Special Concern	NA	NA
Ski-tailed emerald (*Somatochlora elongate*) (dragonfly)	NA	Special Concern	NA	
Spartina borer moth (*Spartiniphaga inops*) (moth)	NA	Special Concern	NA	Concern
Barrens itame (*Speranza exornata*) (moth)	NA	Threatened	NA	NA
Atlantis fritillary butterfly (*Speyeria atlantis*) (butterfly)	NA	Threatened	NA	NA
Regal fritillary* (*Speyeria idalia*) (butterfly)	NA	Special Concern	Endangered	State Historical
Tabanid fly (*Stonemyia isabellina*) (fly)	NA	Special Concern	NA	NA
Riverine clubtail (*Stylurus amnicola*) (dragonfly)	NA	Threatened	NA	NA
Horse fly (*Tabanus fulvicallus*) (fly)	NA	Special Concern	NA	NA
Ground beetle (*Tetragonoderus fasciatus*) (beetle)	NA	Special Concern	NA	NA
Grassland thaumatopsis (*Thaumatopsis edonis*) (moth)	NA	Threatened	NA	NA
Cicada (*Tibicen auletes*) (cicada)	NA	Special Concern	NA	NA
Banded bog skimmer (*Williamsonia lintneri*) (dragonfly)	NA	Endangered	NA	State Endangered
Noctuid moth (*Zale curema*) (moth)	NA	Threatened	NA	NA
Noctuid moth (*Zale oblique*) (moth)	NA	Special Concern	NA	NA
Noctuid moth (*Zale submediana*) (moth)	NA	Threatened	NA	Concern
Noctuid moth (*Zanclognatha martha*) (moth)	NA	Threatened	NA	Concern

Sources: [a]USFWS (2014g); [b]CTDEEP (2014l); [c]NYSDEC (2014c); [d]RIGIS (2014d).

* Believed extirpated.

Table 4-49. Federal Threatened and Endangered Freshwater Mollusks and Other Invertebrates and State Designations for Connecticut, New York, and Rhode Island.

Species	Federal Status[a]	CT Status[b]	NY Status[c]	RI Status[d]
Rayed bean (*Villosa fabalis*)	Endangered	NA	Endangered	NA
Chittenango ovate amber snail (*Succinea chittenangoensis*)	Threatened	NA	Endangered	NA
Dwarf wedgemussel (*Alasmidonta heterodon*)	Endangered	Endangered	Endangered	NA
Brook floater (*Alasmidonta varicosa*)	NA	Endangered	Threatened	State Historical
Mystic valley amphipod (*Crangonyx aberrans*)	NA	Special Concern	NA	NA
Fairy shrimp (*Eubranchipus holmanii*)	NA	Endangered	NA	NA
Clam shrimp* (*Eulimnadia agassizii*)	NA	Special Concern	NA	NA
Lymnaeid snail* (*Fossaria galbana*)	NA	Special Concern	NA	NA
Lymnaeid snail (*Fossaria rustica*)	NA	Special Concern	NA	NA
Aquatic snail (*Gyraulus circumstriatus*)	NA	Special Concern	NA	NA
Yellow lamp mussel (*Lampsilis cariosa*)	NA	Endangered	NA	NA
Tidewater mucket (*Leptodea ochracea*)	NA	Special Concern	NA	NA
Eastern pond mussel (*Ligumia nasuta*)	NA	Special Concern	NA	Concern
Eastern pearl shell (*Margaritifera margaritifera*)	NA	Special Concern	NA	State Endangered
Slender walker (*Pomatiopsis lapidaria*)	NA	Special Concern	NA	NA
Whiteriver crayfish (*Procambarus acutus*)	NA	Special Concern	NA	NA
Purse web spider (*Sphodros niger*)	NA	Special Concern	NA	NA
Lymnaeid snail (*Stagnicola catascopium*)	NA	Special Concern	NA	NA
Piedmont groundwater amphipod (*Stygobromus tenuis tenuis*)	NA	Special Concern	NA	NA
Coastal pond amphipod (*Synurella chamberlaini*)	NA	Special Concern	NA	Concern
Boreal turret snail (*Valvata sincera*)	NA	Special Concern	Special Concern	NA
Turret snail (*Valvata tricarinata*)	NA	Special Concern	NA	NA
Pink mucket (*Lampsilis abrupta*)	NA	NA	Endangered	NA
Clubshell (*Pleurobema clava*)	NA	NA	Endangered	
Fat pocketbook (*Potamilus capax*)	NA	NA	Endangered	
Wavy-rayed Lampmussel (*Lampsilis fasciola*)	NA	NA	Threatened	NA
Green Floater (*Lasmigona subviridis*)	NA	NA	Threatened	
Buffalo Pebble Snail (*Gillia altilis*)	NA	NA	Special Concern	
Fringed Valvata (*Valvata lewisi*)	NA	NA	Special Concern	
Lampmussel (*Lampsilis radiate*)	NA	NA	NA	Concern
Squawfoot (*Strophitus undulatus*)	NA	NA	NA	Concern

Sources: [a]USFWS (2014g); [b]CTDEEP (2014l); [c]NYSDEC (2014c); [d]RIGIS (2014d)

* Believed extirpated.

4.16.2 Open-Water Environment

Neither the unconfined nor the confined open-water placement site alternatives are applicable to this terrestrial wildlife section because the alternatives are located in open water.

4.16.3 Nearshore/Shoreline Environment

Confined Placement

Of the confined placement alternatives, only the island CDF Site B (Greenwich Captain Harbor), Site C/D (Norwalk Outer Harbor Islands- marsh/containment), and Site O (Clinton Harbor Shoreline CDF) sites contain mapped habitat for terrestrial wildlife and threatened and endangered species (Table 4-50).

Beneficial Use

Numerous beach nourishment sites contain terrestrial wildlife and mapped estimated habitat of threatened and endangered species; these resources are summarized in Table 4-50.

Table 4-50. Terrestrial Wildlife and Threatened and Endangered Species Resources Present in the Nearshore/Shoreline Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1, 2]
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	N/A
		H	N/A
		M	N/A
	Island CDF	B	Yes
		L	No
		N	No
		P	No
		Q	No
		R	No
	Shoreline CDF	A	No
		C	Yes
		D	Yes
		F	No
		I	No
		J	No
		K	No
		O	Yes
	Nearshore Bar Placement/ Nearshore Berm Sites	177, 178, 179, 121/446, 453, 173, 180, 454A, 454B, 455/82, 445, 171, 170, 63, 456, 441, 320, 440, 449, 438, 433, 434, 323, 467, 364, 451, 447, 327/333/330, 337, 457, 365, GP, 367, 368, 381/382, 384, 600, 610, 620	Not applicable
	Beach Nourish-ment	323, 433, 434, 436, 365, 457, 364, 444, 451, 337, 320, 441, 450, 438, 440, 449, 181, 453, 63, 456, 454E, 454W, 455/82, 384, 368, 171, 173, 177, 178, 179, 170, 180, 445, 446, 343, 474, 339, 459, 348, 480, 467, 468, 329, 332, 345, 121, 64, 67, 68, 111, 76, 79, 382, 437, 610, 620	Yes
		442, 447, 367, 325, 327, 330, 331, 333, 334, 381, 600	No

Sources: [1]USACE (2010a); [2]USACE (2012b).
Note: The GIS-based data (polygons) do not differentiate between plants or animals or mention species names.

4.16.4 Upland Environment

Confined Placement

Landfill Placement

There are no Landfill Placement sites with threatened and endangered terrestrial wildlife species. Common terrestrial wildlife species that may be encountered would be limited to rodents, raccoons, eastern cottontail, moles, voles, coyote, and red fox. Common herpetofauna, including snapping turtles, painted turtles, bullfrogs, green frogs, and northern water snakes may be associated with perimeter drainages and may migrate to the upland landfill portions of these study areas.

Beneficial Use

Terrestrial wildlife and threatened and endangered species are present at landfill capping alternative Site 272, Brownfields/redevelopment alternative site 422/423 (Flushing Airport Wetlands/Uplands), and habitat restoration alternative sites 427 (Plumb Beach) and 429 (Jamaica Bay Marsh Islands) (Table 4-51).

Table 4-51. Terrestrial Wildlife and Threatened and Endangered Species Resources Present in the Upland Environments.

Environment	Alternative Type	Alternative ID	Resources Present[1,2]
Upland Environment	**Landfill Placement**	59	No
	Landfill Cover/Capping	60	No
		61	No
		251	No
		272	Yes
	Brownfields & Other Redevelopment	422/423	Yes
	Habitat Restoration / Enhancement or Creation	427	Yes
		429	Yes

Sources: [1]USACE (2010a); [2]NOAA, 2014f.

Note: The GIS-based data (polygons) do not differentiate between plants or animals or mention species names.

4.17 AIR QUALITY

4.17.1 General Long Island Sound Setting

The Clean Air Act (CAA) and the CAA Amendments (CAAA) of 1990 required EPA to set National Ambient Air Quality Standards (NAAQS) (40 CFR §50) for criteria pollutants considered harmful to public health and the environment (EPA, 2014h). These standards are periodically revaluated and updated by EPA as appropriate. The relevant criteria pollutants associated with the emission sources related to the LIS DMMP include: ozone; particulate matter (PM), which is regulated as particles less than 10 microns (PM10) and less than 2.5 microns (PM2.5); and carbon monoxide (CO). Emissions of oxides of nitrogen (NOx) and volatile organic compounds (VOCs) are regulated as precursors of ozone, which is not emitted directly, and sulfur dioxide (SO2) is regulated as a precursor of PM2.5[6].

The results of ambient air monitoring are used to designate areas as either “attainment”, “nonattainment”, or “unclassifiable/attainment” with respect to the standards (Table 4-52). States with designated nonattainment areas are required to develop State Implementation Plans (SIPs) to bring these areas into attainment of the NAAQS (CTDEEP, 2012f); (NYSDEC, 2007); (RIDEM, 2008) . For nonattainment areas that are redesignated as attainment areas, states are required to submit and implement maintenance plans to ensure the areas do not revert to nonattainment status. The LIS DMMP encompasses a large and diverse geographical region that includes the following counties, by state, and their related NAAQS designations as of July 2015[7].

Table 4-52. Nonattainment and Maintenance Areas in in the Long Island Sound Study Area..

State	County	NAAQS Designations			
		Ozone	$PM_{2.5}$	PM_{10}	CO
Connecticut	Fairfield	Nonattainment	Maintenance	Attainment	Maintenance[2]
	Middlesex	Nonattainment	Attainment	Attainment	Maintenance[2]
	New Haven	Nonattainment	Maintenance	Maintenance[1]	Maintenance
	Hartford	Nonattainment	Attainment	Attainment	Maintenance[2]
	Litchfield	Nonattainment	Attainment	Attainment	Maintenance[2]
	New London	Nonattainment	Attainment	Attainment	Maintenance[2]
	Tolland	Nonattainment	Attainment	Attainment	Maintenance[2]
	Windham	Nonattainment	Attainment	Attainment	Attainment
New York	Bronx	Nonattainment	Maintenance	Attainment	Maintenance
	Kings	Nonattainment	Maintenance	Attainment	Maintenance
	Nassau	Nonattainment	Maintenance	Attainment	Maintenance
	New York	Nonattainment	Maintenance	Maintenance	Maintenance
	Queens	Nonattainment	Maintenance	Attainment	Maintenance
	Suffolk	Nonattainment	Maintenance	Attainment	Maintenance
	Westchester	Nonattainment	Maintenance	Attainment	Maintenance
Rhode Island	Washington	Maintenance	Attainment	Attainment	Attainment

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[6] NOx and VOCs may be precursors for PM2.5 depending on State or EPA determinations.
[7] Connecticut 40 CFR §81.307; New York 40 CFR §81.333; and Rhode Island 40 CFR §81.340.

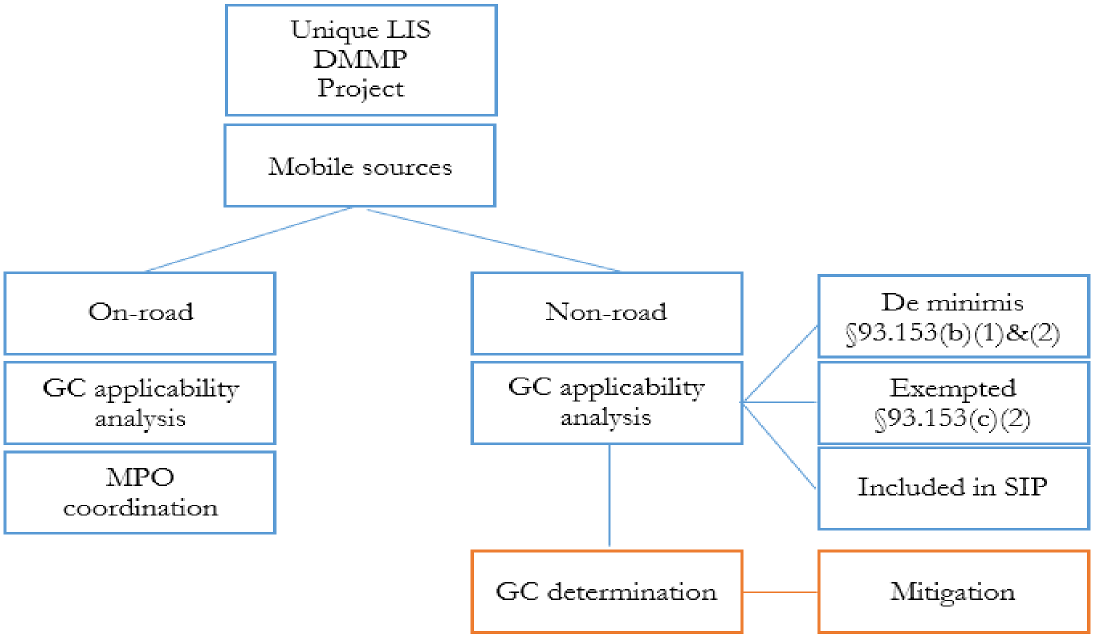
It should be noted that these counties and their related designations include the county's overwater boundaries including their associated portions of the LIS. In addition, the above table is based on July 2015 status and will need to be updated during the duration of the LIS DMMP when specific projects are individually evaluated prior to construction.

Projects associated with the LIS DMMP will typically not introduce permanent emission sources into the county or counties where the projects are located, instead they will typically be short-term in duration. The primary sources of emissions relating to dredging projects associated with the LIS DMMP are nonroad mobile emissions sources including: dredges, dredge support vessels, and applicable land-based construction equipment. Secondary emission sources include onroad mobile sources such as heavy-duty vehicles hauling dredged material and, occasionally, onshore stationary sources including dredged material disposal/treatment facilities. Based on the experience of the New York District (NAN) Deep-Draft Navigation Program, which is within the New York, New Jersey, Long Island, Connecticut (NYNJLICT) ozone non-attainment area (NAA), and which includes both improvement and maintenance construction projects, the primary pollutant of concern is typically NOx. NOx, is a precursor for ozone, is emitted in significant quantities by the diesel engines that power most of the equipment used in dredging projects. These engines also emit PM2.5, PM10, VOCs, SO2, and CO, although at significantly lower rates. The primary pollutant(s) of concern from related stationary sources could potentially be NOx, VOCs, and/or PM depending on the facility configuration.

The primary regulation that covers dredging projects is General Conformity (GC), 40 CFR §93 Subpart B, which ensures that the Federal actions do not adversely impact (delay attainment dates, cause/contribute to new violations, etc.) an applicable SIP. Because GC is applicable only in nonattainment and maintenance areas, each project planned under the LIS DMMP will need to go through its own GC applicability analysis (see Figure 1.). The GC applicability analysis should consider all project-induced direct and indirect mobile and stationary source emissions, as applicable. For stationary source emissions, if they trigger for a New Source Review (NSR) and/or Prevention of Significant Deterioration (PSD) regulatory program, they are exempt from the GC applicability analysis. A conformity determination will be needed for those projects that are not de minimis (40 CFR §153(b)), included in the applicable SIP, or exempt (for example maintenance dredging (40 CFR §153(c)(2)(ix)). The criteria and requirements for a GC determination are defined in 40 CFR §51.858.

For those projects that are conducted in more than one nonattainment or maintenance area, a conformity evaluation must be completed for each area separately (Figure 4-63).

Figure 4-63. Overview of Typical Dredging Project GC Applicability Analysis[8].



In 2001, NAN established the Regional Air Team (RAT) consisting of representatives of NYSDEC, NJDEP, EPA Region 2, NAN, USACE Philadelphia District (NAP)[9], the Port Authority of New York and New Jersey, and New York City Department of Transportation. The RAT has been coordinating and collaborating on GC issues and related tasks associated with dredging projects and has established numerous precedents, definitions, and methods relating to GC applicability analysis, conformity determinations, and acceptable mitigation planning options. Individual projects implemented as part the LIS DMMP that include activities within New York will be coordinated through the RAT to ensure that projects are consistent with the approaches, methods, and standards developed and used by the RAT relating to GC.

Similar to the project-by-project analysis that will need to be conducted related to GC evaluations, LIS DMMP projects will need to be evaluated individually with regards to NEPA to determine potential air quality impacts. It should be noted that GC only considers project-related nonattainment pollutant emission sources that are part of the Federal action and only where the Federal agency maintains jurisdiction as determined by its authority[10]. Therefore, the GC analysis may not include the projects' broader impacts that may need to be evaluated under NEPA on local and regional impacts particularly for large scale and long-duration projects for both nonattainment and attainment criteria pollutants. In addition to the applicable regulated

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[8] This diagram is for illustrative purposes for typical dredging-related projects that only involve mobile source emissions. Specific GC applicability analysis will be completed on a project-by-project basis and coordinated through the RAT. MPO – Metropolitan Planning Organization.

[9] NAP's projects are located in the NYNJLICT and Philadelphia-Wilmington-Atlantic City nonattainment areas.

[10] This can occur when the overall project is larger in scope than what is required to be evaluated for GC.

criteria pollutants listed above, each project's NEPA assessments will need to consider and evaluate greenhouse gases (GHGs) consistent with CEQ draft guidance (CEQ, 2010).

4.17.2 Air Quality in the Open-Water Environment

Air quality conditions at open-water sites are affected by the air pollution within the study area primarily caused by upland activities. Occasional in-water vessel traffic and near-shoreline activities are also sources of mobile source emissions. However, no sensitive receptors are located close to these sites; therefore. air quality effects in open-water environment are less of concern.

4.17.3 Air Quality in the Nearshore/Shoreline Environment

The majority of project alternative sites, such as those for beach nourishment and nearshore bar/berm placement, would be located near the shoreline within each of three states. Sensitive populations in the vicinity of these sites are mostly located along local roads near shorelines. Air quality conditions at these nearshore/shoreline sites are affected predominantly by neighborhood on-road vehicles and motor boats.

4.17.4 Air Quality in the Upland Environment

The upland sites would be mainly related to alternative Landfill Capping/Cover sites. Additionally, upland sites included in the DMMP by the program could include those involving Brownfields redevelopment, habitat restoration, enhancement or recreation, agriculture/aquaculture, road and berms, asphalt/cement production facilities, etc. Air quality conditions around these sites are affected by the emissions from existing facility site operations and on-road vehicles, including disposal trucks to and from each site. Operation of other background sources from highway vehicles, stationary facilities, and construction activities in neighborhoods would also affect ambient air quality conditions. Project-level attainment may be achieved by showing *de minimis* net emission increase or localized dispersion modeling analysis with a direct comparison with the NAAQS. Mitigation measures would be proposed under the project-specific NEPA assessment.

4.18 NOISE

Noise is unwanted sound. Environmental noise is defined as the sound in a community emanating from man-made sources such as automobiles, trucks, buses, aircraft, and fixed industrial, commercial, transportation, and manufacturing facilities, or from natural sources such as animals, insects, and wind (EPA, 1974). Since environmental noise is composed of sounds from moving as well as stationary sources, it varies from place to place and from time to time.

Noise in terms of air pressure is the force experienced by an object immersed in air divided by the area on which the force acts, also referred to as intensity. The typical unit of measurement used to evaluate air pressure is pounds per square inch (psi). However, when dealing with sound pressure levels, an international unit, the Pascal (Pa) is commonly used. One pound per square inch is equal to 6,890 Pa. The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. Because of this vast range, using a linear scale to represent the intensity of sound becomes very unwieldy. As a result, a logarithmic unit known as the decibel (dB) is used to represent the intensity of a sound. Such a representation is called a sound level. The dB unit expresses the ratio of sound pressure to a reference standard. Specifically, the sound pressure level in dB is defined as 20 times the common logarithm of the ratio of sound pressure in Pa to the reference pressure (0.00002 Pa or 20 µPa for airborne sound).

Because of the logarithmic nature of the dB unit, sound levels cannot be arithmetically added or subtracted and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level (Berglund & Lindvall, 1995). For example:

60dB + 60 dB = 63dB
80dB + 80 dB = 83dB

Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60dB + 70dB = 70.4dB

The ability to perceive changes in noise levels varies widely from person to person, as do responses to perceived changes. Generally, a 3-dBA change (increase or decrease) in noise level is barely perceptible to most listeners. A 10-dBA change (increase or decrease) is normally perceived as a doubling (or halving) of noise levels and is considered a substantial change. These thresholds (summarized in Table 4-53) make it possible to estimate a person's probable perception of changes in noise levels.

Other descriptors representing noise levels over extended periods of time are also used by regulatory agencies because an instantaneous noise measurement (measured in dBA) describes noise levels at just one moment in time, and very few noises in a community are constant or of limited duration. Such descriptors include the noise levels exceeded over a specified percentage of the measurement period and the equivalent continuous noise levels for a specified period. For example, L_{10} is the noise level exceeded for 10% of the measurement period and would be a measure of the intrusive noise levels during that period. The equivalent continuous level (e.g., L_{eq} [1 hr]) is defined as the steady-state noise level that, for a specified period of time, would contain the same amount of acoustic energy as the time varying sound over the same period.

Table 4-53. Perception of Changes in Noise Levels.

Change in dBA	Perception	
	Increase in dBA	Decrease in dBA
3	Barely perceptible change	
5	Readily perceptible change	
10	Twice as loud	Half as loud
20	Four times as loud	1/4 as loud
40	Eight times as loud	1/8 as loud

Source: FHA (2010).

Historically, the health effects (e.g., hearing damage) and the welfare effects (e.g., task interference and sleep disruption) of noise were studied and documented in terms of the Equivalent Sound Level (L_{eq}), and the Day-Night Sound Level, L_{dn} (EPA, 1974). These two metrics have been widely used in evaluating noise conditions. Table 4-54 presents some typical noise source levels and ambient background noise conditions.

Table 4-54. Noise Levels of Common Sources and Typical Background Noise.

Sound Source	Sound Level (dBA)
Air raid siren at 50 ft	120
Maximum levels at rock concerts (rear seats)	110
On platform by passing subway train	100
On sidewalk by passing heavy truck or bus	90
On sidewalk by typical highway	80
On sidewalk by passing automobiles with mufflers	70
Typical urban area	60-70
Typical suburban area	50-60
Quiet suburban area at night	40-50
Typical rural area at night	30-40
Isolated broadcast studio	20
Audiometric (hearing testing) booth	10
Threshold of hearing	0

Sources: Cowan (1994); Egan (1988).

4.18.1 General Long Island Sound Setting

Connecticut

The State of Connecticut has implemented noise regulations (as Control of Noise [Section 22a-69]) as prescribed in the state code. In these regulations, noise limits are established on the basis of both emitter and receptor land use classifications. These limits apply at or within the receptor property boundary and are summarized in Table 4-55.

Table 4-55. State of Connecticut Sound Level Limits (dBA).

Emitter Class	Receptor Class			
	C	B	A (day)	A (night)
C	70	66	61	51
B	62	62	55	45
A	62	55	55	45

Definitions:

Day: the time between 7:00 a.m. to 10:00 p.m.
Night: the time between 10:00 p.m. to 7:00 a.m. the following day.
Class A noise zone: land uses generally designated for residential use or areas where serenity is essential to the intended use.
Class B noise zone: land uses generally of a commercial nature.
Class C noise zone: land uses generally of an industrial nature, including utility facility.

In addition to the noise limits, CTDEEP also prohibits the production of prominent, audible discrete noise tones. If a facility produces such sounds, the applicable limits in Table 4-55 are reduced by 5 dBA to offset the undesirable nature of tonal sound in the environment on the basis of one-third octave band sound levels.

In an area where high ambient background noise from sources not subject to these regulations (e.g., noise produced by traffic) already exceeds the appropriate limits shown in Table 4-55, the limits are increased by 5 dBA above the background noise level with a ceiling of 80 dBA.

New York

The NYSDEC has issued a program policy for facilities undergoing State Environmental Quality Review Act processes for NYSDEC permits (NYSDEC, 2001). This policy presents noise impact assessment methods, examines the circumstances under which sound creates significant noise impacts, and identifies avoidance and mitigation measures to reduce or eliminate noise impacts. The policy document provides the following guidelines:

- An increase of 6 dBA over the existing ambient noise levels is considered the threshold of causing complaints.
- An increase of 10 dBA over the existing ambient noise levels deserves consideration of avoidance and mitigation measures.
- In any non-industrial setting, the addition of any noise source should not raise the cumulative noise level above a maximum of 65 dBA.

Rhode Island

The State of Rhode Island does not have regulations that set community noise exposure criteria. It is up to each individual community to establish noise regulations through community by-laws.

However, Rhode Island General Laws (Section 31-45-1) provide noise limits to regulate on-road vehicle noise measured at 50 ft from the center of a travel lane. Project-associated vehicles would be required to undergo annual inspections; therefore, they would be expected to be in compliance with the state noise limits.

4.18.2 Noise in the Open-Water Environment

The open-water noise environment is dominated by sound from natural waves. It can be characterized as an environment similar to a rural quiet area at night, with occasional elevated levels caused by marine vessel traffic or storms and wind.

4.18.3 Noise in the Nearshore/Shoreline Environment

The nearshore/shoreline noise environment is similar to the open-water condition with seasonal elevated levels, particularly during the summer season, caused by human/boat activities.

4.18.4 Noise in the Upland Environment

Depending on the population density, commercial activity, and local traffic conditions, the upland noise environment is anticipated to vary from a quiet suburban area (around 50 dBA) to a noisy urban area (70 dBA).

4.19 CULTURAL RESOURCES

4.19.1 General Long Island Sound Setting

Overall, Long Island Sound is an archeologically sensitive region, with more historical resources currently identified at its western and eastern ends than in its wide center. The terrestrial portion of the study area (inland at a distance of no greater than 10 mi) contains 3,146 recorded archaeological sites, of which 195 are identified as National Register and State Register (NR/SR) listed or eligible sites (USACE and PAL, 2010). There are also 2,032 aboveground historic resources, including buildings, sites, structures, objects, and districts that are listed, determined eligible, or potentially eligible for the NR/SR within the respective states in which they are located. No traditional cultural properties were identified in the state inventories; however, it is expected that such resources are present in some areas and would need to be identified through discussions with Native American tribes and other ethnic groups or communities. Overall, the Long Island Sound DMMP study area along the coast of the Sound is a highly sensitive region for terrestrial archaeological resources (Figure 4-64 through Figure 4-66) that date from all temporal/cultural periods of documented human occupation, approximately 12,000 years ago to the present.

In the underwater portions of the study area, 847 shipwrecks and obstructions are reported. Areas of low, moderate, and high sensitivity for underwater archaeological resources is highest at the study area’s western end closest to the port of New York City (Figure 4-64) and at its eastern end in association with the Groton-New London port area (Figure 4-66). Detailed results of the cultural resource inventory are presented in USACE and PAL (2010).

4.19.2 Cultural Resources in the Open-Water Environment

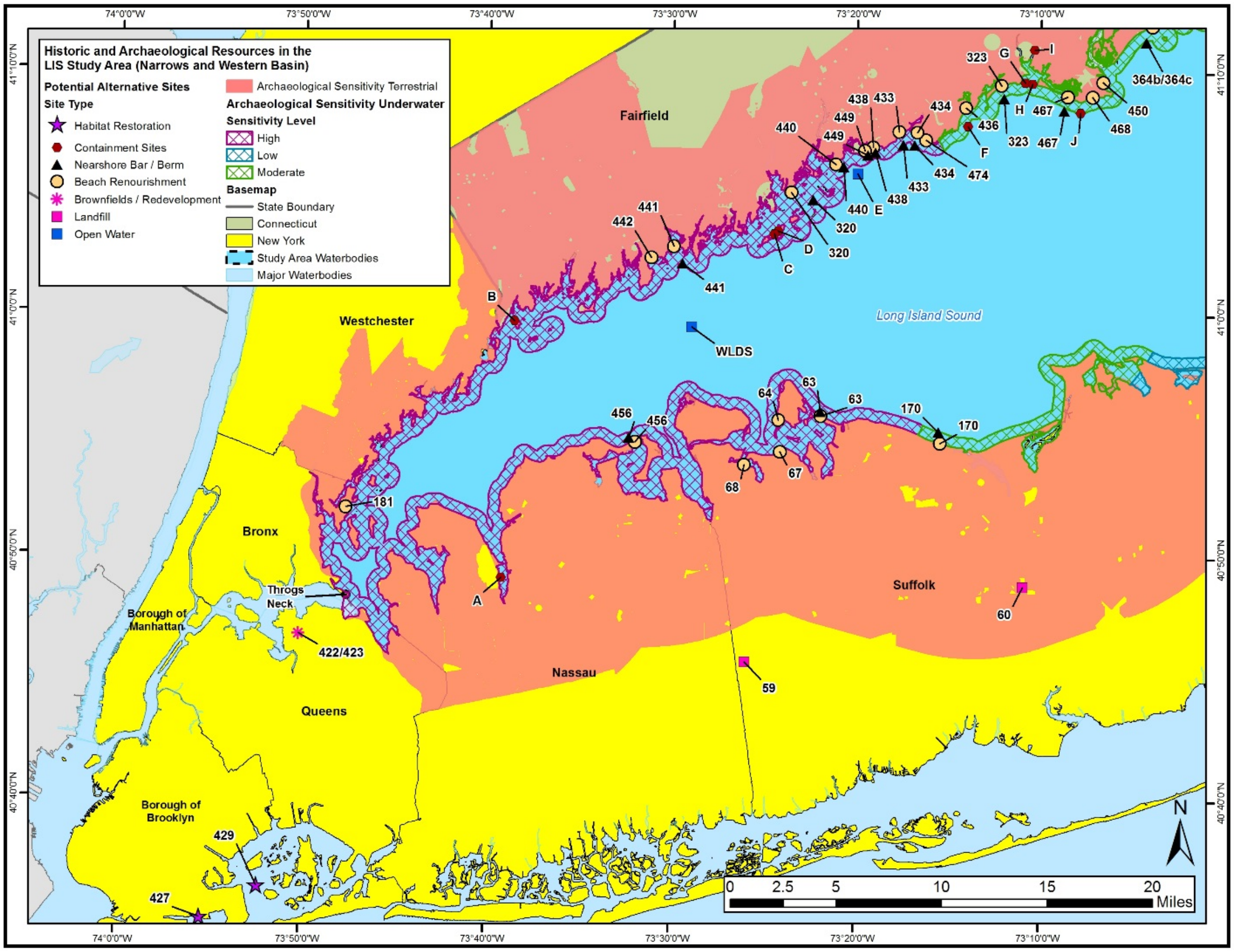
This section provides available information on cultural resources found at proposed alternative sites in the study area’s open-water environment. Cultural resources present within the study area’s open-water alternative sites are listed in Table 4-56. For underwater archaeological resources, further investigation is recommended for any proposed action that may impact the seafloor within the Long Island Sound DMMP study area. Project area-specific Phase IA marine archaeological sensitivity assessment is recommended to evaluate the full potential for unrecorded sites to be present. Results from such an assessment are necessary to develop a research design for conducting a Phase IB marine archaeological remote sensing identification survey.

Unconfined Open-Water Placement

Four charted shipwrecks have been documented within 1 mi of Alternative WLDS, and two charted shipwrecks have been documented within 1 mi of Alternative NLDS (Table 4-56). There were no charted shipwrecks within 1 mi of either Alternatives CLDS or CSDS.

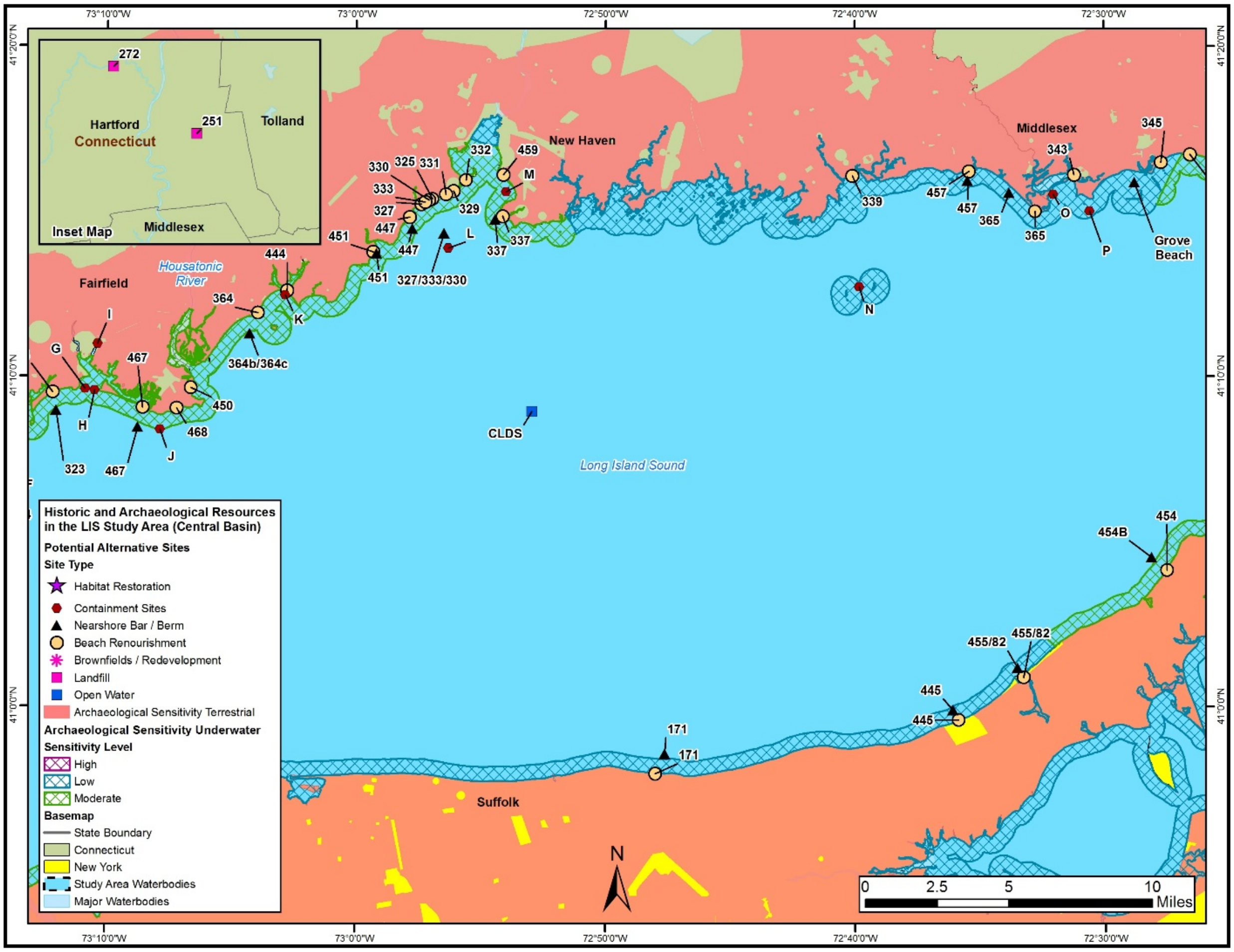
Confined Open-Water Placement

Two shipwrecks have been documented within ½ to 1 mi shoreward of Containment Site Alternative E – Sherwood Island Borrow Pit (Table 4-56). In addition, the Compo/Owenoke and Mill Cove Historic Districts are located shoreward of Alternative E.



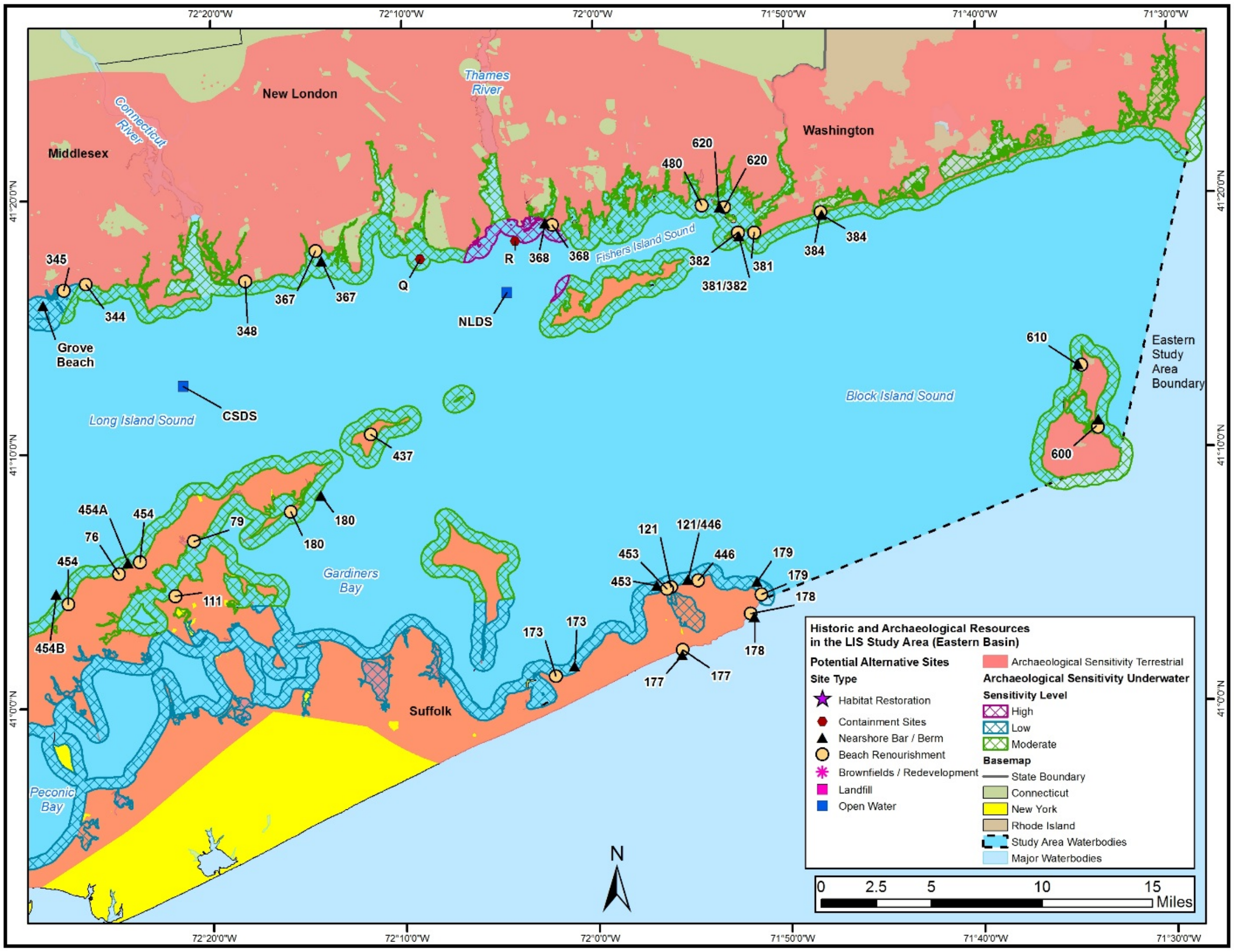
Source: USACE and PAL (2010).

Figure 4-64. Archaeological Sensitivity in the Long Island Sound Study Area (Western Basin).



Source: USACE and PAL (2010).

Figure 4-65. Archaeological Sensitivity in theLong Island Sound Study Area (Central Basin).



Source: USACE and PAL (2010).

Figure 4-66. Archaeological Sensitivity in the Long Island Sound Study Area (Eastern Basin).

Table 4-56. Cultural Resources in the Open-Water Environment.

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
Open-Water Environment	**Unconfined Open-Water Placement**	WLDS	4 shipwrecks within 1 mi of the site	Underwater: No Terrestrial: No
		CLDS	No shipwrecks within 1 mi of the site	Underwater: No Terrestrial: No
		CSDS	No shipwrecks within 1 mi of the site	Underwater: No Terrestrial: No
		NLDS	2 shipwrecks within 1 mi of the site	Underwater: No Terrestrial: No
	Confined Open-Water Placement	E	2 shipwrecks within 1 mi of CAD 2 historic districts within 1 mi of CAD	Underwater: High Terrestrial: No

Sources: NOAA (2014l), USACE (2012a).

4.19.3 Cultural Resources in the Nearshore/Shoreline Environment

This section provides available information on cultural resources found at alternative sites in the study area's nearshore/shoreline environment.

Confined Placement

Seventeen (17) nearshore/shoreline locations were identified as potential containment sites: 3 as In-Harbor CAD cells, 6 as Island CDFs, and 8 as Shoreline CDFs.

In-Harbor CAD cells

While no shipwrecks were documented as being located within the boundaries of the three In-Harbor CAD cells (Alternatives G, H, and M), multiple shipwrecks are adjacent to these alternatives (Table 4-57). Shipwrecks are located less than ½ mi from Alternatives G and H. A number of other shipwrecks are located in Bridgeport Harbor itself, many within ½ to 1 mi of Alternatives G and H. One shipwreck is located within ½ mi seaward of Alternative M (Morris Cove) outside of New Haven Harbor.

There is a historic district located west of Alternatives G and H, and another located shoreward of Alternative M (Table 4-57).

Island CDFs

One shipwreck is documented as being located within the boundaries of Alternative N (Falkner Island CDF) (Table 4-57). No shipwrecks were documented as being located within the boundaries of the other five Island CDFs (Alternatives B, L, P, Q, and R), although multiple shipwrecks are within ¼ to ½ mi of the alternatives. Only Alternative L (New Haven Breakwaters CDF) did not have any shipwrecks located within 1 mi. No other cultural resources were found within ½ mi of the sites.

One historic district is located within the influence of Alternative P (Duck Island Roads) (Table 4-57). Four historic districts are located along the shoreline within the influence of Alternative Q (Twotree Island). Two historic districts are located along the shoreline within the influence of Alternative R (Groton Black Ledge). Alternatives B, L, and N did not have historic districts located within ½ mi of the sites.

One archaeological site is located within ½ mi northeast of Alternative R. Alternatives B, L, N, P, and Q did not have archaeological sites within 1/2 mi of the sites.

Shoreline CDFs

Multiple shipwrecks are within ¼ to 1 mi of the eight Shoreline CDFs (Alternatives A, C, D, F, I, J, K, and O), including seven shipwrecks located within the boundaries of Alternatives A (three), C (three), and D (one) (Table 4-57). Only Alternative O – Clinton Harbor CDF – did not have any shipwrecks located within 1 mi.

Three historic districts were located within the vicinity (½mi) of Alternative A (Hempstead Harbor), three within the vicinity of Alternative F (Penfield Reef), four within the vicinity of

Alternative I (Bridgeport Yellow Mill Channel), two within the vicinity of Alternative K (Milford Harbor), and one within the vicinity of Alternative O (Clinton Harbor) (Table 4-57). Alternatives C, D, and J did not have historic districts within ½ mi of the sites.

No archaeological sites were located within the vicinity of any of the Shoreline CDF alternatives.

Beneficial Use

One-hundred six (106) Beneficial Use locations were identified as potential placement sites. These include nearshore bar/berm and beach nourishment placement sites.

Nearshore Bar/Berm Placement

Approximately[11] 55 shipwrecks are located within the vicinity of 19 of the nearshore bar/berm placement alternative sites (Table 4-57): approximately 38 shipwrecks within ½ mi and 18 within 1 mi. Seventeen of the alternative sites do not have shipwrecks within their vicinity. There is no specific information on shipwrecks for the nearshore berms on Block Island (600 and 610).

Ten historic districts are located within the vicinity of eight nearshore bar/berm placement alternative sites (3 alternatives are within the vicinity of two historic districts). Twenty-nine of the alternative sites do not have any historic districts within their vicinity.

Eight archaeological sites are located within the vicinity of eight nearshore bar/berm placement alternative sites (one alternative is within the vicinity of two archaeological sites). Twenty-eight of the alternative sites do not have any archaeological sites within their vicinity.

Fourteen nearshore bar/berm placement alternative sites did not have any known cultural resources within their vicinity.

Beach Nourishment

Four beach nourishment alternative sites have archaeological sites located within ½ mi.

Fourteen beach nourishment alternative sites have historic districts or parks located on site or within ½ mi (Table 4-57). Thirteen beach nourishment alternative sites have historic sites or buildings located on site or within ½ mi. Eight beach nourishment alternative sites have shipwrecks within ½ mi of the beach. Thirty-six beach nourishment alternative sites do not have any cultural resources within their vicinity.

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[11] The exact number is uncertain because USACE (2012b) states that there are “multiple [shipwrecks] documented in nearshore areas shoreward of berm, within 1 mile”. An exact number is not given.

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	Multiple shipwrecks adjacent to CAD 1 historic district west of CAD	Underwater: Moderate Terrestrial: Yes
		H	Multiple shipwrecks adjacent to CAD 1 historic district west of CAD	Underwater: Moderate Terrestrial: Yes
		M	1 shipwreck within ½ mi of CAD 1 historic district shoreward of CAD	Underwater: Moderate Terrestrial: Yes
	Island CDF	B	Multiple shipwrecks within ½ mi of CDF	Underwater: High Terrestrial: Yes
		L	No cultural resources within vicinity of CDF	Underwater: No Terrestrial: No
		N	1 shipwreck inside CDF 1 shipwreck within ½ mi of CDF 1 shipwreck on non-project side of Falkner Island	Underwater: Low Terrestrial: Yes
		P	1 historic district inside harbor entrance	Underwater: Low Terrestrial: Yes
		Q	1 shipwreck within ½ mi of CDF 1 shipwreck within ¾ mi of CDF 4 historic districts along shoreline north of CDF	Underwater: Moderate Terrestrial: Yes
		R	1 shipwreck within ½ mi of CDF 2 historic districts along shoreline north of CDF 1 archaeological site within ½ mi of CDF	Underwater: High Terrestrial: No
	Shoreline CDF	A	3 shipwrecks inside CDF 1 shipwreck within ¼ mi of CDF 2 historic districts across harbor from CDF 1 historic district within ½ mi of CDF	Underwater: High Terrestrial: Yes
		C	3 shipwrecks inside CDF 5 shipwrecks within ½ mi of CDF 7 shipwrecks within 1 mi of CDF	Underwater: High Terrestrial: Yes
		D	1 shipwreck inside CDF 7 shipwrecks within ½ mi of CDF 6 shipwrecks within 1 mi of CDF	Underwater: High Terrestrial: Yes
		F	2 shipwrecks within ½ mi of CDF 1 shipwreck within 1 mi of CDF 3 historic districts shoreward of CDF	Underwater: Moderate Terrestrial: Yes
		I	1 shipwreck immediately south of CDF Multiple shipwrecks in Bridgeport Harbor 4 historic districts in upland surrounding CDF	Underwater: Moderate Terrestrial: Yes
		J	2 shipwrecks within 1 mi of CDF	Underwater: Moderate Terrestrial: Yes
		K	1 shipwreck within ½ mi of CDF 2 historic districts inside Milford Harbor 1 historic district within ½ mi of CDF	Underwater: Moderate Terrestrial: Yes
		O	1 historic district within ¾ mi of CDF	Underwater: Low Terrestrial: Yes

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
	Nearshore Bar Placement/ Nearshore Berm Sites	177	1 historic district within 1 mi of berm 1 archaeological site within 1 mi of berm	Underwater: No Terrestrial: Yes
		178	1 archaeological site within 1 mi of berm	Underwater: No Terrestrial: Yes
		179	1 shipwreck immediately west of berm 1 archaeological site within ½ mi of berm	Underwater: Low Terrestrial: Yes
		121/446	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: Yes
		453	2 shipwrecks within ½ mi of berm 1 archaeological site within ½ mi of berm	Underwater: Low Terrestrial: Yes
		173	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: Yes
		180	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: No
		454A	2 shipwrecks within 1 mi of berm	Underwater: Moderate Terrestrial: Yes
		454B	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: No
		455/82	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: Yes
		445	4 shipwrecks shoreward of berm 2 shipwrecks within 1 mi of berm 2 archaeological sites within ½ mi of berm	Underwater: Low Terrestrial: No
		171	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: No
		170	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: Yes
		63	1 shipwreck within ½ mi of berm	Underwater: High Terrestrial: Yes
		456	5 shipwrecks immediately shoreward of berm 3 shipwrecks within ½ mi of berm 5 shipwrecks within 1 mi of berm	Underwater: High Terrestrial: Yes
		441	Multiple shipwrecks within 1 mi of berm	Underwater: High Terrestrial: Yes
		320	6 shipwrecks within ½ mi of berm	Underwater: High Terrestrial: Yes
		440	2 shipwrecks within ½ mi of berm 1 historic district within ½ mi of berm	Underwater: High Terrestrial: Yes
		449	1 historic district within ½ mi of berm	Underwater: High Terrestrial: Yes
		438	No cultural resources within vicinity of berm	Underwater: High Terrestrial: Yes
		433	2 shipwrecks within ½ mi of berm 2 historic districts within 1 mi of berm	Underwater: High Terrestrial: Yes
		434	1 shipwreck within ½ mi of berm 2 historic districts within 1 mi of berm	Underwater: High Terrestrial: Yes
		323	2 shipwrecks within ¾ mi of berm 5 shipwrecks within 1 mi of berm	Underwater: Moderate Terrestrial: No

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
			1 historic district within ½ mi of berm	
		467	2 shipwrecks within ½ mi of berm	Underwater: Moderate Terrestrial: No
		364	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: No
		451	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: Yes
		447	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: Yes
		327/333/330	No cultural resources within vicinity of berm	Underwater: No Terrestrial: No
		337	2 shipwrecks within ½ mi of berm	Underwater: Moderate Terrestrial: Yes
		457	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: Yes
		365	No cultural resources within vicinity of berm	Underwater: Low Terrestrial: Yes
		GP	1 shipwreck within ½ mi of berm	Underwater: Low Terrestrial: Yes
		367	1 shipwreck within 1 mi of berm	Underwater: Moderate Terrestrial: Yes
		368	1 shipwreck within ½ mi of berm 1 archaeological site within 1 mi of berm	Underwater: High Terrestrial: Yes
		381/382	4 shipwrecks within ½ mi of berm 1 historic district within ½ mi of berm	Underwater: Moderate Terrestrial: Yes
		384	1 shipwreck within ½ mi of berm	Underwater: Moderate Terrestrial: Yes
		600	2 shipwrecks within ½ mi of berm 1 archaeological site within ½ mi of berm	Underwater: Moderate Terrestrial: Yes
		610	No cultural resources within vicinity of berm	Underwater: Moderate Terrestrial: Yes
		620	Within 1 mi of historic district and buildings	Underwater: Moderate Terrestrial: within ½ mi
	Beach Nourishment	323	Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		433	Historic districts and/or parks on site or within ½ mi from beach	Underwater: High Terrestrial: Yes
		434	1 shipwreck within ½ mi from beach	Underwater: High Terrestrial: Yes
		436	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		365	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		457	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		364	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
		444	1 shipwreck within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		451	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		337	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		320	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		441	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: High Terrestrial: Yes
		442	1 shipwreck within ½ mi from site	Underwater: High Terrestrial: Yes
		450	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		447	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		438	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		440	Historic districts and/or parks on site or within ½ mi from beach 1 shipwreck just offshore from beach	Underwater: High Terrestrial: Yes
		449	Historic districts and/or parks on site or within ½ mi from beach	Underwater: High Terrestrial: Yes
		181	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: High Terrestrial: Yes
		453	1 shipwreck within ½ mi from beach 1 archaeological site within ½ mi from beach	Underwater: Low Terrestrial: Yes
		63	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		456	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		454E	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		454W	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		455/82	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		384	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		367	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		368	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		171	Historic sites and/or buildings on site or within ½ mi from beach Historic districts and/or parks on site or within ½ mi from beach	Underwater: Low Terrestrial: Yes

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
		173	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		177	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: No Terrestrial: Yes
		178	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: No Terrestrial: Yes
		179	1 archaeological site within ½ mi from beach	Underwater: Low Terrestrial: Yes
		170	Historic sites and/or buildings on site or within ½ mi from beach Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		180	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		445	Historic districts and/or parks on site or within ½ mi from beach	Underwater: Low Terrestrial: No
		446	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		343	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		474	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		339	Historic districts and/or parks on site or within ½ mi from beach	Underwater: Low Terrestrial: Yes
		459	Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		348	1 shipwreck within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		480	Historic sites and/or buildings on site or within ½ mi from beach Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		467	1 shipwreck within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		468	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		325	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		327	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		329	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		330	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		331	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		332	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes

Table 4-57. Cultural Resources Present in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
		333	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		344	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		345	No cultural resources within ½ mi from beach	Underwater: Low Terrestrial: Yes
		121	Historic sites and/or buildings on site or within ½ mi from beach 1 archaeological site within ½ mi from site	Underwater: Low Terrestrial: Yes
		64	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		67	No cultural resources within ½ mi from beach	Underwater: High Terrestrial: Yes
		68	Historic districts and/or parks on site or within ½ mi from beach	Underwater: High Terrestrial: Yes
		111	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		76	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		79	No cultural resources within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		381	Historic sites and/or buildings on site or within ½ mi from beach Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		382	Historic districts and/or parks on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		437	Historic sites and/or buildings on site or within ½ mi from beach	Underwater: Moderate Terrestrial: Yes
		600	3 shipwrecks within ½ mi of site Historic sites and/or buildings on site or within ½ mi from beach Historic districts and/or parks on site or within ½ mi from beach 1 archaeological site within ½ mi of site	Underwater: Moderate Terrestrial: Yes
		610	No cultural resources within vicinity of the site	Underwater: Moderate Terrestrial: Yes
		620	Within 1 mi of historic district and buildings	Underwater: Moderate Terrestrial: within ½ mi

Sources: USACE (2012a), USACE (2012b), USACE (2010a).

4.19.4 Cultural Resources in the Upland Environment

Cultural resources data for the upland environment were gathered for the inland areas within 10 mi of the coastline. Therefore, alternative sites outside of the inventoried area do not have any cultural resource data available. The following sections provide details on the various sites and potential uses. Table 4-58 provides details on the various sites.

For terrestrial archaeological resources, further investigations (in the form of Phase I assessment surveys) to refine the generalized archaeological sensitivity model provided in the USACE inventory document (USACE, 2010a) should be conducted for any Long Island Sound DMMP alternatives that involve upland placement or other land area impacts once they are developed by the dredging proponents. The Phase I assessments would be designed to determine the full potential for unrecorded sites to be present using in-depth reconnaissance survey methods as required by the State Historic Preservation Offices (SHPOs). This survey phase would also include the identification of any traditional cultural properties that may be present through discussions with consulting parties, including Native American tribes. For historic properties, it is recommended that all alternative sites be screened for their potential to include properties that have not been previously evaluated. This would include resources included in the SHPO inventories that have not been evaluated in accordance with the National Register Criteria for Evaluation or have not been previously recorded in the inventories. In the event the alternative site location has the potential to contain those types of resources, a reconnaissance-level historic architecture survey should be conducted.

Confined Placement

Landfill Placement

No cultural resources data were gathered for landfill placement alternative 59.

Table 4-58. Cultural Resources Present in the Upland Environment.

Environment	Alternative Type	Alternative ID	Resources Present	Archaeological Sensitivity within ½ mi of site
Upland Environment	**Landfill Placement**	59	No cultural resources data were gathered.	Underwater: No Terrestrial: No
	Landfill Cover/ Capping	60	No cultural resources within ½ mi from site	Underwater: No Terrestrial: Yes
		61	No cultural resources data were gathered.	Underwater: No Terrestrial: No
		251	No cultural resources data were gathered.	Underwater: No Terrestrial: No
		272	No cultural resources data were gathered.	Underwater: No Terrestrial: No
	Brownfields & Other Redevelopment	422/423	No cultural resources data were gathered. Underwater sensitivity: None	Underwater: No Terrestrial: No
	Habitat Restoration / Enhancement or Creation	427	No cultural resources data were gathered.	Underwater: No Terrestrial: No
		429	No cultural resources data were gathered.	Underwater: No Terrestrial: No

Source: USACE (2010a)

Beneficial Use

Landfill Capping/Cover

No cultural resources are located within ½ mi of landfill capping/cover alternative 60 (Blydenburgh Road Landfill Complex). There are no cultural resource data for the other three landfill capping/cover alternatives (61, 251, and 272).

Brownfields and Other Redevelopment

No cultural resources data were gathered for Brownfields/redevelopment alternative 422/423.

Habitat Restoration/Enhancement or Creation

No cultural resources data were gathered for habitat restoration/enhancement alternatives 427 or 429.

4.20 SOCIOECONOMIC ENVIRONMENT

4.20.1 General Long Island Sound Setting

The following sections describe the socioeconomic environment (commercial and recreational fisheries, shipping and navigation, recreational activities and beaches, parks and natural areas, and other human uses) of the Long Island Sound study area.

Geographic Setting, Waterways, and Counties along Long Island Sound

For the purposes of characterizing the socioeconomic environment, the study area includes the following areas surrounding Long Island Sound:

- All of Connecticut, comprising the counties of Fairfield, New London, Litchfield, Windham, Tolland, Hartford, Middlesex, and New Haven;
- New York: Westchester, Bronx, Queens, Suffolk, and Nassau counties, and the Boroughs of Brooklyn (Kings County) and Manhattan (New York County);
- Rhode Island: Washington County (including Block Island).

Overall, the land area of the counties surrounding Long Island Sound and within the study area encompasses over 7,000 mi^2. The western boundary of the study area runs from Throgs Neck, Bronx, New York, to Willets Point, Queens, New York; the eastern boundary runs from Westerly, Rhode Island, across western Block Island Sound to the eastern tip of Long Island at Montauk, New York.

The study area encompasses one of the most densely populated and industrialized regions in North America. Cargo and petroleum products are shipped through the study area to or from the New York City area, and several ferries transport people and goods between Long Island and Connecticut. Three of the major rivers that transit the study area empty into Long Island Sound (the Housatonic, Connecticut, and Thames). These each originate farther north in New England, effectively connecting Massachusetts, New Hampshire, and Vermont to Long Island Sound (EPA, 2004).

Land Use

The USGS (2011b) has developed a national land cover database from which land use for the study area has been identified. The land use for the 16-county study area is presented in Table 4-59. Overall, the study area (including land and water surface area) encompasses 9,765 mi^2 and is 25% developed.

Population and Density

Over 60% of Connecticut's population resides along the coast of Long Island Sound in Fairfield, New London, Middlesex, and New Haven Counties. About 12% of Rhode Island's total population resides in Washington County, the only county in that state within the study area. Nearly 60% of New York State's population lives within the study area. New York City, located at the far western end of Long Island Sound, is the most populous city in the United States, with a 2010 population of 8.2 million persons (U.S. Census Bureau, 2010).

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Table 4-59. 2011 Land Use for the Long Island Sound Study Area in Square Miles.

County	**Open Water**	**Developed**				**Barren Land (Rock/Sand/ Clay)**	**Forest**			**Shrub/ Scrub**	**Grassland / Herbaceous**	**Pasture/ Hay**	**Cultivated Crops**	**Woody Wetlands**	**Emergent Herbaceous Wetlands**
		Open Space [a]	**Low Intensity**	**Medium Intensity**	**High Intensity**		**Deciduous**	**Evergreen**	**Mixed**						
Bronx County, NY	14.69	3.56	4.29	13.38	16.65	0.26	1.56	1.03	0.12	0.13	0.43	0.01	0.01	0.33	1.03
Fairfield County, CT	210.34	125.98	74.82	51.18	16.44	1.76	276.41	11.98	3.67	5.01	2.17	15.64	0.53	35.11	5.97
Hartford County, CT	18.31	103.00	106.27	73.55	16.28	2.91	249.47	26.20	19.98	10.82	5.27	44.01	17.73	52.89	4.03
Kings County, NY	13.80	1.66	3.52	14.32	36.90	0.41	0.55	0.05	0.02	1.10	0.96	0.01	0.01	0.11	2.16
Litchfield County, CT	28.79	62.84	21.84	10.64	1.98	1.97	557.93	47.01	43.86	10.76	2.93	90.23	8.29	49.95	5.90
Middlesex County, CT	69.32	35.13	22.23	10.80	2.35	1.84	221.28	6.51	7.74	6.13	1.64	16.75	0.82	28.02	8.51
Nassau County, NY	161.24	55.08	54.50	97.22	26.07	3.80	19.94	2.12	8.55	1.35	0.63	0.56	0.42	2.41	19.22
New Haven County, CT	256.52	89.86	84.01	64.49	15.15	3.35	255.45	10.74	6.64	6.76	6.95	19.17	1.81	31.00	10.11
New London County, CT	104.94	48.57	32.65	24.75	5.84	3.02	362.97	13.70	13.93	9.50	4.90	46.95	7.12	79.70	13.25
New York County, NY	6.54	1.65	1.73	5.37	10.73	0.01	0.22	0.20	0.06	0.00	0.00	0.00	0.00	0.01	0.62
Queens County, NY	61.81	4.05	11.11	38.96	47.08	1.55	1.75	0.12	0.07	0.72	0.23	0.02	0.12	0.42	4.00
Suffolk County, NY	1444.61	211.57	182.19	102.52	27.07	29.89	142.70	64.63	20.66	10.51	7.58	32.88	36.34	15.47	44.29
Tolland County, CT	7.22	33.50	17.41	5.18	1.06	0.89	211.82	16.42	35.97	7.48	1.37	29.35	7.89	38.87	2.86
Washington County, RI	228.08	23.40	25.66	20.40	3.81	6.93	127.78	19.11	14.33	2.42	7.25	17.43	3.35	54.34	8.31
Westchester County, NY	66.15	112.48	48.88	37.82	12.66	0.21	165.85	21.25	2.36	2.04	0.53	13.13	0.31	14.03	2.31
Windham County, CT	8.02	32.00	14.79	6.61	1.60	2.34	248.88	23.65	38.31	7.26	1.64	47.96	3.68	77.59	7.10

Source: USGS (2011b).

[a] Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

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Table 4-60 presents the 2010 decennial census of the population and the population density by county within the Long Island Sound study area. Statistics for state totals are also provided for comparison purposes. Overall, the population within the study area exceeds 15.2 million persons with an urban population density of 2,157 persons per square mile.

Table 4-60. Population within Long Island Sound Study Area, 2010.

State	County	Land Area (mi^2)	2010 Total Population	Persons / mi^2
Connecticut		48,423.55	3,574,097	74
Counties	Fairfield County[a]	624.89	916,829	1,467
	New London County[a]	664.88	274,055	412
	Litchfield County	920.56	189,927	206
	Windham County	512.91	118,428	231
	Tolland County	410.21	152,691	372
	Hartford County	735.10	894,014	1,216
	Middlesex County[a]	369.30	165,676	449
	New Haven County[a]	604.51	862,477	1,427
New York		471,263.97	19,378,102	41
Counties	New York County (Manhattan)	22.83	1,585,873	69,468
	Kings County (Brooklyn)	70.82	2,504,700	35,369
	Nassau County[a]	284.72	1,339,532	4,705
	Westchester County[a]	430.50	949,113	2,205
	Queens County[a]	108.53	2,230,722	20,554
	Suffolk County[a]	912.05	1,493,350	1,637
	Bronx County[a]	42.10	1,385,108	32,903
Rhode Island		10,338.14	1,052,567	102
County	Washington County[a]	329.23	126,979	386

Source: U.S. Census Bureau (2010).

[a] Adjacent to Long Island Sound.

Population Centers and Urban Concentrations

The coastline throughout the study area is densely populated with urban cities and communities, especially those surrounding Long Island Sound. The boroughs of Queens, Manhattan, Brooklyn, and the Bronx within New York City house 7.7 million persons, slightly over half of the total population within the study area. The remaining population is distributed over 200 other communities within the study area (U.S. Census Bureau, 2010).

Income and Employment

Table 4-61 shows the number of businesses, employees, and annual payroll by economic activity within the study area. In total, there were over 430,000 businesses and 6.1 million employees within the Long Island Sound study area in 2011. The estimated annual payroll was $409 billion in 2011 (U.S. Census Bureau, 2011a).

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Table 4-61. Long Island Sound Study Area Establishments, Employment, and Wages by Industrial Economic Sector, 2011.

		Study Area in New York State			Study Area in Rhode Island State			Study Area in Connecticut State			Total Study Area		
2007 NAICS Economic Sector	**Description of Economic Sector**	**Number of Establish-ments**	**Paid Employees for Pay Period including March 12, 2011**	**Annual Payroll ($1,000)**	**Number of Establish-ments**	**Paid Employees for Pay Period including March 12, 2011**	**Annual Payroll ($1,000)**	**Number of Establish-ments**	**Paid Employees for Pay Period including March 12, 2011**	**Annual Payroll ($1,000)**	**Number of Establish-ments**	**Paid Employees for Pay Period including March 12, 2011**	**Annual Payroll ($1,000)**
11	Agriculture, forestry, fishing and hunting	162	1,169	$41,281	12	44	$1,695	71	266	$8,911	245	1,479	$51,887
21	Mining, quarrying, and oil and gas extraction	45	358	$21,970	7	47	$2,527	74	1,022	$93,497	126	1,427	$117,994
22	Utilities	234	27,041	$378,434	6	174.5	D	157	17,000	$1,169,894	397	44,216	>$15,48,328
23	Construction	25,255	183,200	$12,164,363	493	1454	$72,499	7,909	48,782	$2,914,236	33,657	233,436	$15,151,098
31-33	Manufacturing	9,332	153,093	$7,326,122	157	5879	$344,734	4,388	150,646	$9,627,981	13,877	309,618	$17,298,837
42	Wholesale trade	24,151	233,023	$16,162,473	150	2717	$221,080	4,383	71,127	$5,240,744	28,684	306,867	$21,624,297
44-45	Retail trade	48,957	490,074	$14,825,658	535	6536	$173,907	12,738	180,535	$5,119,030	62,230	677,145	$20,118,595
48-49	Transportation and warehousing	7,776	144,004	$6,570,371	74	905	$29,402	1,638	38,802	$1,656,303	9,488	183,711	$8,256,076
51	Information	7,691	200,647	$19,960,887	46	491	$26,923	1,647	37,559	$2,713,642	9,384	238,697	$22,701,452
52	Finance and insurance	18,238	403,554	$92,174,723	123	1042	$62,374	6,178	115,490	$16,611,813	24,539	520,086	$108,848,910
53	Real estate and rental and leasing	24,828	126,809	$7,374,148	131	302	$11,213	3,088	19,204	$1,013,263	28,047	146,315	$8,398,624
54	Professional, scientific, and technical services	42,033	418,144	$39,441,891	345	1371	$79,938	9,344	101,163	$8,050,707	51,722	520,678	$47,572,536
55	Management of companies and enterprises	1,703	122,701	$18,326,021	8	749.5	D	676	35,510	$4,374,671	2,387	158,961	>$22,700,692
56	Administrative and support and waste management and remediation services	16,093	279,679	$12,433,755	277	1428	$81,589	5,137	86,242	$3,372,683	21,507	367,349	$15,888,027
61	Educational services	5,088	245,237	$10,607,749	52	1278	$49,060	1,317	67,239	$2,857,414	6,457	313,754	$13,514,223
62	Health care and social assistance	35,561	900,647	$43,019,337	405	8252	$281,304	10,240	265,810	$12,193,272	46,206	1,174,709	$55,493,913
71	Arts, entertainment, and recreation	7,747	106,559	$5,329,965	127	1051	$30,385	1,597	23,820	$706,021	9,471	131,430	$6,066,371
72	Accommodation and food services	29,384	382,159	$9,807,812	470	4999	$101,874	8,039	128,681	$2,582,500	37,893	515,839	$12,492,186
81	Other services (except public administration)	35,377	238,321	$8,874,522	328	1632	$41,508	9,285	60,509	$1,821,118	44,990	300,462	$10,737,148
99	Industries not classified	684	770	$18,654	8	10	$142	134	175	$3,224	826	954	$22,020
	Total All Economic Sectors	**340,339**	**4,657,188**	**$324,860,136**	**3,754**	**40,362**	**$1,684,778**	**88,040**	**1,442,620**	**$82,130,924**	**432,133**	**6,140,170**	**$408,675,838**

Source: U.S. Census Bureau (2011a).
Note: D: Information withheld to avoid disclosure of data of individual companies.
NAICS: North American Industry Classification System.

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Housing

Housing within the study area demonstrates the area's urban character as well as its recreational and tourism opportunities. Table 4-62 presents the 2010 U.S. Bureau of Census housing count for the three states, both statewide and for the counties within the study area. The percentage of renter-occupied units within the counties (boroughs) of New York City — New York (Manhattan), Kings (Brooklyn), Queens (Queens), and Bronx (the Bronx) — suggest high urban land values and consequently high renter occupancy. Washington County in Rhode Island and Suffolk County in Long Island, New York, have high percentages of seasonal housing stock, illustrating these counties' recreational appeal.

Table 4-62. Housing by Occupancy and Recreational Use, 2010.

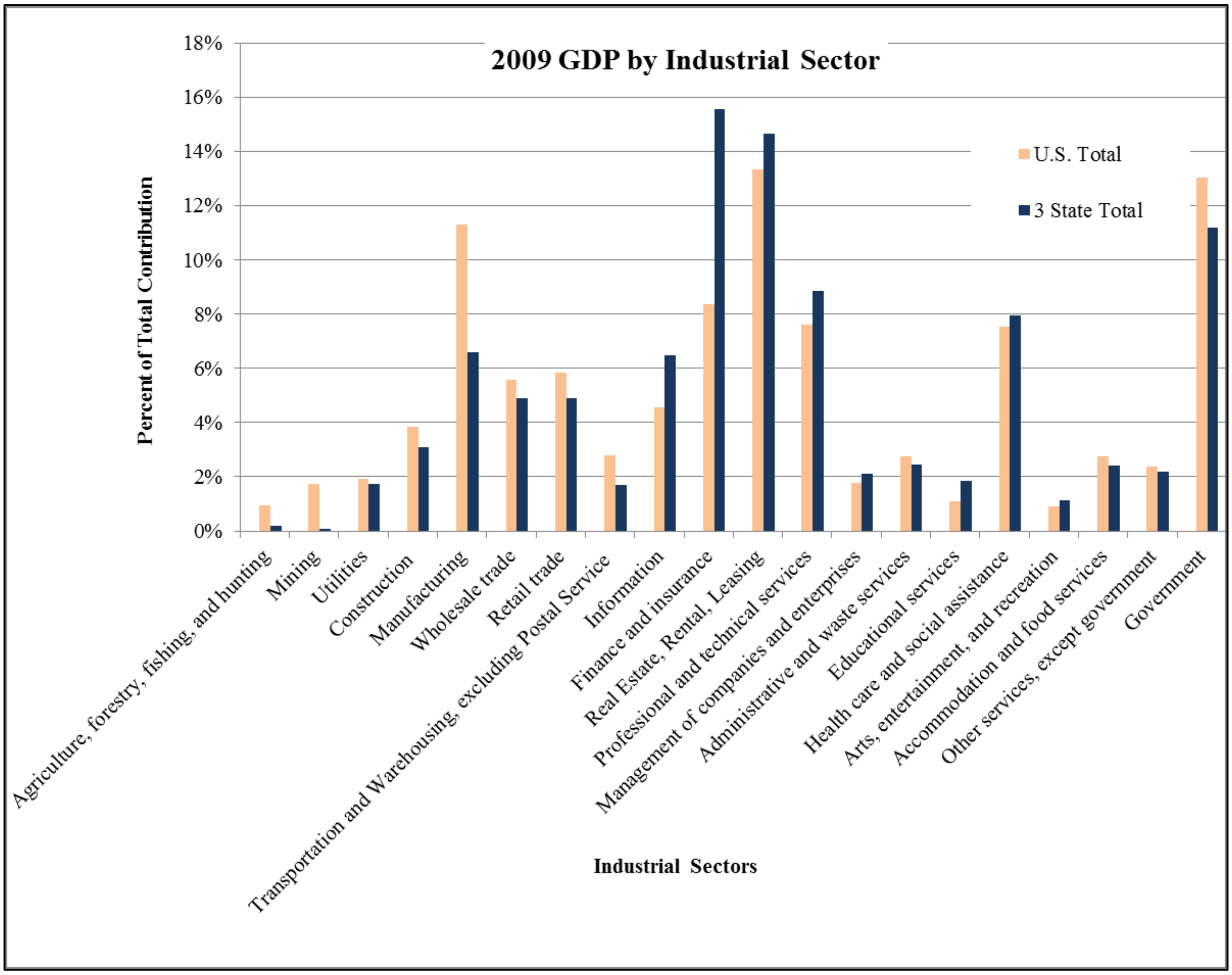
State	County	Total Housing Units	Percent Owner-Occupied	Percent Renter-Occupied	Percent Vacant	Percent of Total Units for Seasonal, Recreational, or Occasional Use
Connecticut		1,487,891	62.2%	30.0%	7.9%	2.0%
Counties	Fairfield County[a]	361,221	63.7%	29.2%	7.1%	1.5%
	New London County[a]	120,994	59.9%	28.5%	11.5%	4.8%
	Litchfield County	87,550	**66.8%**	20.8%	**12.5%**	6.6%
	Windham County	49,073	63.3%	28.0%	8.7%	2.2%
	Tolland County	57,963	**70.7%**	23.2%	6.0%	1.4%
	Hartford County	374,249	61.4%	32.3%	6.3%	0.6%
	Middlesex County[a]	74,837	**66.8%**	23.0%	10.2%	5.4%
	New Haven County[a]	362,004	58.6%	33.8%	7.6%	1.2%
New York		8,108,103	48.1%	42.2%	9.7%	3.6%
Counties	New York County	847,090	20.5%	**69.6%**	9.8%	3.3%
	Kings County	1,000,293	25.4%	**66.2%**	8.3%	0.4%
	Nassau County[a]	468,346	76.5%	19.3%	4.2%	0.9%
	Westchester County[a]	370,821	57.7%	36.0%	6.4%	0.9%
	Queens County[a]	835,127	40.2%	**53.2%**	6.6%	0.7%
	Suffolk County[a]	569,985	**69.0%**	18.7%	**12.3%**	**8.2%**
	Bronx County[a]	511,896	18.2%	**76.3%**	5.6%	0.2%
Rhode Island		463,388	54.2%	35.1%	10.7%	3.7%
County	Washington County[a]	62,206	57.9%	21.2%	**20.9%**	**16.0%**

Source: U.S. Census Bureau (2010).
[a] Adjacent to Long Island Sound
Note: Bolded cells show the top percentages in each category.

Regional Economy

Gross Domestic Product and Industrial Sectors

The three states in which the study area lies include the most vibrant economic center for commerce in the nation. The economies of the states of Connecticut, New York, and Rhode Island made up 10% of the total national gross domestic product (GDP) in 2009 by contributing $1.4 trillion to the national economy (U.S. Census Bureau, 2012). Figure 4-67 presents the composition of the regional GDP in comparison to the nation as a whole.



Source: U.S. Census Bureau (2012).

Figure 4-67. Percent Contribution to 2009 GDP by Industrial Sector: New York, Connecticut, and Rhode Island Compared with National Total.

Based on contribution to the states' GDP, industrial sectors in the three-state area that contribute most significantly to the regional economy are finance and insurance; real estate, rental and leasing; and government services. In contrast, the industrial sectors that contribute most significantly to the total national economy are manufacturing; real estate, rental and leasing; and government services (U.S. Census Bureau, 2012).

The GDP is derived from the compensation to employees, including wages, salaries, employee contributions to employee pensions and insurance and to government social insurance; plus taxes paid on products and imports; minus subsidies; plus gross operating surplus. The relationship between the national GDP and gross state product (GSP) is that the GSP is generally used to represent individual states' economic productivity and serves as the counterpart to the national GDP. Both the GDP and the GSP are highly technical estimates of economic productivity but with some differences. The GSP is derived as the sum of economic productivity originating in all industries in the state. The GSP is a value-added measure that is equivalent to the gross output minus intermediate inputs (Kort, 2005). However, the relationship between gross state products

(GSP) of individual states and the national gross domestic product (GDP) at the national level is not additive. Transaction leakages occur across state lines which are not necessarily captured in individual state's GSPs. Therefore, reporting agencies at the national level tend to express economic productivity in terms of GDP as their models incorporate some estimation of interstate transactions and other factors. In reality, each expression, GDP and GSP, are approximations of the economic productivity of the nation and state, respectively. Both serve to provide a relative comparison among states' economic productivity.

Table 4-63 shows the composition of the three states' economies within the study area. The economy of New York dominates the regional economy. Economic activity in New York generated $1.1 trillion in GDP in 2009; the economies of Connecticut and Rhode Island generated $220 billion and $48 billion, respectively. The finance and insurance industrial sector and the real estate industrial sector contribute most significantly to the regional economy and are the two largest sectors in the economies of the three states. Connecticut's manufacturing sector ranks third in contribution to that state's economy, while government services rank third in the economies of New York and Rhode Island (U.S. Census Bureau, 2012).

Table 4-63. Gross Domestic Product by State in the Long Island Sound Study Area.

Industrial Sectors	Connecticut		New York		Rhode Island	
	Billions	**Percent of Total**	**Billions**	**Percent of Total**	**Billions**	**Percent of Total**
All industries, total	$220.4	100.0%	$1,085.1	100.0%	$47.6	100.0%
Agriculture, forestry, fishing, and hunting	$0.3	0.2%	$1.9	0.2%	$0.1	0.2%
Mining	$0.0	0.0%	$0.9	0.1%	$0.0	0.1%
Utilities	$3.8	1.7%	$19.0	1.7%	$0.9	1.8%
Construction	$5.9	2.7%	$34.1	3.1%	$2.0	4.1%
Manufacturing	$26.2	**11.9%**	$58.8	5.4%	$4.0	8.4%
Wholesale trade	$11.4	5.2%	$52.6	4.9%	$2.3	4.9%
Retail trade	$11.1	5.0%	$52.8	4.9%	$2.5	5.3%
Transportation and warehousing, excluding U.S. Postal Service	$3.5	1.6%	$19.1	1.8%	$0.7	1.4%
Information	$8.3	3.8%	$77.6	7.1%	$1.9	4.1%
Finance and insurance	$36.2	**16.4%**	$168.5	**15.5%**	$5.7	**12.0%**
Real estate, rental, leasing	$33.1	**15.0%**	$158.0	**14.6%**	$7.2	**15.2%**
Professional and technical services	$16.5	7.5%	$100.7	9.3%	$2.7	5.7%
Management of companies and enterprises	$5.3	2.4%	$22.1	2.0%	$1.1	2.4%
Administrative and waste services	$5.3	2.4%	$26.5	2.4%	$1.1	2.4%
Educational services	$4.0	1.8%	$19.6	1.8%	$1.3	2.7%
Health care and social assistance	$17.6	8.0%	$85.2	7.9%	$4.8	10.1%
Arts, entertainment, and recreation	$1.7	0.8%	$13.1	1.2%	$0.4	0.8%
Accommodation and food services	$4.1	1.8%	$27.4	2.5%	$1.4	2.9%
Other services, except government	$4.5	2.0%	$23.8	2.2%	$1.1	2.3%
Government	$21.6	9.8%	$123.4	**11.4%**	$6.4	**13.3%**

Source: U.S. Census Bureau (2012).
Note: Bolded cells show the top three industrial sectors in each state for GDP generation.

Navigation-Dependent Economic Sectors, Revenue Generated, and Taxes Paid

The Woods Hole Group [(USACE, 2010b)] estimated the contribution of navigation-dependent economic activities within Long Island Sound by employing a proprietary input-output model (IMPLAN) whose expression of economic productivity is gross state product (GSP) and not GDP. This reference, [(USACE, 2010b)], served as the sole source for an approximation of navigation-dependent economic activity within Long Island Sound as well as an expression of economic impacts based on assumptions associated with the No Action Alternative. The input-output model was not employed to estimate differences across “With Project” Alternative actions.

Historically significant in its contribution to the overall development of the region, Long Island Sound provides open-water access to commercial navigation, commercial and recreational fishing, strategic military operations, and shore-side tourism (Latimer, et al., 2014). USACE (2010b) estimated the regional economic significance of Long Island Sound activities that are dependent upon the commercial opportunities afforded by the water body. This analysis estimated the economic importance of navigation-dependent activities in Long Island Sound utilizing input-output modeling that estimated annual direct, indirect, and induced effects of spending. The navigation-dependent economic activities evaluated were marine transportation (including commercial shipping, scenic water transportation, and ship-building activities), commercial fishing, recreational boating, ferry-dependent tourism, and activities associated with the U.S. Navy Submarine Base in New London, Connecticut.

The contribution of navigation-dependent activity to economic output in the study area is approximately $9.4 billion per year (Table 4-64). Navigation-dependent activity is estimated to contribute $5.5 billion per year to the region’s GSP, providing 55,720 jobs. In addition, navigation-dependent activity accounts for an estimated $1.6 billion per year in Federal and state tax revenues. The contribution of navigation-dependent activity to GSP within the Long Island Sound region represents approximately 0.93% of the study area’s overall contribution to GSP, or 0.38% of total 2007 GSP for Connecticut, New York, and Rhode Island (USACE, 2010b).

Table 4-64. Regional Economic Significance of Navigation-Dependent Activities (2009 Dollars).

Region	Annual Output[g] (millions of dollars)	GSP (millions of dollars)	Employment[h]	Annual Tax Revenue[i] (millions of dollars)
Rhode Island[a]	$71.3	$26.1	487	$7.6
Eastern Connecticut[b]	$4,278.4	$2,655.8	29,730	$688.4
Western Connecticut[c]	$1,951.7	$1,130.1	9,681	$336.3
New York mainland[d]	$126.5	$80.7	1,018	$25.7
Western Long Island[e]	$1,063.0	$564.5	4,557	$169.7
Eastern Long Island[f]	$1,397.6	$723.5	8,518	$224.9
Leakages outside study area	$493.4	$349.3	1,729	$139.6
All Long Island Sound	$9,381.9	$5,530.0	55,720	$1,592.2

Source: USACE (2010b).

[a] Washington County

[b] Hartford, Middlesex, and New London Counties

[c] Fairfield and New Haven Counties

[d] Westchester and Bronx Counties

[e] Kings, Queens, and Nassau Counties

[f] Suffolk County

[g] Includes direct, indirect, and induced effects

[h] Includes full, part-time, temporary, and intermittent employment

[i] Includes all payments to government and represents the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

Marine transportation provided the largest relative contribution to GSP, accounting for 59% of the total for all navigation-dependent activities analyzed (Table 4-65). Recreational boating accounted for an additional 22%, while the submarine base accounted for 17%. Commercial fishing and ferry-dependent tourism each accounted for approximately 1% of the contribution of navigation-dependent activities to GSP (USACE, 2010b).

Table 4-65. Relative Contribution of Navigation-Dependent Activities to GSP in the Long Island Sound Study Area, 2009.

Navigation-Dependent Activity	Relative Contribution to GSP
Marine transportation	59%
Commercial fisheries	1%
Ferry-dependent tourism	1%
Recreational boating	22%
Submarine base	17%

Source: USACE (2010b).

Transportation Infrastructure

Ports

There are nearly 400 identified ports within the study area (Table 4-66): 35 in Washington County, Rhode Island; 219 ports in the New York counties within the study area; and 143 ports within Connecticut (ACCSP, 2014a).

Table 4-66. Number of Ports Within the Long Island Sound Study Area by County.

State	County	Ports
Connecticut	Within study area	143
Counties	Fairfield	31
	Hartford	6
	Middlesex	24
	New Haven	32
	New London	50
New York	Within study area	219
Counties	Bronx	7
	Kings	11
	Nassau	30
	New York	3
	Queens	20
	Suffolk	127
	Westchester	21
Rhode Island	Washington	35

Source: ACCSP (2014a)

Roads and Highways

The study area is highly developed with a complex roadway system of 3,300 mi of Interstate, U.S., and State Highways (Table 4-67; Figure 4-68). Interstate Highway 95 follows the northern shore of Long Island Sound from Bronx and Westchester Counties of New York, throughout Connecticut and continuing into Rhode Island. Interstate Highway 495 and State Highways 25 and 27 run the length of Long Island and form the principal highways through Nassau and Suffolk Counties on Long Island (UConn (2014); USACE (2014c); RIGIS (2014e)).

Bridges

Two bridges traverse Long Island Sound on the western end of the water body (Figure 4-68). The bridges connect New York City boroughs and run from Throgs Neck, Bronx, to Whitestone, Queens. The Throgs Neck Bridge is on Interstate Highway 295, and the Whitestone Bridge is on Interstate Highway 678.

Commuter Rail Lines

Commuter lines are a reflection of the study area’s population density and degree of urbanization (Figure 4-68). Commuter rail lines operated by the Metropolitan Transit Authority run throughout the study area, with connection to New York City’s Penn Station or Grand Central Station. Along the north shore of the study area, the New Haven Line provides commuter rail transport from New Haven, Connecticut, and points along New Haven and Fairfield Counties to New York City. The Harlem Line and the Hudson Line provide commuter rail transport from New York City to points north in Westchester County and beyond (UConn, 2014). Amtrak serves the study area with stations noted on Figure 4-68.

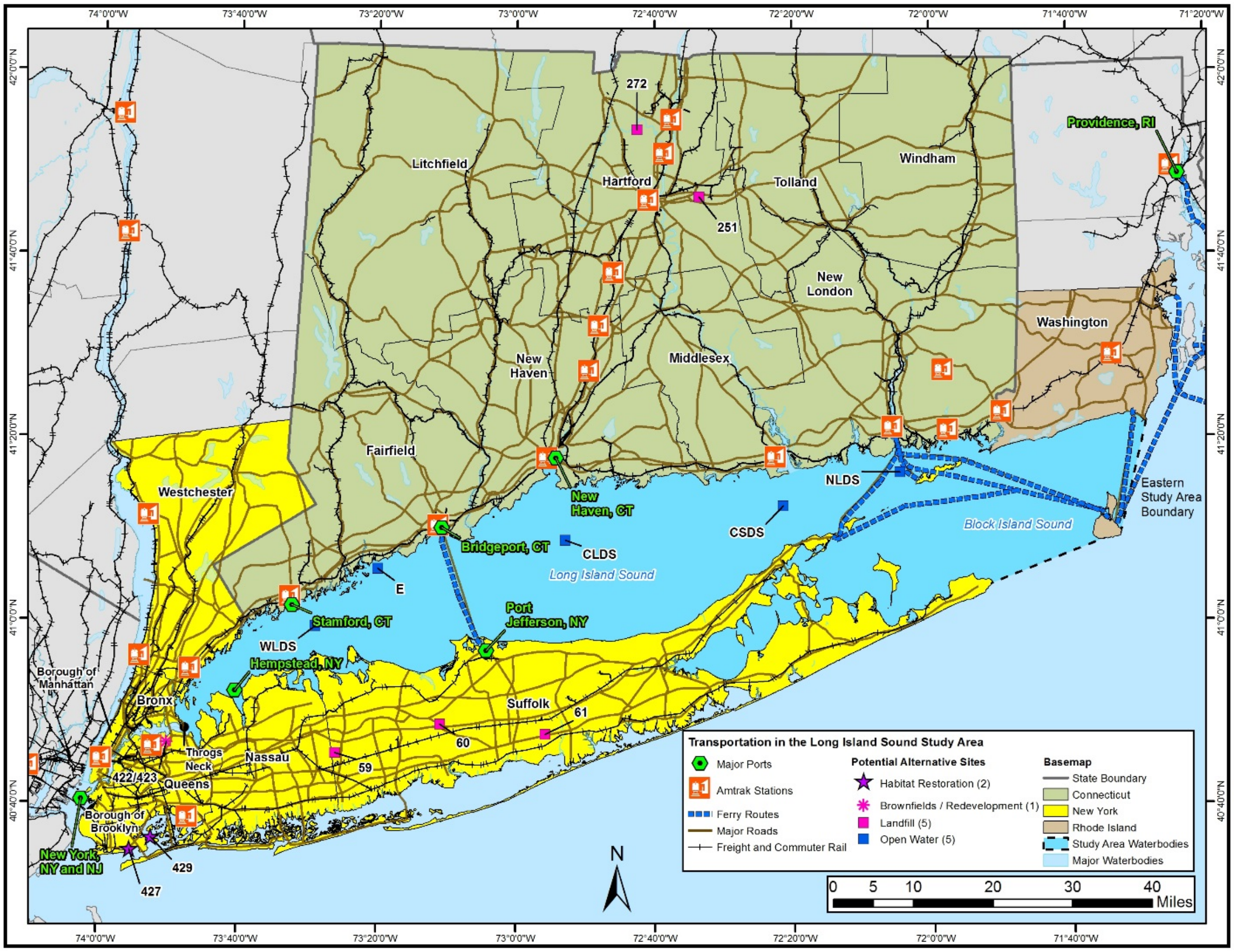
The Long Island Rail Road runs commuter lines from Brooklyn and Penn Station in Manhattan to termini at Port Washington, Oyster Bay, Port Jefferson, Greenport, Montauk, Long Beach, and Far Rockaway (NYSDEC, 2014g).

In Rhode Island, the Amtrak Shoreline Rail transports commuters to and through Washington County (RIGIS, 2014e).

Table 4-67. Miles of Major Roads by County in the Long Island Sound Study Area.

State	County	Major Roads Length (mi)
Connecticut[a]	Fairfield County	262
	Hartford County	360
	Litchfield County	226
	Middlesex County	130
	New Haven County	342
	New London County	256
	Tolland County	157
	Windham County	149
New York[b]	Bronx County	58
	Kings County	48
	Nassau County	203
	New York County	40
	Queens County	115
	Suffolk County	488
	Westchester County	296
Rhode Island[c]	Washington County	171

Sources: [a]UConn (2014): [b]USACE (2014c); [c]RIGIS (2014e).



Sources: USACE (2014c), USACE (2014d), UConn (2014); RIGIS (2014e), USDOT (2014a) USDOT (2014b).

Figure 4-68. Transportation Infrastructure, Long Island Sound Study Area.

Freight Rail Lines

New York City and Long Island – From the start of railroading in America through the first half of the twentieth century, New York City and Long Island were major areas for rail freight transportation, but their location, across the Hudson River from northeastern New Jersey (and from most of the United States), presented a formidable barrier to rail transportation. As of late 2013, most rail freight to New York City moves over lines on the west side of the Hudson River and is unloaded in New Jersey, where it is brought by truck to the city. Increasingly over time, freight lines within the study area must share track with commuter lines (Paaswell & Eickemeyer, 2011).

Railroad freight cars that enter the study area in New York City or Long Island do so via the following routes:

1. Via the Bronx. The main land rail connection to New York City and Long Island from the national rail network is from tracks on the east bank of the Hudson River. CSX freight trains from the west cross the Hudson River 140 mi to the north at Selkirk, New York, a

regional hub for freight rail directly connected to the national rail network. Trains from all across the country are routed directly to Selkirk. From there south to Poughkeepsie, the two-track line, known as the Hudson Subdivision, is owned by CSX but is leased to Amtrak. Amtrak runs 28 trains a day on this segment (RailwayAge, 2012). South of Poughkeepsie, the Hudson Line widens. This section is owned by Metro North Commuter Railroad. CSX runs four freight trains a day on this line, with an average of 75 cars per train. In the Bronx, the Hudson line connects with the Oak Point Link, which serves the Harlem River Intermodal Yard and the Oak Point Yard, the latter being the largest rail yard in New York City or Long Island. Freight trains to Long Island move from the yard over the Hell Gate Bridge to the New York and Atlantic Railway yard at Fresh Pond Junction in Queens. The Oak Point Yard, which directly serves local industry and the Hunts Point Market and also connects to Amtrak's Northeast Corridor line to Boston, is occasionally used by the Providence and Worcester Railroad to haul crushed stone to Long Island. As part of the agreement to create the Oak Point Link, The Canadian Pacific Railway was granted trackage rights over the Hudson Line and the link, but it is currently allowing CSX to haul its traffic in exchange for hauling CSX traffic on another route (New York Times, 2012).

2. By car float barge through Brooklyn: The sole remaining car float operation in the area, New York New Jersey Rail, LLC, carries railroad cars from the Greenville Yard in Jersey City to Brooklyn, where cars either go to local customers or are picked up by the New York and Atlantic Railway and moved over the Bay Ridge Branch to Fresh Pond Junction. The New York and Atlantic Railway is a short line railroad formed in 1997 to provide freight service over the tracks of the Long Island Rail Road, a public commuter rail agency which had decided to privatize its freight operations (Anacostia Rail Holdings, 2014).

Connecticut – There are 10 privately owned freight railroad companies operating in Connecticut. These companies own most of the rail freight infrastructure in the state and all of the rail freight equipment operating within the state. There are over 628 mi of freight railroad right-of-way in the state consisting of public and privately owned property. All of these freight railroads are connected to the national rail network. CSX Transportation handles the vast majority of long-haul rail freight traffic into and out of Connecticut. It has developed and expanded a freight hub at a large rail yard in Selkirk, New York. From Selkirk, large blocks of railcars are sent to direct connections with Connecticut short line and regional railroads (CTDOT, 2012).

Significant tonnage is moved each year by the freight railroads that serve Connecticut. The major categories of freight rail traffic terminating in Connecticut include crushed stone, gravel and sand; primary metal products; grain and food products; lumber and wood products; pulp and paper products; chemicals; and petroleum and coal products. The major categories of freight rail traffic originating in the state include scrap metal and paper; crushed stone, gravel, and sand; concrete and clay products; pulp and paper products; and chemicals. Rail freight tonnage by carrier is presented in Table 4-68 (CTDOT, 2012).

Rhode Island – The amount of active railroad track and the number of rail lines in Rhode Island have declined over time. However, 13 rail lines in the state are considered active. The main rail freight corridor is the Northeast Corridor, which runs through Washington County and is owned by Amtrak. Amtrak owns the majority of the rail track mileage in the state (about 52 mi); the Rhode Island Department of Transportation owns the second longest amount (about 25 mi), with the remaining track ownership (about 28 mi) split between railroads, cities, and towns (RISPP, 2006).

Table 4-68. 2010 Connecticut Rail Freight Tonnage, All Carriers.

Freight Carrier	2010
Pan Am Southern Railway (estimate)	223,860
Providence & Worcester RR	2,005,000
CSX Transportation	810,000
Central New England RR	162,000
Connecticut Southern Railroad Co.	1,710,000
Housatonic RR	339,240
New England Central RR	980,000
Tilcon/BSRR (estimate 2009/2010)	1,300,000
Total	7,530,100

Source: CTDOT (2012).
Note: Naugatuck RR currently hauling less than 10,000 tons/year. Valley RR currently hauls for internal use only.

The Providence and Worcester Railroad Company is a regional freight railroad operating in Massachusetts, Rhode Island, Connecticut, and New York. The company transports a wide variety of commodities, including construction aggregate, iron and steel products, lumber, coal, chemicals, scrap metals, plastic resins, cement, and food and beverage products (RISPP, 2006).

Within Washington County, the Seaview Transportation Company is the sole rail operator at the Quonset Business Park, the former Quonset Point/Davisville naval base. It operates on the track the Navy installed as part of the base. Forest products and plastic components account for the bulk of movements (RISPP, 2006).

Ferries

Ferries offer cross-Long Island Sound transportation to commuters, tourists, commercial vehicles, and automobiles. Ferry operators provide access to the destinations shown in Table 4-69 and Figure 4-68.

Coastal Infrastructure

Coastal Structures

Coastal structures such as groins, breakwaters, jetties, bulkheads, and other armoring structures along the Long Island Sound shoreline were identified using Google Earth mapping (USACE, 2012a). This method was also used to determine the proximity of alternative sites to coastal structures.

Table 4-69. Ferry Routes Crossing Long Island Sound.

Bi-Directional Destinations	
From/To	**From/To**
Block Island	Newport, RI
Bridgeport, CT	Port Jefferson, NY
Greenport	Block Island
Montauk, NY	Block Island
Montauk, NY	New London, CT
New London, CT	Block Island
New London, CT	Fisher's Island
New London, CT	Orient Point, NY
Shelter Island, NY	Greenport/North Fork Long Island
Shelter Island, NY	North Haven NY
Shelter Island, NY	South Fork, Long Island

Source: LongIsland.com (2014).

Cable/Power/Utility Crossings

USACE identified submerged cable areas and pipelines in Long Island Sound through information obtained from NOAA's National Ocean Service Coastal Services Center and from the CTDEEP GIS data website. CTDEEP identified locations of submerged cable and pipeline areas off the Connecticut coast, including electrical transmission lines, telephone and fiber optic cables, and natural gas and petroleum pipelines (USACE, 2012a).

A submerged telephone cable runs the length of Long Island Sound from Huntington, New York, to the open waters of the Atlantic Ocean (Figure 4-69 thru Figure 4-71). A power cable traverses the Sound running from New Haven, Connecticut, to Brookhaven, New York (Figure 4-69 and Figure 4-70). Six submerged cables originate at South Kingstown, Rhode Island, and run south to the open waters of the Atlantic Ocean (Northeast Ocean Data, 2014a) (Figure 4-71).

The EPA (2004) identified pipelines, electrical wires, and submerged cables, all of which supply Long Island, New York, with power and communication needs. These are reported as follows:

- A major cable extends from New Rochelle, New York, southeastward to Port Washington on Long Island, New York (greater than 11 nmi west of the WLDS);
- A set of seven cables crosses Long Island Sound southward from Norwalk, Connecticut, to Northport, New York (approximately 4 nmi east of the WLDS);
- Terminating in Northport, New York, is the Iroquois pipeline, which extends past the Bridgeport alternative (less than 2 nmi south) northeastward past the Milford alternative (less than 1 nmi north) to Milford, Connecticut;
- The Cross Sound Cable connects New Haven, Connecticut, and Shoreham, New York;
- There are several telecommunication cables, including the Trans-Atlantic cable that heads eastward through Long Island Sound before heading toward the Atlantic Ocean (approximately 6 nmi south of the CLDS);
- From New Haven and Guilford, Connecticut, several cables head southward toward Port Jefferson and Shoreham, New York. One cable passes to the north of

the CLDS, approximately 1 nmi from the northwest corner of the site (EPA, 2004).

Anchorage Areas

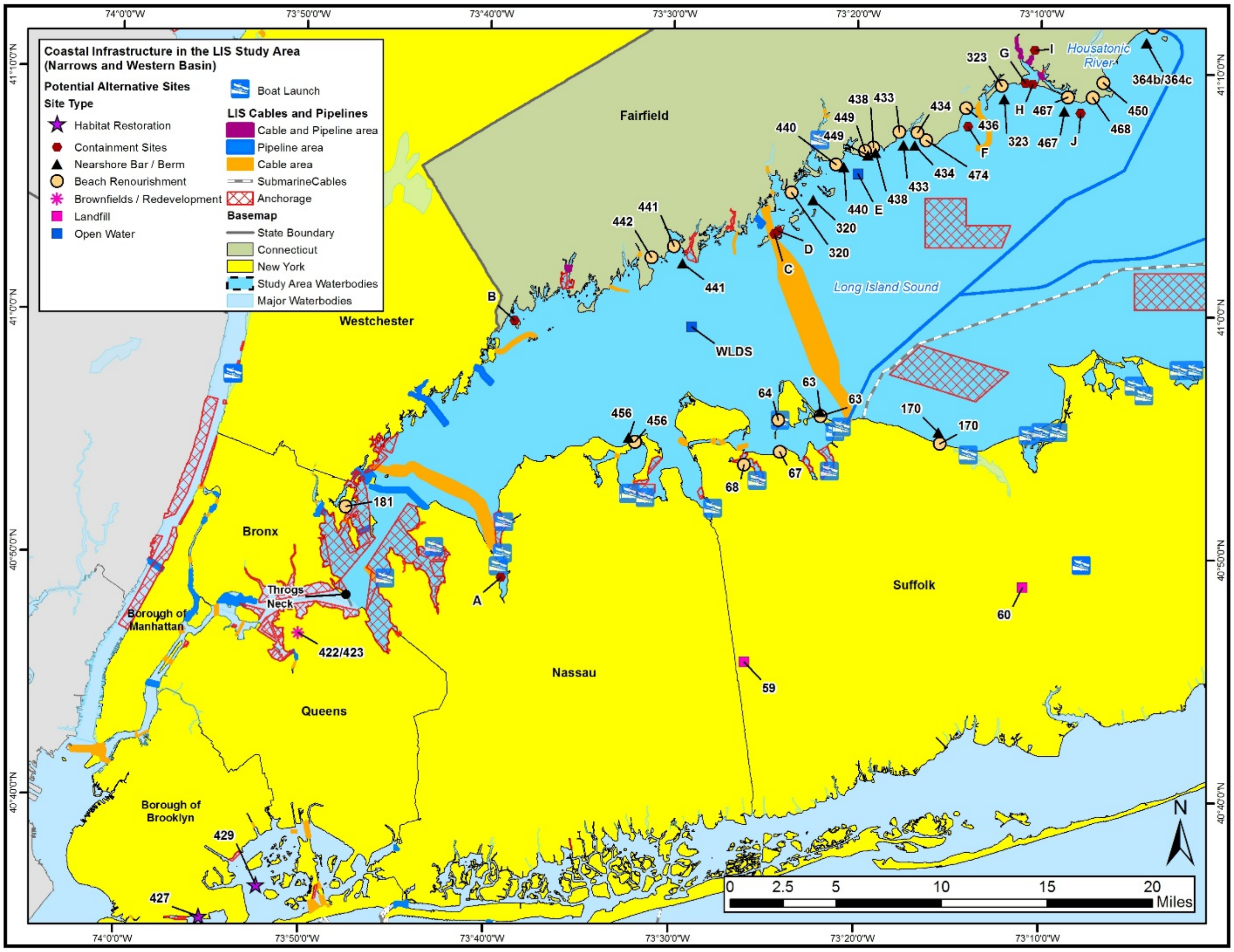
USACE accessed data on mooring areas from the U.S. Coast Guard's "Anchorage Areas" database and downloaded the data from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data files (Northeast Ocean Data, 2014a). Anchorage areas are scattered throughout Long Island Sound in harbors and open water (Figure 4-69 thru Figure 4-71). Anchorages are concentrated within the westernmost portion of the Sound near Throgs Neck; in the harbors at Oyster Bay and Huntington, New York; and in the open waters off Northport, Bridgeport, Port Jefferson, New London, Riverhead, and North Haven. Anchorage areas are also located in Narragansett Bay, Rhode Island.

Boat Launches

Connecticut has 118 boat launches that are located primarily in the interior of the state (Figure 4-69 thru Figure 4-71). Of those, 27 boat launches require car top/carry-in, and 90 launches accommodate trailered craft launches. One launch can accommodate either car top/carry-in or trailered watercraft (Northeast Ocean Data, 2014b).

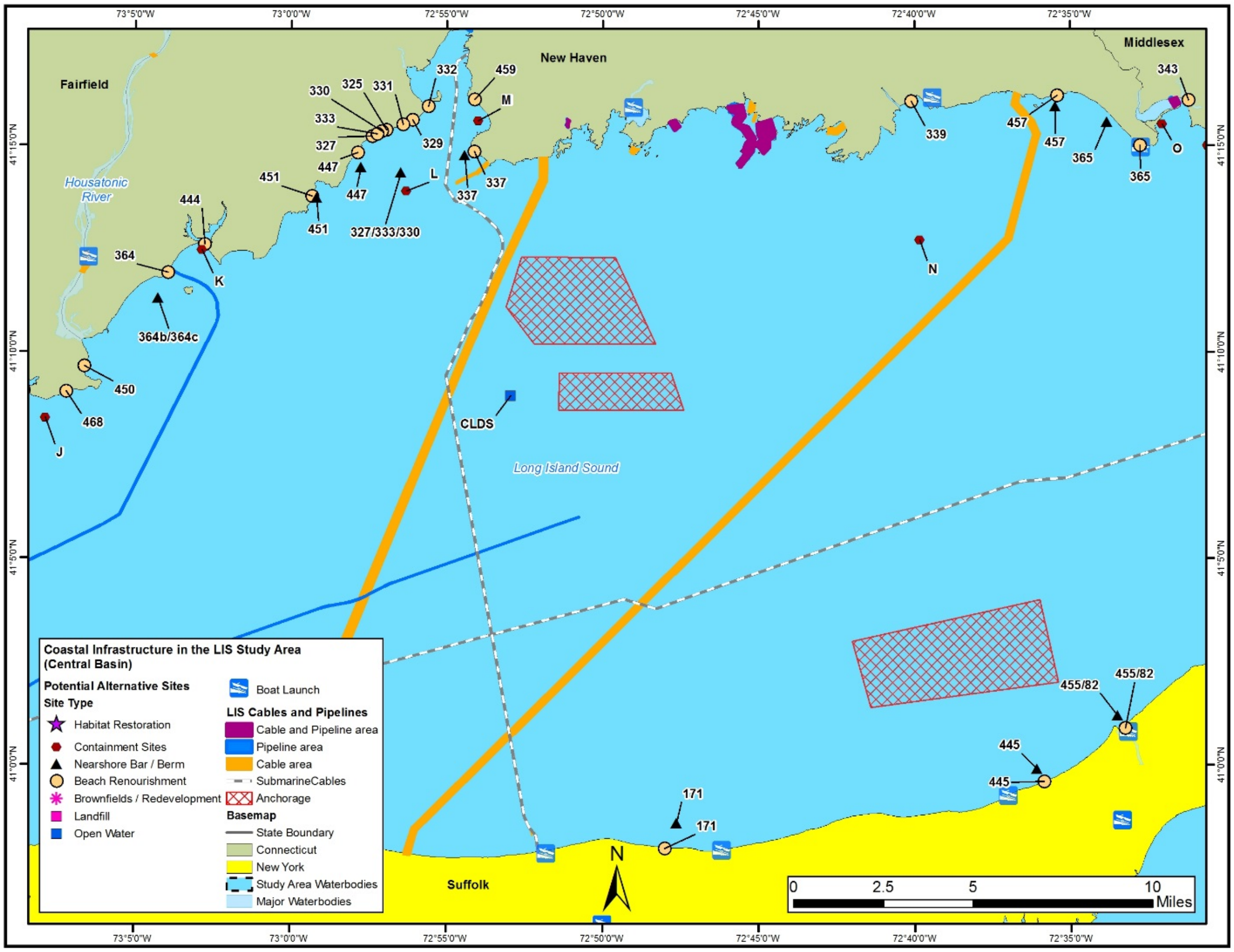
New York State boat launches in the study area are primarily inland on rivers and ponds (Figure 4-69 and Figure 4-70). Eighteen boat launches are located in Suffolk County, and one is located in Westchester County in the study area (NYSDEC, 2014h).

Rhode Island boat launches are inventoried at the state's GIS portal and include recreational boat launching ramp and marine pump-out facilities accessible to the public within the state (RIGIS, 2014e) (Figure 4-71).



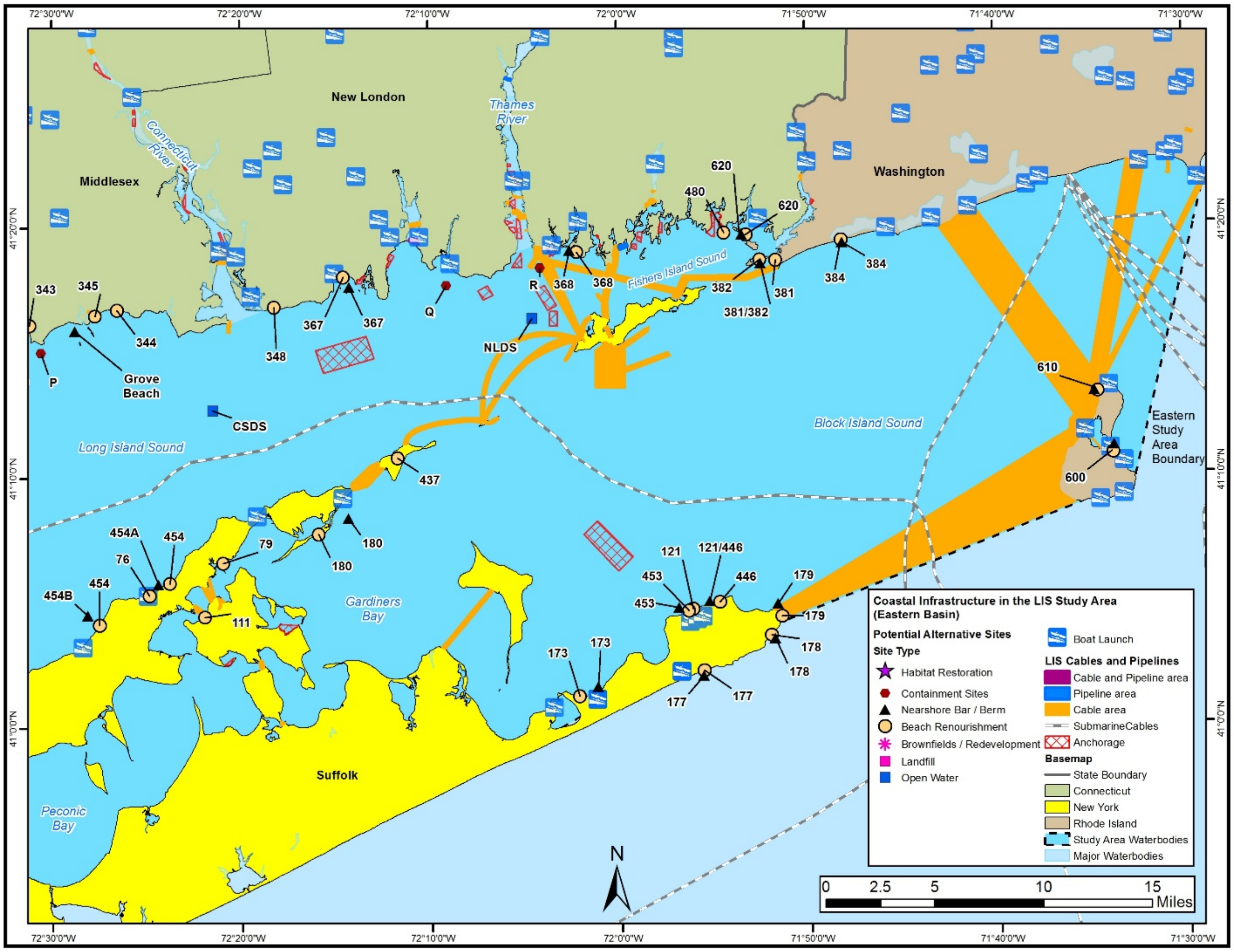
Sources: UConn (2014), NYSDEC (2014h), RIGIS (2014e), Northeast Ocean Data (2014a).

Figure 4-69. Coastal Infrastructure, Western Long Island Sound Study Area.



Sources: UConn (2014), NYSDEC (2014h), RIGIS (2014e), Northeast Ocean Data (2014a).

Figure 4-70. Coastal Infrastructure, Central Long Island Sound Study Area.



Sources: UConn (2014), NYSDEC (2014h), RIGIS (2014e), Northeast Ocean Data (2014a).

Figure 4-71. Coastal Infrastructure, Eastern Long Island Sound Study Area.

Commercial Fisheries

Commercial fisheries of Long Island Sound are valuable resources to the states of Connecticut, New York, and Rhode Island. The Atlantic Coastal Cooperative Statistics Program reports commercial fisheries catch by county to NOAA's NMFS. The 2012 commercial catch statistics (live pounds and dollar values) for the three states, both statewide and by county within the study area, are shown in Table 4-70.

Commercial fishing relies heavily on upland facilities to create a link between fish harvesting and wholesale and retail markets. Commercial fishermen purchase fuel, ice, bait, insurance, and other products and services from local businesses, and strong social networks involve relationships between fishermen, crews, fish buyers, processors, and vessel service suppliers, among others (EPA and USACE, 2004).

Table 4-70. Commercial Catch Statewide and by County, 2012.

State	County	2012	
		Live Pounds	Ex-Vessel Value
New York		29,970,631	$39,076,837
Counties	Bronx	4,783	$2,970
	Kings	52,565	$60,274
	Nassau	2,163,146	$3,152,221
	New York	5,449	$26,368
	Queens	2,133	$5,083
	Suffolk	26,892,905	$33,800,657
	Westchester	571	$698
Connecticut		8,673,000	$20,608,314
Counties	Fairfield	not reported	not reported
	Hartford	not reported	not reported
	Middlesex	not reported	not reported
	New Haven	27,538	$124,823
	New London	8,074,600	$19,027,839
Rhode Island		83,229,009	$80,710,963
County	Washington	69,856,431	$57,617,930

Source: ACCSP (2014b)

Commercially Important Species: Finfish and Shellfish

Commercial fishing in Long Island Sound targets both finfish and shellfish, including bivalves and American lobster (Figure 4-72 thru Figure 4-74). For 2012, the NMFS reported the following statistics for commercially harvested finfish and invertebrate species (NOAA, 2014e):

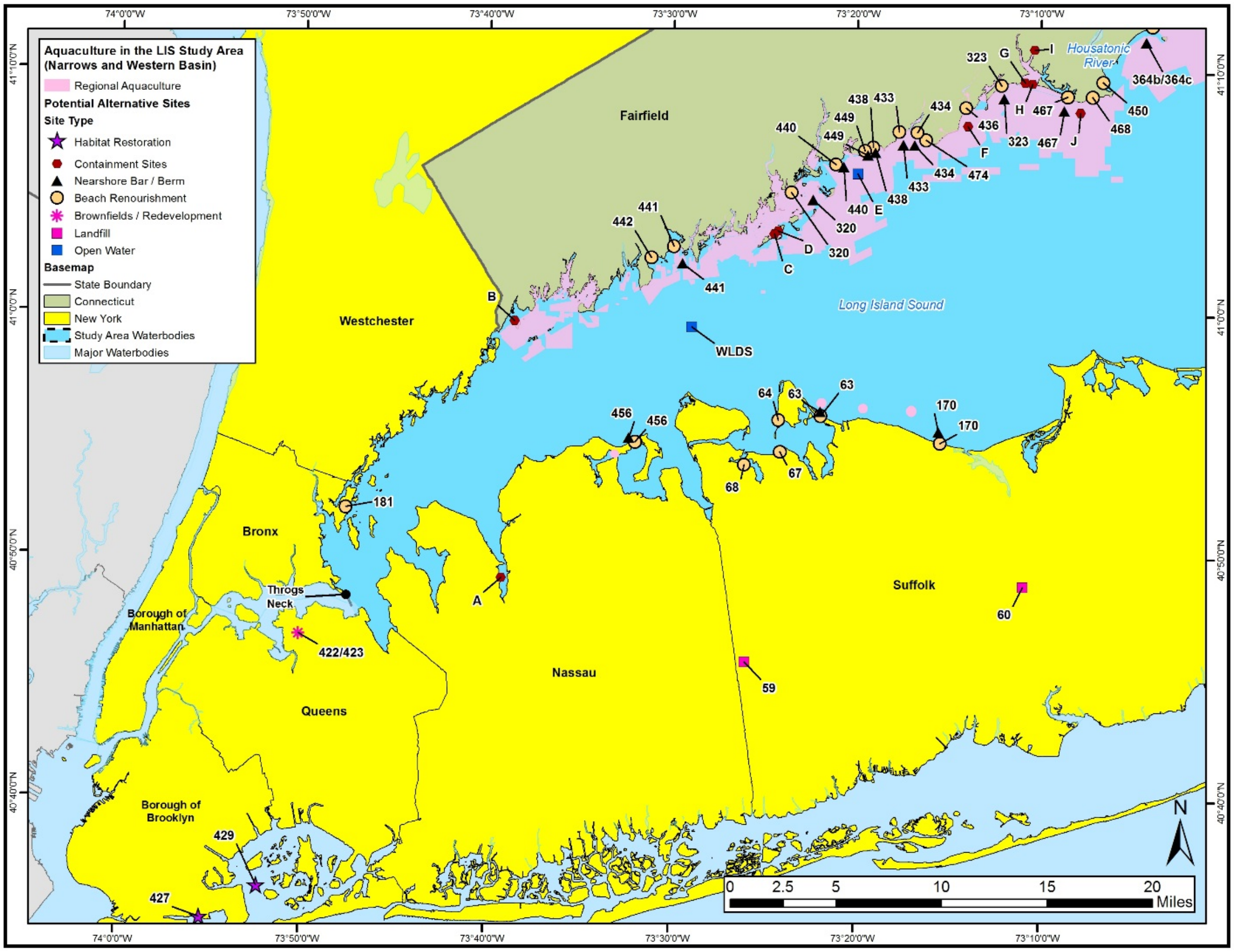
- Rhode Island: 56 distinct finfish species and 18 invertebrate species
- New York: 102 finfish species and 24 invertebrate species
- Connecticut: 60 finfish and 15 invertebrate species

Landings and Ex-Vessel Values for Commercially Important Species

Table 4-71 presents the most prolific finfish and invertebrate harvests by weight and value within the three states surrounding Long Island Sound. By weight, longfin squid, Atlantic herring, scup, and Northern shortfin squid rank in order as the largest catches within the tri-state area. By ex-vessel value, sea scallops rank highest, followed by longfin squid, American lobster, and summer flounder in the tri-state area (NOAA, 2014e).

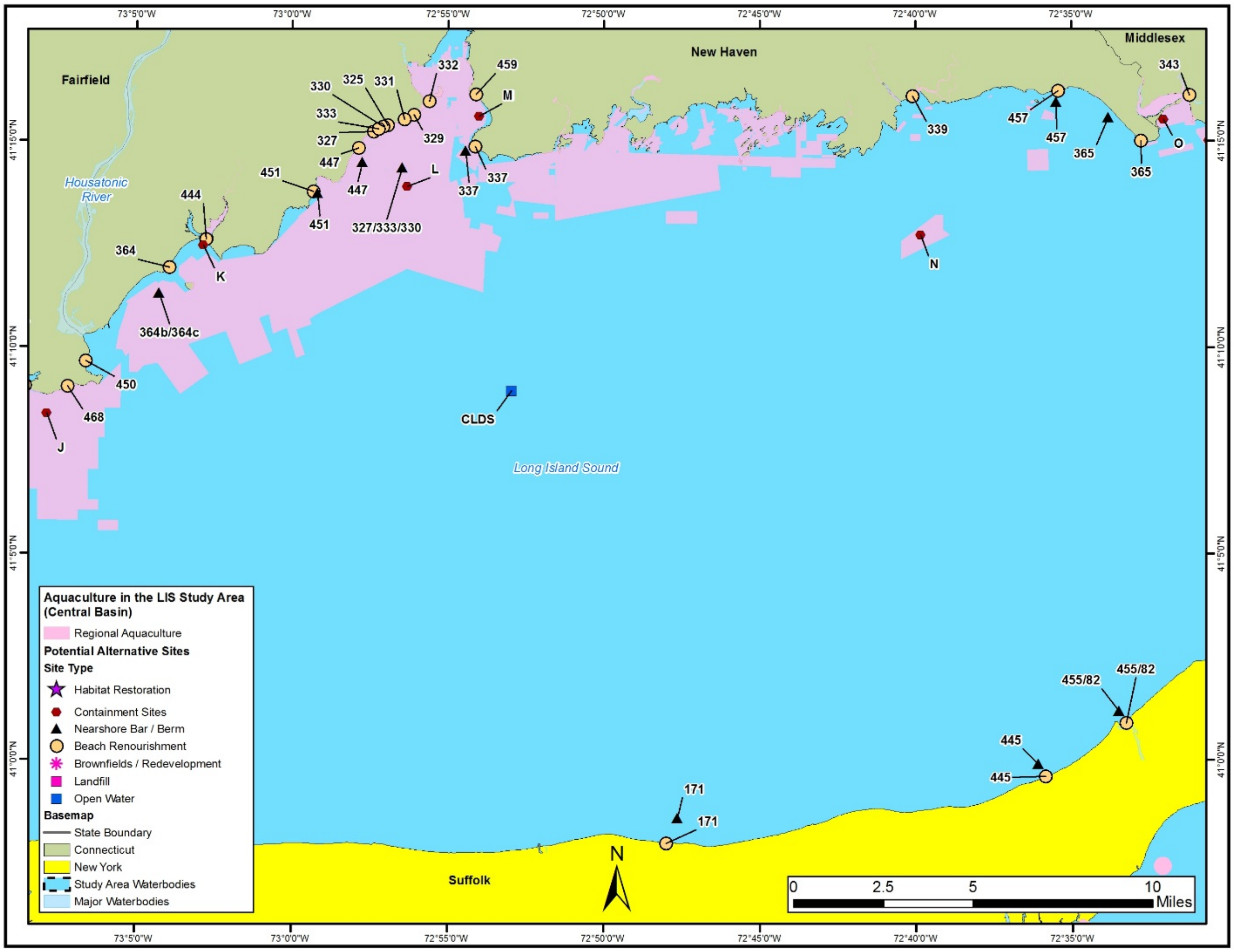
Aquaculture

Marine aquaculture is an important economic contributor to the regional commercial fisheries for shellfish, including oysters, clams, mussels, and scallops. Aquaculture takes place in beds off the coasts of New York, Connecticut, and Rhode Island and in all of the coastal lagoons (i.e., salt ponds) within the study area (Figure 4-72 thru Figure 4-74). Table 4-72 lists the active aquaculture grounds in 2009 that lie within the study area (Northeast Ocean Data, 2014a).



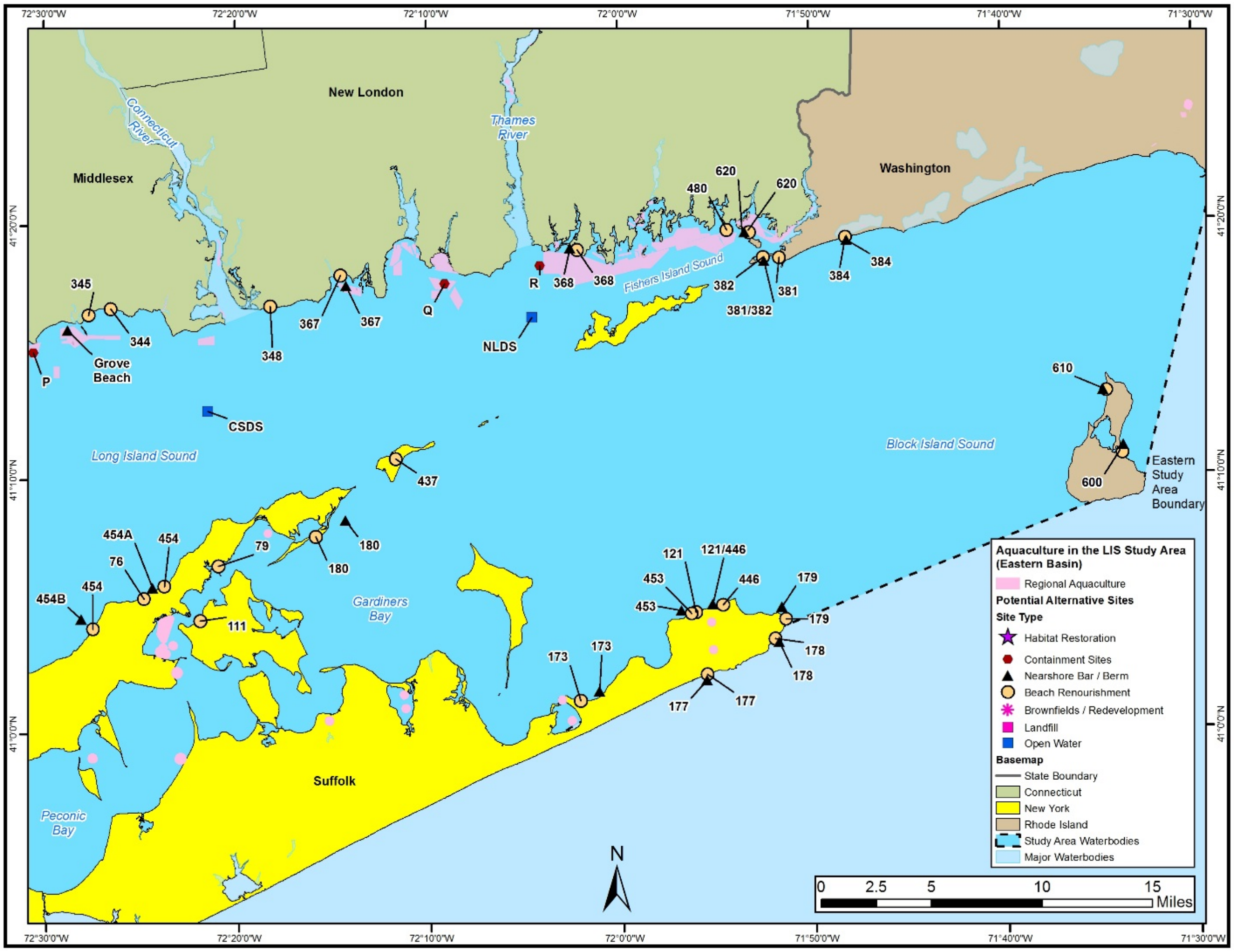
Source: Northeast Ocean Data (2014a).

Figure 4-72. Aquaculture Sites, Western Long Island Sound Study Area.



Source: Northeast Ocean Data (2014a).

Figure 4-73. Aquaculture Sites, Central Long Island Sound Study Area.



Source: Northeast Ocean Data (2014a).
Note: There are several aquaculture operations located in all of the coastal lagoons (i.e.: salt ponds) within the study area.

Figure 4-74. Aquaculture Sites, Eastern Long Island Sound Study Area.

Table 4-71. Largest Annual Fish Harvest or Highest Grossing Species by State, 2012.

	Rhode Island			**New York**			**Connecticut**		
Species[a]	**Pounds**	**Ex-Vessel Value**[b]	**Price/Pound**[b]	**Pounds**	**Ex-Vessel Value**[b]	**Price/Pound**[b]	**Pounds**	**Ex-Vessel Value**[b]	**Price/Pound**[b]
Finfish									
Bass, Striped	239,945	$1,014,282	$4.23	683,951	$1,689,389	$2.47			
Flounder, Summer	2,409,371	$6,936,669	$2.88	1,237,126	$3,651,989	$2.95			
Goosefish	2,872,556	$3,844,486	$1.34	1,854,537	$2,716,828	$1.46	715,768	$1,000,447	$1.40
Hake, Silver	2,481,765	$1,438,201	$0.58	2,819,209	$2,247,619	$0.80	1,816,434	$1,361,035	$0.75
Herring, Atlantic	11,967,930	$1,986,894	$0.17						
Mackerel, Atlantic	5,467,000	$2,798,187	$0.51						
Scup	6,309,321	$3,904,147	$0.62	4,306,621	$3,536,145	$0.82			
Shark, Spiny Dogfish	1,351,254	$247,236	$0.18						
Skate, Little	8,844,254	$909,259	$0.10						
Skates	5,382,186	$1,295,618	$0.24				1,158,924	$419,670	$0.36
Tilefish				1,411,798	$4,256,867	$3.02			
All Other	3,501,502	$3,978,604			$5,589,498		1,956,707	$2,359,980	
Subtotal Finfish	**50,827,084**	**$28,353,583**		Note c	$23,688,335		5,647,833	$5,141,132	
Invertebrates									
Clam, Northern Quahog	902,919	$5,168,971	$5.72						
Crab, Jonah	3,282,175	$2,293,936	$0.70						
Lobster, American	2,688,712	$12,032,647	$4.48				241,322	$1,025,850	$4.25
Oyster, Eastern	121,879	$2,883,259	$23.66						
Scallop, Sea	944,264	$9,190,816	$9.73	429,878	$4,082,963	$9.50	1,230,197	$11,995,710	$9.75
Squid, Longfin	11,688,294	$12,743,264	$1.09	7,838,113	$8,647,680	$1.10	1,375,939	$1,713,257	$1.25
Squid, Northern Shortfin	11,829,515	$5,939,000	$0.50						
Whelk, Channeled	206,163	$1,303,309	$6.32						
All Other	798,710	878,174			$2,889,419		177,709	$732,437	
Subtotal Invertebrates	**32,462,631**	**$52,433,376**		Note c	**$15,620,062**		**3,025,167**	**$15,467,254**	
Total Catch, 2012	**83,289,715**	**$80,786,959**		**30,127,205**	**$39,308,397**		**8,673,000**	**$20,608,386**	

Source: NOAA (2014e).

[a] Species whose weight exceeds 1 million lbs or value exceeds $1 million are listed individually; [b] In 2012 dollars; [c] Data not released.

Table 4-72. Aquaculture Sites Located within the Long Island Sound Study Area .

Connecticut Locations	No. of Sites
Baker Cove	1
Beattie Pond	1
Beebe Cove	1
Branford	6
Branford	17
Branford Harbor	17
Branford River	6
Bridgeport	18
Captain Harbor	28
Clinton Harbor	14
Cockenoe Harbor	63
Cove Harbor	13
Darien	8
Duck Island Roads	5
East River	1
Fairfield	11
Farm River Gut	1
Fence Creek	1
Fish Island	1
Fishers Island Sound	37
Greenwich	4
Greenwich Point	7
Guilford Harbor	5
Hammonasset State Park	1
Indian Neck	22
Johnsons Point	3
Jordan Cove	7
Kelsey Island	2
Little Narragansett Bay	7
Long Island Sound	508
Madison	6
Madison and Clinton	1
Madison and Guilford	1
Menunketsuck River	6
Milford	1
Mystic Harbor	1
Neck River	2
New Haven Harbor	144
Niantic River	7
Norwalk	8
Norwalk Harbor	120
Old Saybrook	4
Palmer Cove	3
Patchogue River	2
Pawcatuck River	4
Quinnipiac River	5
Rocky Neck State Park	1
Sheffield Island Harbor	150
Sherwood Millpond	43
Sixpenny Island	3
Southport	5
Stamford Harbor	7
Stratford	2
Thimble Islands	184
Uncas Point	14
West Haven	3
West River	1
Westcott Cove	4
Westport	4
Rhode Island Locations (Washington County)	**No. of Sites**
Block Island	3
Bristol	0
Jamestown	0
Middletown	0
Ninigret Pond	10
Potters Pond	1
Quonset	1
Rocky Point	0
Sakonnet River	0
Wickford	3
Wickford Harbor	1
Winnapaug Pond	1
New York Locations	**No. of Sites**
NA[a]	NA[a]

Source: Northeast Ocean Data (2014a).

[a] Equivalent sites not available for New York portion of study area.

Fishing Grounds

Shellfishing occurs in open-water and aquaculture environments (Figure 4-72 through Figure 4-74). Fin fishing also takes place throughout Long Island Sound, although trawl fishing exists only at three central Long Island Sound locations because of the density of lobster pots throughout the Sound (Figure 4-72) (EPA, 2004).

Fishing Communities

Various Federal statutes and orders, including the Magnuson-Stevens Act (Public Law 94-265, as amended), NEPA (42 U.S.C. 4321 et seq.), and EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), among others, require agencies to examine the social and economic impacts of policies and regulations at the community level. To meet these mandates, NOAA's NMFS initiated a national effort to create and maintain a series of regional fishing community profiles. Community profiles are needed in preparing the section of an EIS covering National Standard 8 of the Magnuson-Stevens Act. National Standard 8 requires that conservation and management measures "shall take into account the importance of fishery resources to fishing communities by utilizing economic and social data … to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities" (Fishery Conservation and Management Act of 1976).

In the reauthorized Magnuson-Stevens Act in 1996, the following specific language was included to define the term "fishing community":

> "…a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community" (Fishery Conservation and Management Act of 1976).

In response to the Magnuson-Stevens Act, NOAA has identified communities in Connecticut, New York, and Rhode Island as "fishing communities" with economies dependent upon commercial fishing (Colburn, et al., 2014). The identified "fishing communities" that fall within the study area are listed in Table 4-73.

Commercial Fishing Ports

The EPA (2004) reported the following active commercial shellfishing and finfishing ports in Long Island Sound: Greenwich Harbor, Stamford Harbor, Darien, Norwalk Harbor, Westport, Southport, Fairfield, Bridgeport, Stratford (Housatonic River), Milford, New Haven, Branford Harbor, and Guilford Harbor in Connecticut; and, counterclockwise from the Connecticut state line: Mamaroneck Harbor, Hempstead Harbor, Oyster Bay, Cold Spring Harbor, Huntington Harbor, Northport Harbor, Stony Brook Harbor, Port Jefferson, Mt. Sinai Harbor, and Mattituck Harbor in New York. The EPA listing is restricted by the study area that was confined to the western and central Long Island Sound for the purposes of the report (EPA, 2004).

Table 4-73. Fishing Communities Identified by NOAA in Response to the Magnuson-Stevens Act, as Amended.

Connecticut	New York	Rhode Island
Branford	Amagansett	North Kingstown
Bridgeport	Greenport	Point Judith
Darien	Hampton Bays	South Kingstown
East Haven	Islip	
Groton	Mattituck	
New Haven	Montauk	
New London	Oceanside	
Portland	Point Lookout	
Stonington		

Source: NOAA (2009).

Commercial Fishing Contribution to Local Economy

USACE (2010b) estimated the contribution of commercial fishing to the GSP. Table 4-74 presents the estimated total economic outputs, employment, and tax revenue generated by this economic activity.

Table 4-74. Regional Economic Contribution of Commercial Fishery Activities (2009 Dollars).

Region	Annual Output[g]	GSP	Employment[h]	Annual Tax Revenue[i] (millions of dollars)
	(millions of dollars)			
Rhode Island[a]	$0.5	$0.4	8	$0.1
Eastern Connecticut[b]	$21.0	$16.9	328	$3.6
Western Connecticut[c]	$34.0	$26.6	587	$5.7
New York Mainland[d]	$0.0	$0.0	0	$0.0
Western Long Island[e]	$1.1	$0.8	32	$0.2
Eastern Long Island[f]	$43.9	$35.1	1,334	$8.3
Leakages Outside Region	$5.80	$2.90	Note j	$0.90
All Long Island Sound	$106.3	$82.7	1,632	$18.8

Source: USACE (2010b).

[a] Washington County

[b] Hartford, Middlesex, and New London counties

[c] Fairfield and New Haven counties

[d] Westchester and Bronx Counties

[e] Kings, Queens, and Nassau counties

[f] Suffolk County

[g] Includes direct, indirect, and induced effects

[h] Includes full, part-time, temporary, and intermittent employment

[i] Includes all payments to government and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

[j] Sum of total exceeds total modeled for region

Seafood Industry Economic Contribution to Local Economy

NOAA's NMFS estimates the local impact of the seafood industry to states. Annual estimates are provided to determine the industry's employment, sales, and income impacts. Employment impacts are measured in number of jobs, which includes both part-time and full-time jobs. Sales reflect total dollar sales generated from the seafood industry. Income represents wages, salaries, benefits, and proprietary income generated from the seafood industry.

The seafood industry is divided into the following five sectors: commercial harvesters, primary dealers and processors, secondary seafood wholesalers and distributors, grocers, and restaurants. Impacts represent direct, indirect, and induced impacts for only the impacts that occurred within the specified state. For the commercial harvesters sector, the harvesting activity is attributed to the state where the fish were landed. Impacts generated in one state by seafood industry activities in other states are not included in the estimated impacts for that state.

Table 4-75 presents the contribution of the seafood industry by state for 2009 (NOAA, 2014m). In 2009, the tri-state seafood industry supported over 8,600 jobs with a cumulative income of $161 million and generated $458 million in sales. Value added by the seafood industry was $226 million in 2009 (NOAA, 2014m). Figure 4-72 through Figure 4-74 present commercial fisheries aquaculture resources.

Table 4-75 . Seafood Industry Economic Impacts by State, 2009.

State	**Jobs (part- and full-time)**	**Income**	**Sales**	**Value Added**
		($1,000s)		
Connecticut	989	$20,140	$58,760	$28,078
New York	3,888	$62,766	$180,646	$87,796
Rhode Island	3,763	$78,539	$218,341	$110,291
Totals:	**8,640**	**$161,445**	**$457,747**	**$226,165**

Source: NOAA (2014m).

Recreational Fisheries

Recreationally Important Species: Finfish and Shellfish

The top seven important recreational species of finfish are bluefish, scup, striped bass, summer flounder, tautog, weakfish, and winter flounder. Crabs (horseshoe, lady, rock, and spider), long-finned squid, and American lobster are important recreational invertebrates (CTDEEP, 2013c).

Recreational shellfishing focuses on quahogs, soft-shell clams, and oysters. Popular locations for recreational shellfishing can be found in the salt ponds of Washington County, Rhode Island (EPA and USACE, 2004).

Fishing Pressure

Recreational fish catch and total weight are reported by NOAA's NMFS by state. The annual fish catch for 2012 within the three-state area is presented in Table 4-76. Over 30 million fish were caught recreationally in 2012 within the area. The most frequently caught species are flounders, bluefish, porgies, sea basses, and searobins, which made up 82% of all fish caught in 2012 (NOAA, 2014n).

Table 4-76. 2012 Fishing Pressure for Three-State Region.

	Connecticut[a]		**New York**		**Rhode Island**		**Total Three-State Catch**	
Fishing Area/ Species Caught	**Fish Caught (count)**	**Weight (lbs)**	**Fish Caught (count)**	**Weight (lb)**	**Fish Caught (count)**	**Weight (lb)**	**Fish Caught (count)**	**Weight (lb)**
Inland	**6,325,408**	**5,789,345**	**11,962,055**	**5,763,312**	**3,385,819**	**1,425,938**	**21,673,282**	**12,978,595**
Bluefish	1,158,811	2,466,639	2,225,306	1,618,248	825,277	173,024	4,209,394	4,257,911
Cartilaginous fishes	155,784	0	120,096	0	81,241	0	357,121	0
Catfishes	902	2,187					902	2,187
Cods and hakes	1,020	6,973			2,349	0	3,369	6,973
Drums			183,664	88,031	4,523	0	188,187	88,031
Eels					499	0	499	0
Flounders	384,725	203,590	2,760,309	713,054	173,887	157,682	3,318,921	1,074,326
Herrings	132,320	91,849	234,146	426,969	170,777	69,846	537,243	588,664
Jacks					650	0	650	0
Mullets					169,212	0	169,212	0
Other fishes			740	0	240,554	0	241,294	0
Porgies	1,917,445	922,372	1,568,576	569,017	835,138	444,802	4,321,159	1,936,191
Puffers			122,894	9,197	3,503	0	126,397	9,197
Sea basses	1,116,877	261,163	1,731,617	98,559	359,402	24,310	3,207,896	384,032
Searobins	212,405	0	2,277,142	42,484	50,877	3,830	2,540,424	46,314
Temperate basses	387,063	849,037	360,958	2,084,548	193,419	321,325	941,440	3,254,910
Toadfishes			14,537	0			14,537	0
Tunas and mackerels	57,211	2,644	2,293	0	20,323	0	79,827	2,644
Wrasses	800,845	982,891	359,777	113,205	254,188	231,119	1,414,810	1,327,215
Ocean (≤ 3 mi)			**6,553,978**	**7,022,675**	**1,700,156**	**1,352,082**	**8,254,134**	**8,374,757**
Bluefish			623,675	1,040,920	250,819	38,326	874,494	1,079,246
Cartilaginous fishes			118,831	0	74,401	97	193,232	97
Cods and hakes			19,186	18,233	829	2,930	20,015	21,163
Drums			58,972	32			58,972	32
Eels			66	0			66	0
Flounders			2,829,126	1,093,494	310,994	177,825	3,140,120	1,271,319
Herrings			32,827	30,909			32,827	30,909

Table 4-76. 2012 Fishing Pressure for Three-State Region (continued).

	Connecticut[a]		**New York**		**Rhode Island**		**Total Three-State Catch**	
Fishing Area/ Species Caught	**Fish Caught (count)**	**Weight (lbs)**	**Fish Caught (count)**	**Weight (lb)**	**Fish Caught (count)**	**Weight (lb)**	**Fish Caught (count)**	**Weight (lb)**
Other fishes			1,431	0			1,431	0
Porgies			258,940	206,995	310,415	88,946	569,355	295,941
Puffers			4,995	255			4,995	255
Sculpins			27	0	664	0	691	0
Sea basses			1,054,772	446,663	474,982	183,058	1,529,754	629,721
Searobins			826,732	4,694	40,419	0	867,151	4,694
Temperate basses			633,692	4,039,829	112,836	557,789	746,528	4,597,618
Triggerfishes/ filefishes			5,095	5,919	4,597	0	9,692	5,919
Tunas and mackerels			1,404	0	20,173	1,848	21,577	1,848
Wrasses			84,207	134,732	99,027	301,263	183,234	435,995
Ocean (>3 mi)			**214,322**	**1,137,360**	**120,708**	**294,576**	**335,030**	**1,431,936**
Bluefish			109,560	628,452	23,894	24,157	133,454	652,609
Cartilaginous fishes			17,587	132,305	2,370	1,312	19,957	133,617
Cods and hakes			34,794	1,017	15,419	136,163	50,213	137,180
Flounders			11,801	1,445	1,268	0	13,069	1,445
Herrings			9,329	7,455			9,329	7,455
Porgies					26,786	22,289	26,786	22,289
Sculpins					83	0	83	0
Sea basses			5,731	0	34,376	18,763	40,107	18,763
Searobins			3,295	0	1,378	0	4,673	0
Temperate basses			15,915	361,878	3,408	36,615	19,323	398,493
Tunas and mackerels					8,905	52,779	8,905	52,779
Wrasses			6,310	4,808	2,821	2,498	9,131	7,306
Grand Total	**6,325,408**	**5,789,345**	**18,730,355**	**13,923,347**	**5,206,683**	**3,072,596**	**30,262,446**	**22,785,288**

Source: NOAA (2014n).

[a] All available data are reported.

Recreational Fishing Grounds

In the Long Island Sound region, a large portion of the recreational fishing activity occurs between the spring and fall months when weather and water temperatures are most favorable. During these months, offshore angling is concentrated around ledges, shoals, banks, and other places where habitat and depth changes induce fish to congregate. Historic recreational fishing areas occur off Lloyd's Neck, Huntington Bay, and Eaton's Neck, in New York and off Long Neck Point, Sheffield Island (Norwalk), and 3 nmi east of the WLDS Alternative in Connecticut (EPA, 2004).

Recreational fishing activity takes places both from shore and from boats off the coast. Shore-based fishing, generally defined as surf casting, takes places at beaches along the coast. Jetties, piers, shoals, and banks are all angling sites for shore-based recreational fishermen (EPA and USACE, 2004).

Private, charter, and party boats are used for recreational fishing offshore. Charter vessels often carry up to six passengers to a recreational fishing location in the area. Party boats carry more passengers than charter vessels and are normally offshore for shorter periods of time. Party boats can be found in the active recreational ports of Montauk, New York; Point Judith, Rhode Island; and New London, Connecticut, with the majority taking place out of Montauk (EPA and USACE, 2004).

Artificial reefs and other man-made obstructions are often areas of active recreational fishing and diving. Types of submerged obstructions include shipwrecks, jetties, groins, submerged pipelines, and cables (EPA and USACE, 2004).

Economic Contribution of Marine Recreational Fishing

In 2011, NOAA's NMFS conducted the National Marine Recreational Fishing Expenditure Survey. The survey collected information from anglers on expenditures related to marine recreational fishing, defined as fishing for finfish in the open ocean (or any body of water that is marine or brackish) for sport or pleasure (Lovell, et al., 2013).

Marine Recreational Fishing in Connecticut

Marine recreational fishing effort in 2011 in Connecticut was 994,000 trips by 286,000 residents and 113,000 trips by 82,000 non-residents. Total angler expenditures on marine recreational fishing in Connecticut were $126 million in 2011. Marine angling trip expenditures were 28% of total angling expenditures; durable good expenditures accounted for the remaining 72%. Mean expenditures by residents were $164.96 on for-hire fishing trips, $30.51 on private boat trips, and $18.27 on shore trips. Non-resident mean trip expenditures were $144.57 on for-hire fishing trips, $28.29 on private boat trips, and $12.70 on shore trips. Table 4-77 presents the economic contribution of the activity on the local economy (Lovell, et al., 2013).

State and local tax revenues in Connecticut totaled $14.8 million, while Federal tax generated was $20 million, for total tax revenues of $34.8 million in 2011 (Lovell, et al., 2013).

Table 4-77. Contribution of Marine Recreational Fishing to the Connecticut Economy, 2011.

Expense Type	Fishing Mode	Expense (in $1,000s)	Economic Contribution			
			Employment (Jobs)	Labor Income[a] (in $1,000s)	Value Added (in $1,000s)	Output (in $1,000s)
Trip Expense	For-Hire	$6,902	63	$5,751	$8,204	$10,807
	Private Boat	$23,751	180	$9,198	$15,755	$25,641
	Shore	$5,032	58	$2,178	$3,518	$6,126
	All Modes	$35,685	301	$17,127	$27,477	$42,574
Durable Expenses		$90,671	889	$58,369	$87,346	$113,841
Total Expenses		$126,356	1,190	$75,496	$114,823	$156,415

Source: Lovell, et al. (2013).

[a] Labor income is both personal and proprietor's income.

Marine Recreational Fishing in New York

Marine recreational fishing effort in 2011 in New York was 3,483,000 trips by 428,000 residents and 104,000 trips by 39,000 non-residents. Total angler expenditures on marine recreational fishing in New York were $330 million in 2011. Marine angling trip expenditures were 62% of total angling expenditures; durable good expenditures accounted for the remaining 38%. Mean trip expenditures by residents were $157.83 on for-hire fishing trips, $59 on private boat trips, and $19.91 on shore trips. Non-resident mean trip expenditures were $116.37 on for-hire fishing trips, $38.83 on private boat trips, and $44.68 on shore trips. Table 4-78 shows the economic contribution of the activity on the local economy (Lovell, et al., 2013).

State and local tax revenues in New York totaled $40.4 million, while Federal tax generated was $37.7 million, for total tax revenues of $78.1 million in 2011 (Lovell, et al., 2013).

Table 4-78. Contribution of Marine Recreational Fishing to the New York Economy, 2011.

Expense Type	Fishing Mode	Expense (in $1,000s)	Economic Contribution			
			Employment (Jobs)	Labor Income[a] (in $1,000s)	Value Added (in $1,000s)	Output (in $1,000s)
Trip Expense	For-Hire	$66,327	787	$53,406	$77,456	$105,336
	Private Boat	$115,693	916	$39,442	$66,600	$113,449
	Shore	$23,883	267	$9,151	$14,871	$26,968
	All Modes	$205,903	1,970	$101,999	$158,927	$245,753
Durable Expenses		$124,412	1,124	$58,032	$95,802	$153,127
Total Expenses		$330,315	3,094	$160,031	$254,729	$398,880

Source: Lovell, et al. (2013).

[a] Labor income is both personal and proprietor's income.

Marine Recreational Fishing in Rhode Island

Marine recreational fishing effort in 2011 in Rhode Island was 511,000 trips by 88,000 residents and 500,000 trips by 156,000 non-residents. Total angler expenditures on marine recreational fishing in Rhode Island were $179 million in 2011. Marine angling trip expenditures were 19% of total angling expenditures and durable good expenditures were the remaining 81%. Mean trip expenditures by residents were $93.66 on for-hire fishing trips, $40.92 on private boat trips, and $15.30 on shore trips. Non-resident mean trip expenditures were $205.88 on for-hire fishing trips, $36.66 on private boat trips, and $16.64 on shore trips. Table 4-79 shows the economic contribution of the activity on the local economy (Lovell, et al., 2013).

State and local tax revenues in Rhode Island totaled $18.9 million, while Federal tax generated was $18.2 million, for total tax revenues of $37.1 million in 2011 (Lovell, et al., 2013).

Table 4-79. Contribution of Marine Recreational Fishing to the Rhode Island Economy, 2011.

Expense Type	Fishing Mode	Expense (in $1,000s)	Economic Contribution			
			Employment (Jobs)	Labor Income[a] (in $1,000s)	Value Added (in $1,000s)	Output (in $1,000s)
Trip Expense	For-Hire	$6,943	113	$5,346	$7,808	$11,080
	Private Boat	$18,884	178	$7,171	$12,028	$20,393
	Shore	$7,853	73	$2,960	$4,906	$8,299
	All Modes	$33,680	364	$15,477	$24,742	$39,772
Durable Expenses		$145,125	1,576	$65,821	$106,273	$168,249
Total Expenses		$178,805	1,940	$81,298	$131,015	$208,021

Source: Lovell, et al. (2013).

[a] Labor income is both personal and proprietor's income.

Recreational Boating Contribution to Local Economy

USACE (2010b) estimated the contribution of recreational boating to the GSP. Table 4-80 presents the 2009 estimated total economic outputs, employment, and tax revenue generated by this economic activity.

Table 4-80. Contribution of Recreational Boating in Long Island Sound (2009 Dollars).

Region	Annual Output[g]	GSP	Employment[h]	Annual Tax Revenue[i] (millions of dollars)
	(millions of 2009 dollars)			
Rhode Island[a]	$14.6	$9.0	167	$2.8
Eastern Connecticut[b]	$551.5	$342.7	5,216	$105.8
Western Connecticut[c]	$545.3	$347.0	4,687	$114.1
New York Mainland[d]	$110.0	$70.5	928	$22.6
Western Long Island[e]	$181.1	$114.3	1,569	$37.8
Eastern Long Island[f]	$402.2	$253.7	3,746	$85.7
Leakages outside region	$96.80	$61.80	150	$20.30
All Long Island Sound	$1,901.5	$1,199.0	16,463	$389.1

Source: USACE (2010b).

[a] Washington County

[b] Hartford, Middlesex, and New London Counties

[c] Fairfield and New Haven Counties [d] Westchester and Bronx Counties

[e] Kings, Queens, and Nassau Counties

[f] Suffolk County

[g] Includes direct, indirect, and induced effects

[h] Includes full, part-time, temporary, and intermittent employment

[i] Includes all payments to government and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

Commercial Navigation

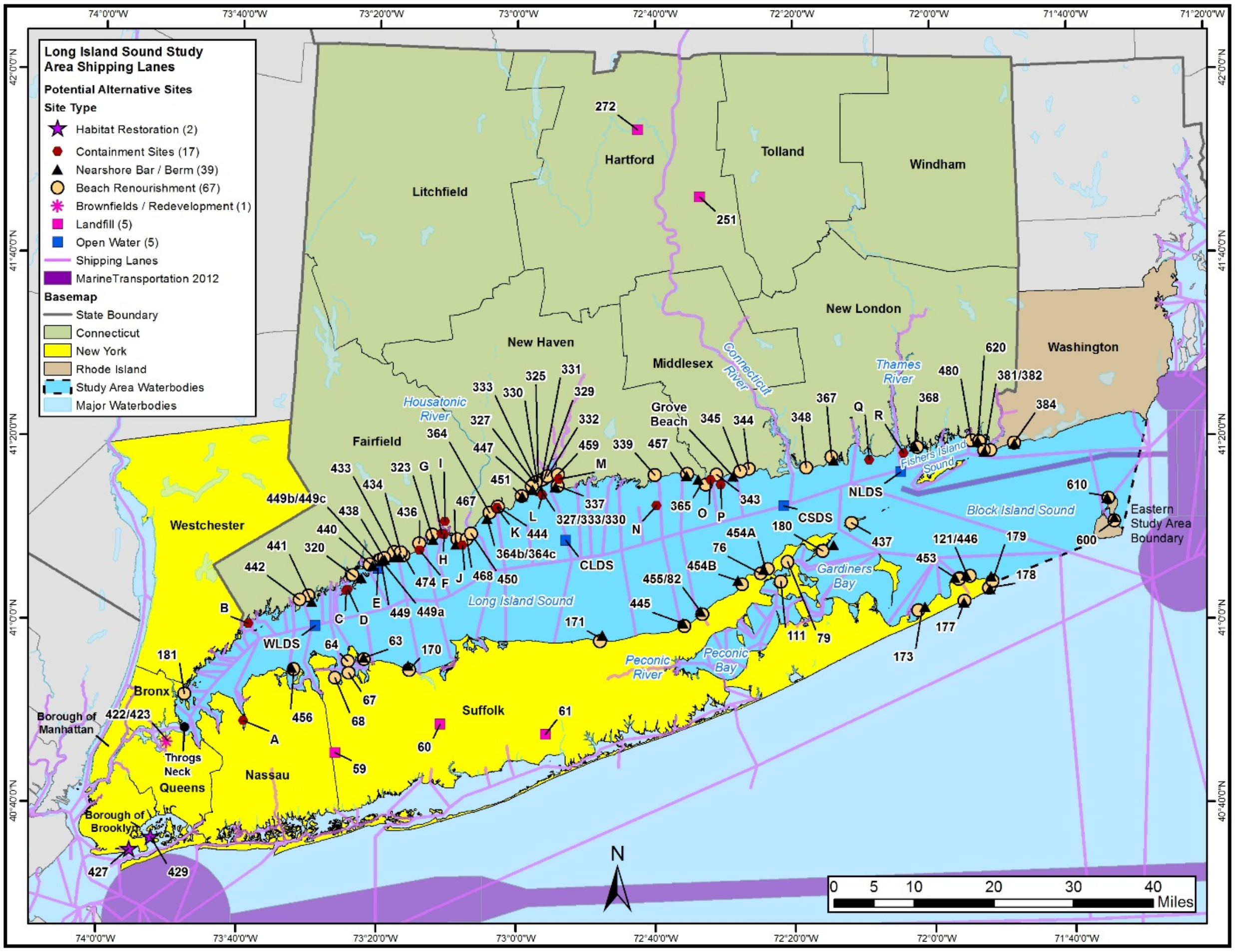
Foreign and Domestic Waterborne Commerce

Waterborne commerce transits Long Island Sound, moving east and west to numerous destinations within and through the Sound (Figure 4-75). Principal commodities moving through, to, and from ports and locations on the Sound are coal, petroleum products, chemicals, crude materials, manufactured goods, farm products, and machinery (USACE, 2014e).

Volume, Maximum Draft, and Trips

The USACE Navigation Data Center (NDC) tracks waterborne commerce along every major waterway in the nation. Tonnage is characterized by commodity and volume (short tons) and direction of flow that passes identified links along the National Waterway Network. Commerce was identified that passes at points between the easternmost and westernmost points of Long Island Sound based on the links associated in the network. In 2012, over 15 million tons of cargo passed the westernmost point of the Sound heading east, of which 8 million tons were delivered to destinations along the Sound. About 1.6 million tons of cargo passed the easternmost point of the Sound heading west, of which 0.2 million tons were delivered to destinations locally. Shipments that originated within points along Long Island Sound totaled 0.2 million tons (USACE, 2014e).

The controlling depth for navigable waters along Long Island Sounds tends to be 20 ft with some exceptions (USACE, 2014f).



Source: USACE (2014g).

Figure 4-75. Commercial Navigation Shipping Lanes, Long Island Sound Study Area.

The NDC tabulates waterborne commerce vessel trips by port, for self-propelled and non-self-propelled vessels. Table 4-81 presents 2011 vessel trips for destinations within the Long Island Sound study area by direction of cargo flow. These data are not additive, but rather give a general overview of vessel activity within the region.

Table 4-81. Vessel Trips by Port, 2011

Port Name	All Vessel Types[a]		
	All Traffic Directions	Receipts	Shipments
Bridgeport, NY	18,923	9,479	9,444
Hempstead, NY	1,459	806	653
New Haven, CT	2,293	1,147	1,146
New London, CT	9,498	4,752	4,746
Greenwich, CT	9,498	4,752	4,746
Long Island Sound at City Island, NY	2	1	1
Mattituck, NY	36	19	17
Niantic Harbor, CT	36	18	18
Norwalk, CT	227	128	99
Pt. Judith, RI	2	1	1
Port Jefferson, NY	18,892	9,484	9,408
Sag Harbor, NY	83,964	41,982	41,982
Stamford, CT	1,204	613	591
Westchester Creek, NY	140	70	70

Source: USACE (2014f).

[a] Includes self-propelled dry cargo, self-propelled tanker, self-propelled towboat, non-self-propelled dry cargo, non-self-propelled tanker liquid barge.

Commercial Navigation Ports/Facilities

The NDC maintains statistics for the top 150 ports in the nation by year. NDC tonnage statistics demonstrate that in 2012, five ports in the Long Island Sound study area were principal ports in terms of tonnage (Table 4-82), in addition to the Port of New York/New Jersey, which is the third largest port in the United States in terms of tonnage shipped. Among these principal ports, 18.4 million tons of cargo were shipped, two-thirds of which were domestic shipments. Overall foreign shipments in the study area consist primarily of imports (USACE, 2014h).

Table 4-82. Principal Ports in the Long Island Sound Study Area.

Port Name	Total Tonnage	Domestic	Foreign	Imports	Exports
Bridgeport, CT	1,592,634	1,529,252	63,382	63,382	0
New Haven, CT	7,807,423	5,433,989	2,373,434	1,841,019	532,415
Hempstead, NY	713,212	713,212	0	0	0
Port Jefferson, NY	1,248,798	1,234,469	14,329	14,329	0
Providence, RI	7,043,104	3,087,188	3,955,916	3,380,617	575,299

Source: USACE (2014d).

Commercial Navigation Contribution to Local Economy

USACE (2010b) estimated the contribution of commercial navigation to the GSP. Table 4-83 presents the estimated total economic outputs, employment, and tax revenue generated by this economic activity.

Figure 4-75 shows the primary commercial shipping lanes within Long Island Sound.

Table 4-83. Regional Economic Significance of Commercial Navigation Activities (2009 Dollars).

Region	Annual Output[g]	GSP	Employment[h]	Annual Tax Revenue[i] (millions of dollars)
	(millions of dollars)			
Rhode Island[a]	$45.2	$10.4	170	$2.7
Eastern Connecticut[b]	$2,485.7	$1,375.5	15,256	$360.3
Western Connecticut[c]	$1,349.2	$742.5	4,190	$212.0
New York Mainland[d]	$16.5	$10.2	90	$3.1
Western Long Island[e]	$880.8	$449.4	2,956	$131.8
Eastern Long Island[f]	$889.3	$397.5	2,789	$118.0
Leakages Outside Region	$358.80	$252.60	1,175	$92.70
All Long Island Sound	$6,025.5	$3,238.1	26,626	$920.6

Source: USACE (2010b).

[a] Washington County

[b] Hartford, Middlesex, and New London Counties

[c] Fairfield and New Haven Counties

[d] Westchester and Bronx Counties

[e] Kings, Queens, and Nassau Counties

[f] Suffolk County

[g] Includes direct, indirect, and induced effects

[h] Includes full, part-time, temporary, and intermittent employment

[i] Includes all payments to government and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

Tourism and Recreational Activities

Tourism has a variety of economic impacts. Tourists contribute to sales, profits, jobs, tax revenues, and income in an area. The most direct effects occur within the primary tourism sectors—lodging, restaurants, transportation, amusements, and retail trade. Through secondary effects, tourism affects most sectors of the economy (Stynes, 1997).

Table 4-84 shows the number of business establishments, paid employees, and estimated annual payroll, by industrial sector, for those economic activities that rely heavily on tourism within the study area.

Tourism supported an estimated 43,000 businesses and 17 million workers with an annual payroll of $15.5 billion within the study area in 2011 (U.S. Census Bureau, 2011b).

Table 4-84. Economic Activity in the Long Island Sound Study Area Related to Tourism, 2011.

Economic Activity	Industrial Sector	2007 NAICS Code[a]	Number of Establishments	Paid Employees[b]	Annual Payroll ($1,000s)
Lodging	Traveler accommodation	721-1	1,315	3,430,737	$2,728,827
Restaurants	Food services and drinking places	722	36,401	11,598,814	$9,144,811
Amusement	Amusement, gambling, and recreation industries	713	3,565	64,824	$1,695,229
Transportation	Scenic and sightseeing transportation	487	141	67,799	$65,882
Retail	General merchandise stores	452	1,917	1,949,171	$1,946,672
Total for Economic Activities that Support Tourism			43,339	17,111,345	$15,581,421

Source: U.S. Census Bureau (2011b).
[a] NAICS = North American Industry Classification System
[b] For pay period including March 12, 2011.

USACE (2010b) estimated total economic outputs, employment, and tax revenue generated by the contribution of ferry-dependent tourism to the GSP (Table 4-85).

Table 4-85. Regional Economic Significance of Ferry-Dependent Tourism (2009 Dollars).

Region	Annual Output[g]	GSP	Employment[h]	Annual Tax Revenue[i] (millions of dollars)
	(millions of dollars)			
Rhode Island[a]	$11.0	$6.3	142	$2.0
Eastern Connecticut[b]	$0.5	$0.3	5	$0.1
Western Connecticut[c]	$23.3	$14.0	217	$4.5
New York Mainland[d]	$0.0	$0.0	0	$0.0
Western Long Island[e]	$0.0	$0.0	0	$0.0
Eastern Long Island[f]	$62.2	$37.2	649	$12.9
Leakages Outside Region	$13.40	$8.20	36	$2.00
All Long Island Sound	$110.4	$66.0	1,049	$21.5

Source: USACE (2010b).
[a] Washington County
[b] Hartford, Middlesex, and New London Counties
[c] Fairfield and New Haven Counties
[d] Westchester and Bronx Counties
[e] Kings, Queens, and Nassau Counties
[f] Suffolk County
[g] Includes direct, indirect, and induced effects
[h] Includes full, part-time, temporary, and intermittent employment
[i] Includes all payments to government and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

Federal and State Parks and Areas of Special Concern

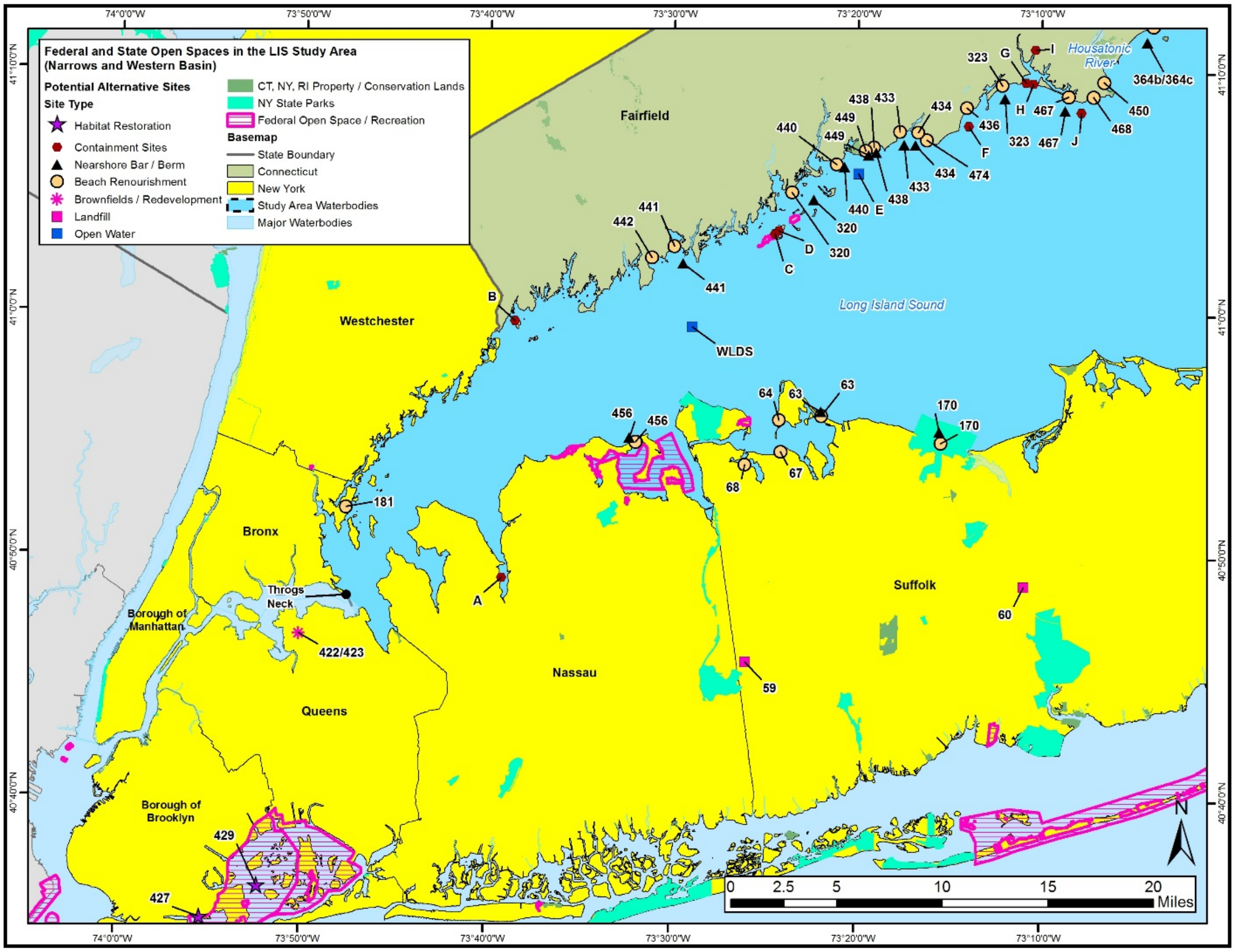
The EPA (2004) identified areas of special concern in the Long Island Sound region, including NWRs, state parks, county and city lands, and habitat management and conservation areas. State parks in Connecticut are located throughout the study area and can be found in Westport and Milford. Connecticut is also home to the Stewart B. McKinney National Wildlife Refuge, which includes holdings along the coast of southern Connecticut from Norwalk to New London. Other parks in Connecticut include Cummings Park and Cove Island Park in Stamford, and Lighthouse Point Park in New Haven. Wildlife management areas can be found in Stratford, Milford, New Haven, and Guilford. In New York, state parks are located near Wildwood, Smithtown, Kings Park, and Huntington. Target Rock National Wildlife Refuge is located in Huntington (EPA, 2004).

Table 4-86 lists the Connecticut and New York counties where designated Federal open space and parks within the study area are found (data for Rhode Island are not available). The area (in square miles) within each county is also listed. The locations of these designated Federal open space and parks are shown in Figure 4-76 through Figure 4-78.

Table 4-86. Federal Open Space/Parks in the Long Island Sound Study Area.

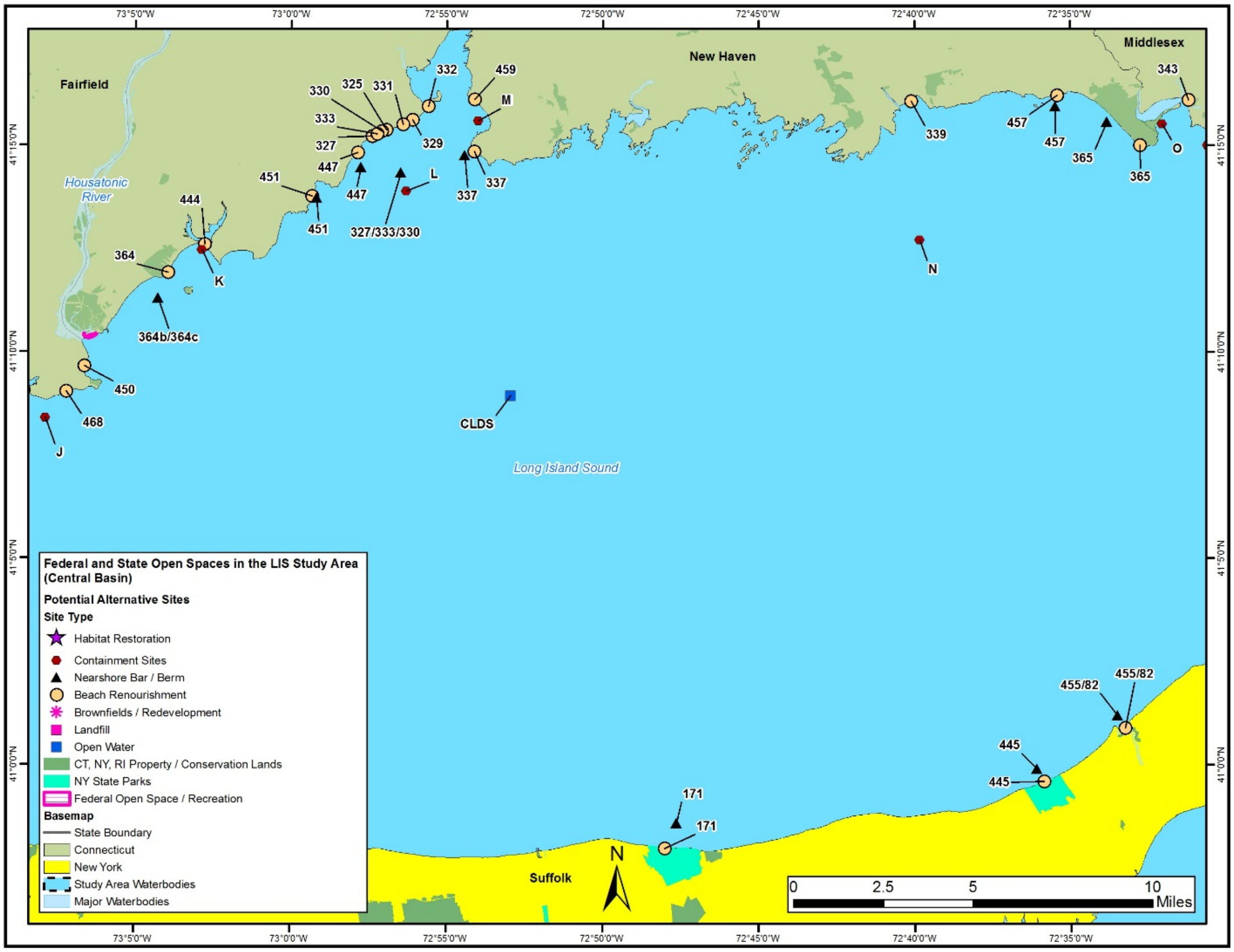
State	County	Federal Open Space (mi^2)
Connecticut	Fairfield County	0.74
	Hartford County	0.00
	Litchfield County	10.24
	Middlesex County	0.40
	New Haven County	0.45
	New London County	0.52
	Tolland County	2.88
	Windham County	3.06
New York	Bronx County	0.00
	Kings County	1.38
	Nassau County	0.00
	New York County	0.00
	Queens County	1.30
	Suffolk County	2.50
	Westchester County	0.00
Rhode Island	Washington County	0.20

Source: Northeast Ocean Data (2014b).



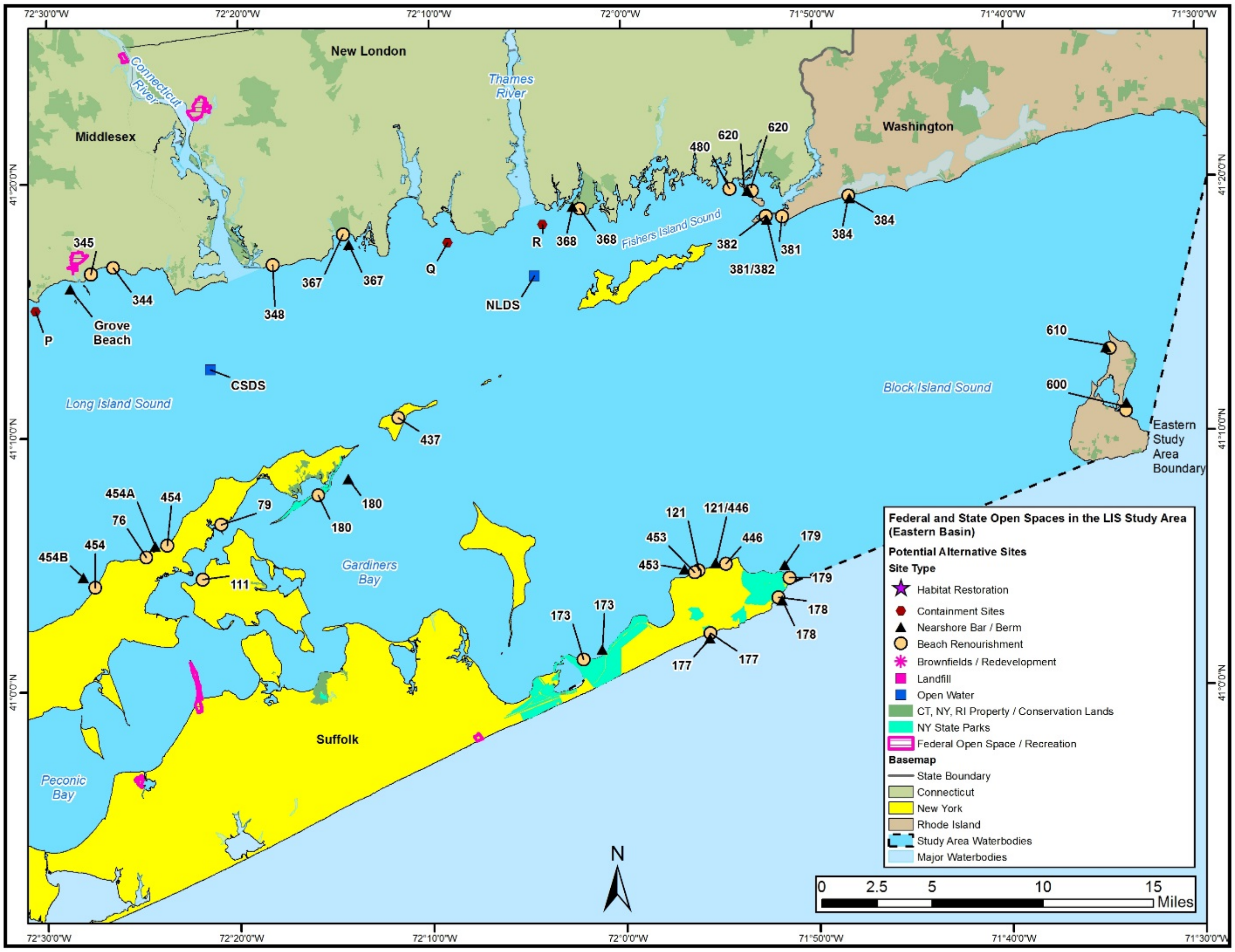
Sources: Northeast Ocean Data (2014b); NYSDEC (2014i); RIGIS (2014e); UConn (2014).

Figure 4-76. Recreational Open Space, Western Long Island Sound Study Area.



Sources: Northeast Ocean Data **(2014b)**; NYSDEC **(2014i)**; RIGIS **(2014e)**; UConn **(2014)**.

Figure 4-77. Recreational Open Space, Central Long Island Sound Study Area.



Sources: Northeast Ocean Data **(2014b)**; NYSDEC **(2014i)**; RIGIS **(2014e)**; UConn **(2014)**.

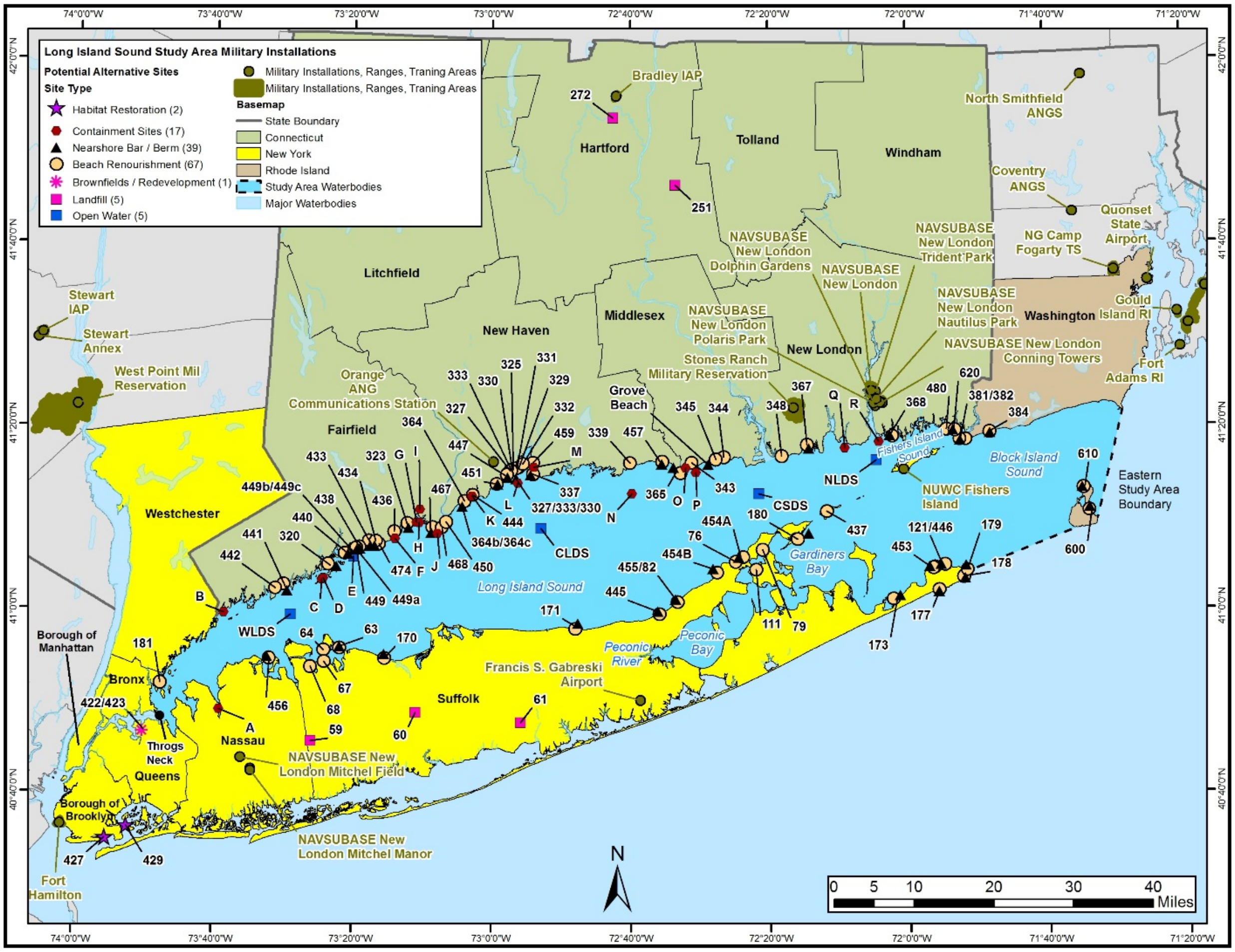
Figure 4-78. Recreational Open Space, Eastern Long Island Sound Study Area.

Other Human Uses

Military Installations

Military activities (Figure 4-79) in the western and central portions of the Long Island Sound region include a decommissioned U.S. Army engine production plant (Stratford, Connecticut) and U.S. Air Force 103rd Air Control Squadron at Orange Air Guard Station (New Haven, Connecticut) (EPA, 2004).

U.S. Coast Guard stations are located at New Haven and New London, Connecticut; at Eaton’s Neck, New York; and at Point Judith, Rhode Island. The U.S. Coast Guard Academy is located in New London. A naval submarine base is located at New London, Connecticut. Army National Guard installations are located at Camp Rell in Niantic and at Stone Ranch Military Reservation at East Lyme (UConn, 2014).



Sources: UConn (2014); USDOD (2014).

Figure 4-79. Military Installations, Long Island Sound Study Area.

The U.S. Navy's submarine base in New London, Connecticut, is a significant contributor to regional employment in Long Island Sound. The New London facility is the Navy's first submarine base and is considered the home of the submarine force. The Navy reports that "every officer and nearly every enlisted sailor in the submarine force will be assigned here at least one time during a military career" (CNIC, 2014). The base employs 7,900 military personnel (USACE, 2010b).

USACE (2010b) estimated total economic outputs, employment, and tax revenue contribution of the submarine base at New London, Connecticut, to the GSP (Table 4-87).

Table 4-87. Regional Economic Significance of New London, Connecticut, Submarine Base (2009 Dollars).

Region	Annual Output[b]	GSP	Employment[c]	Annual Tax Revenue[d] (millions of dollars)
	(millions of dollars)			
Eastern Connecticut[a]	$1,219.7	$920.4	8,925	$218.6
Leakages Outside Region	$18.50	$23.80	1,025	$23.60
All Long Island Sound	$1,238.2	$944.2	9,950	$242.2

Source: USACE (2010b)
[a] Hartford, Middlesex, and New London Counties
[b] Includes direct, indirect, and induced effects
[c] Includes full, part-time, temporary, and intermittent employment
[d] Includes all payments to government and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households.

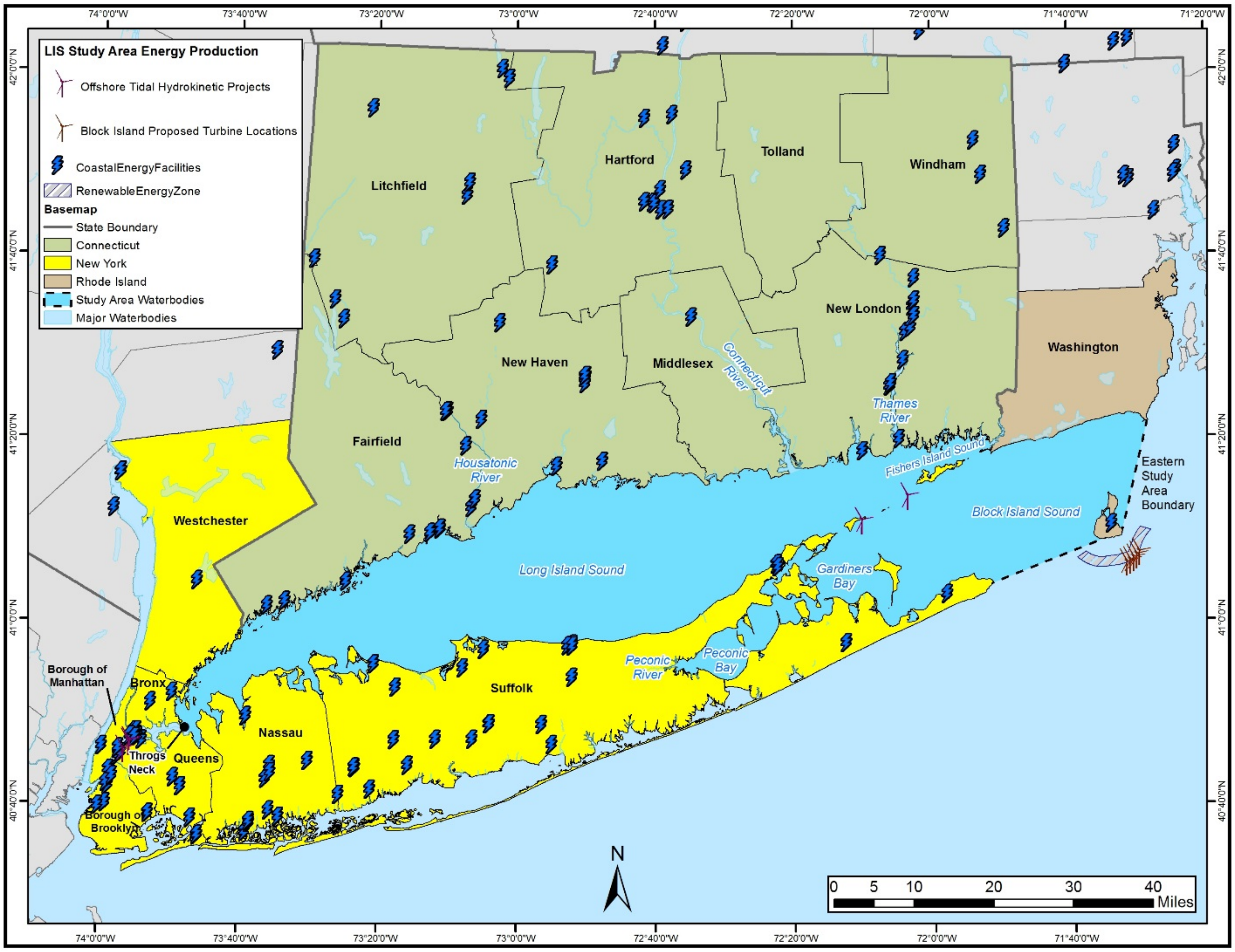
Mineral and Energy Development

USACE identified areas in which energy production is ongoing or being considered for development (Figure 4-80). Energy production locations identified within the Long Island Sound region include sites for wind energy from the Bureau of Ocean Energy Management's Renewable Energy Program; Block Island proposed turbine locations; offshore tidal hydrokinetic projects; and other coastal energy sites throughout the region (Northeast Ocean Data, 2014a).

Environmental Justice

Environmental justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. **Fair treatment** means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. **Meaningful involvement** means that: (1) people have an opportunity to participate in decisions about activities that may affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision; (3) their concerns will be considered in the decision-making process; and (4) the decision makers seek out and facilitate the involvement of those potentially affected (EPA, 2010c).

EJ analysis is required by EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," to focus Federal attention on the environmental and human health conditions of minority and low-income populations with the goal of achieving environmental protection for all communities. The EO directed Federal agencies to develop EJ strategies to help Federal agencies address disproportionately high and adverse human health or environmental effects of their programs on minority and low-income populations (EPA, 2010c).



Source: Northeast Ocean Data (2014a).

Figure 4-80. Areas Where Energy Production is Ongoing or Being Considered for Development.

Disproportionately High and Adverse Burden

The environmental burden or impact can be related to ambient conditions, a specific source or sources, and/or cumulative or area-wide sources. This burden can affect human health, as well as the ecological health of the natural environment. Identifying the magnitude of environmental burden, however, is not a simple process. Whereas high-quality and consistent data are available for the development of the required low-income and minority demographic profiles, there currently exists limited data available for assessing the environmental burden (EPA, 2010c).

Analytical Procedure

This analysis follows the guidance published by the EPA's Office of Environmental Justice regarding definitions of minority and low-income populations and the methodology by which those populations are identified. The designation of "adverse burden" will not be attempted in this PEIS because project-specific placement sites are not identified. However, this analysis will lay the groundwork for an EJ burden assessment by identifying where the potential for EJ consideration exists based on the criteria of minority staus, poverty status, or both.

The following six steps comprise the procedure to identify potential EJ communities and, further, actual EJ communities. This analysis has completed steps 1 through 3 and presents the preliminary results in Table 4-89 and in Figure 4-81 through Figure 4-83:

1. delineate the boundaries of the communities of concern (COC) and conduct, as appropriate, a preliminary environmental burden analysis;
2. compare the demographics of the community to an appropriate statistical reference;
3. determine whether the community is either minority or low income;
4. develop a comprehensive environmental load profile for any community that is either minority or low income;
5. assess whether the burden is disproportionately high and adverse; and
6. summarize and report the results (EPA, 2010c).

Minority Community or Population - EPA's Office of Environmental Justice has defined the term "minority" for EJ purposes to include Hispanics, Asian-Americans and Pacific Islanders, African-Americans, and American Indians and Alaskan Natives *(EPA, 2010c)*.

Low-income Community or Population - The U.S. Census Bureau does not provide a specific definition for "low income." Rather, the term is used interchangeably with "poverty." In this regard, the Census Bureau established a set of income cutoffs/thresholds to determine the poverty status of families. Those poverty thresholds are based on family size and the number of family members under 18 years of age. Further, these groups were differentiated by age of the family householder. In addition, the thresholds for a one-person family (unrelated individual) and two-person family were further differentiated by the number of family members 65 years of age and older. The Census determines poverty by comparing the total income of each family against its corresponding threshold. If the total family income is less than the corresponding cutoff, the family is classified as "below the poverty level" (EPA, 2010c).

Applied EJ Analysis

1. Delineate the boundaries of the COC and conduct, as appropriate, a preliminary environmental burden analysis.

The study area for the EJ analysis is defined as the Long Island Sound study area. COCs are discrete population concentrations based on the U.S. Census Bureau’s Census Block Group (CBG) delineation. CBGs are statistical divisions of census tracts, are generally defined to contain between 600 and 3,000 people, and are used to present data and control block numbering. A CBG consists of clusters of blocks within the same census tract and is the smallest geographical unit for which the U.S. Census Bureau publishes sample data.

All CBGs that lie within the Long Island Sound study area’s 16 counties were identified using georeferenced information from the U.S. Bureau of the Census (2011c). The 2007-2011 American Community Survey 5-Year Estimate provided the basis for the comparison of each CBG to its home state average. Attribute data attached to each CBG contained the data elements necessary to determine percent minority and percent living below poverty level.

2. Compare the demographics of the community to an appropriate statistical reference.

Statistical reference areas are evaluated to determine appropriate cutoffs for demographic factors, minority status and low-income status. This evaluation provides a basis for comparison to determine if the COC meets the demographic EJ criteria.

Each state within the Long Island Sound study area comprised the statistical reference area for the CBGs located within the Long Island Sound study area of that state. The statewide averages for minority population and population living below poverty level were calculated and are shown in Table 4-88.

Table 4-88. State Average Threshold for Potential Environmental Justice Burden*.

State	Percent Minority	Percent Living Below Poverty Level
Connecticut	21.4%	9.5%
New York	33.8%	14.5%
Rhode Island	18.1%	12.8%

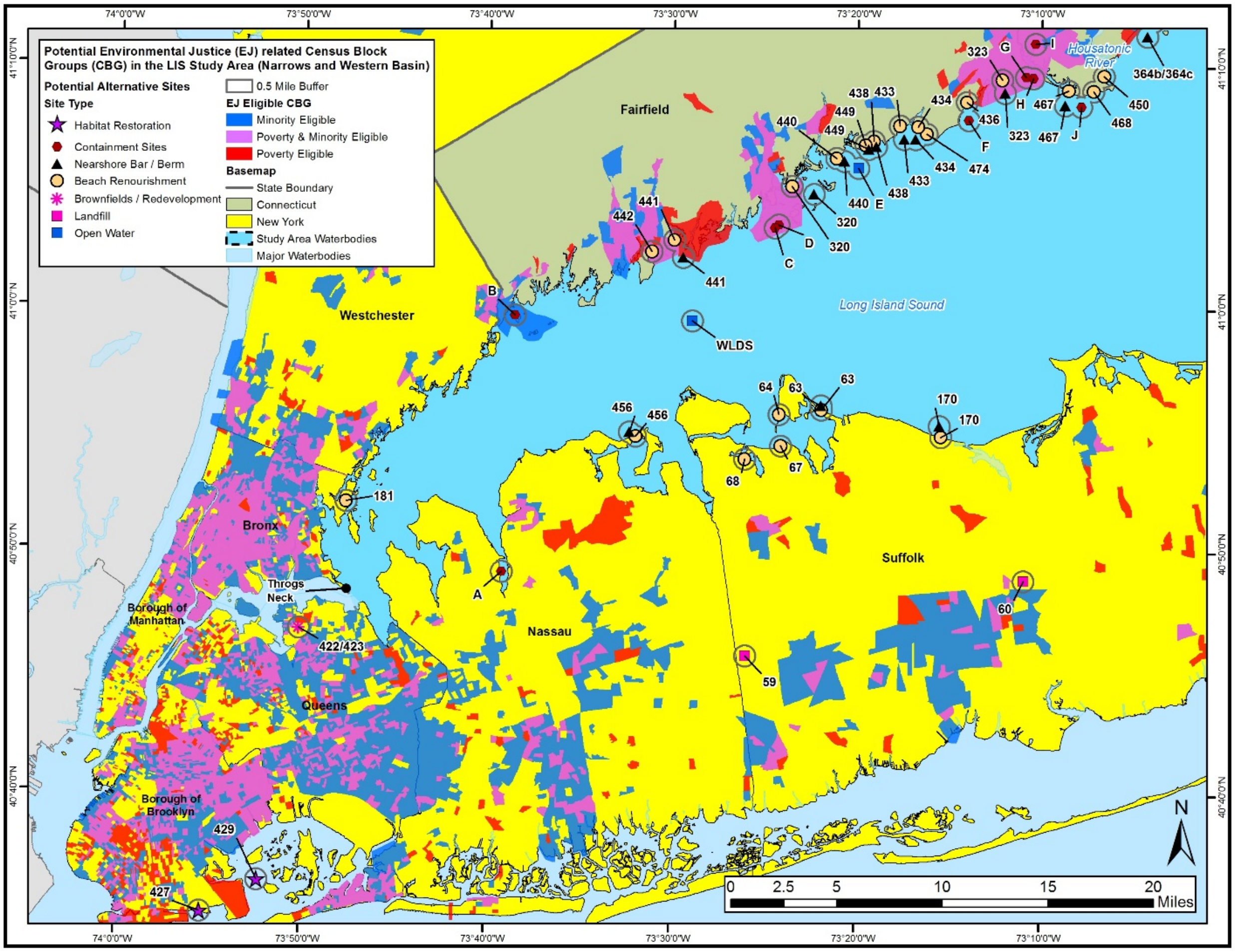
Source: U.S. Census Bureau (2011c).
*CBGs having percent equal to or higher than the state's average are designated EJ eligible.

The EPA noted difficulty with minority demographics skewing the overall state total for New York State due to high minority populations in urbanized areas (EPA, 2010c). However, since the Long Island Sound study area within New York State is completely urbanized, this noted bias is not a factor in this preliminary EJ analysis.

3. Determine whether the community is either minority or low income.

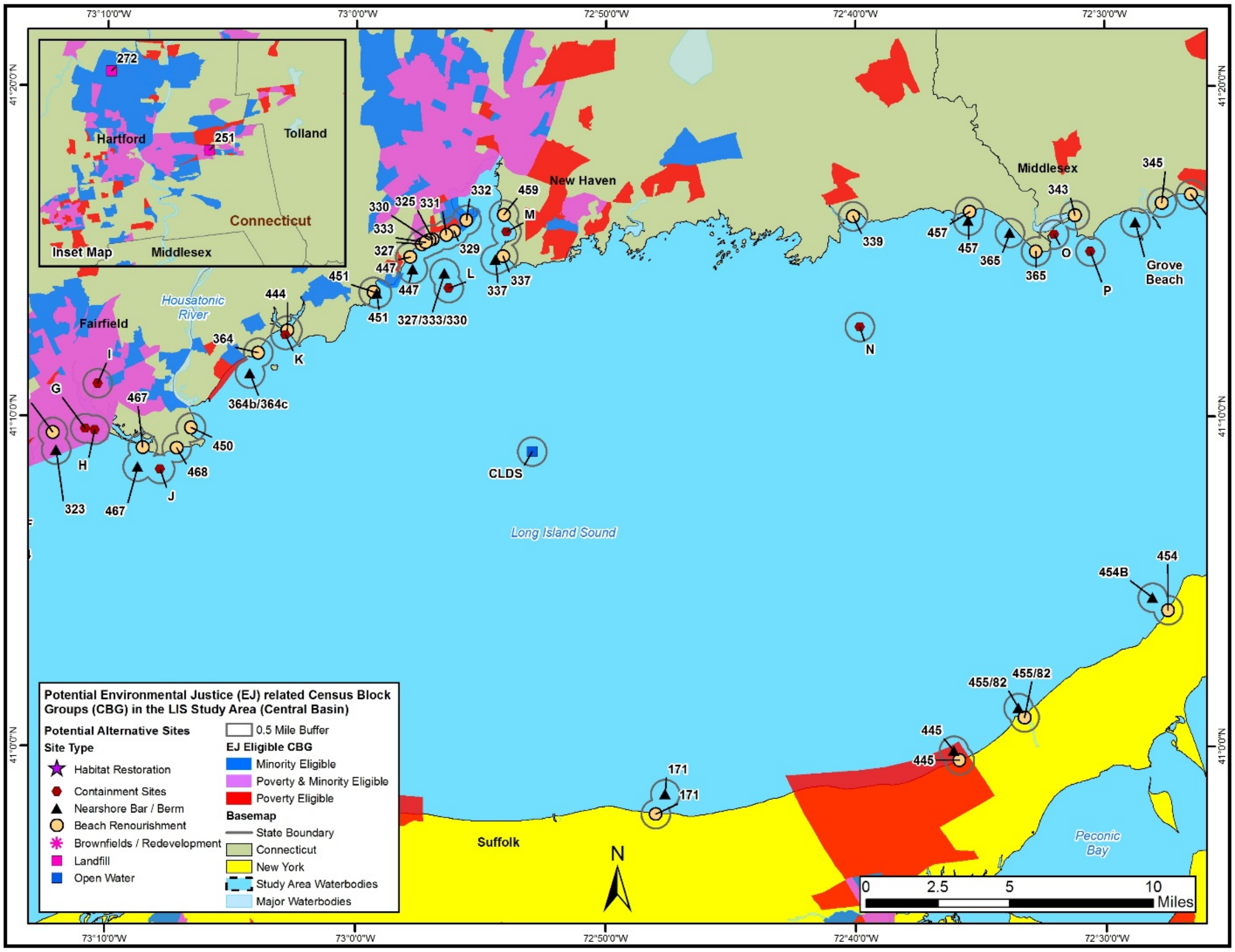
In accordance with EO 12898, a community is a potential EJ community if it is either minority or low income. The comparative analysis indicated whether either of the demographic criteria is met, based on a comparison of the COC (CBG) demographics to statistical reference area (state total) cutoffs. If the COC demographics are equal to or above either cutoff, then the COC is considered a potential EJ area that should be more fully evaluated. All CBGs within the study area were tested for percent minority population and percent population living below poverty level (EPA, 2010c).

Figure 4-81 through Figure 4-83 show the CBGs for which income and minority eligibility was determined within the Long Island Sound study area. Those census blocks that met the threshold for potential EJ consideration are highlighted as being minority eligible, poverty eligible, or both. The alternative sites for dredged material placement activity were overlaid with a 0.5-mi radius buffer surrounding each site. If the buffer of any alternative site intersected a potentially eligible CBG, it is listed in Table 4-89.



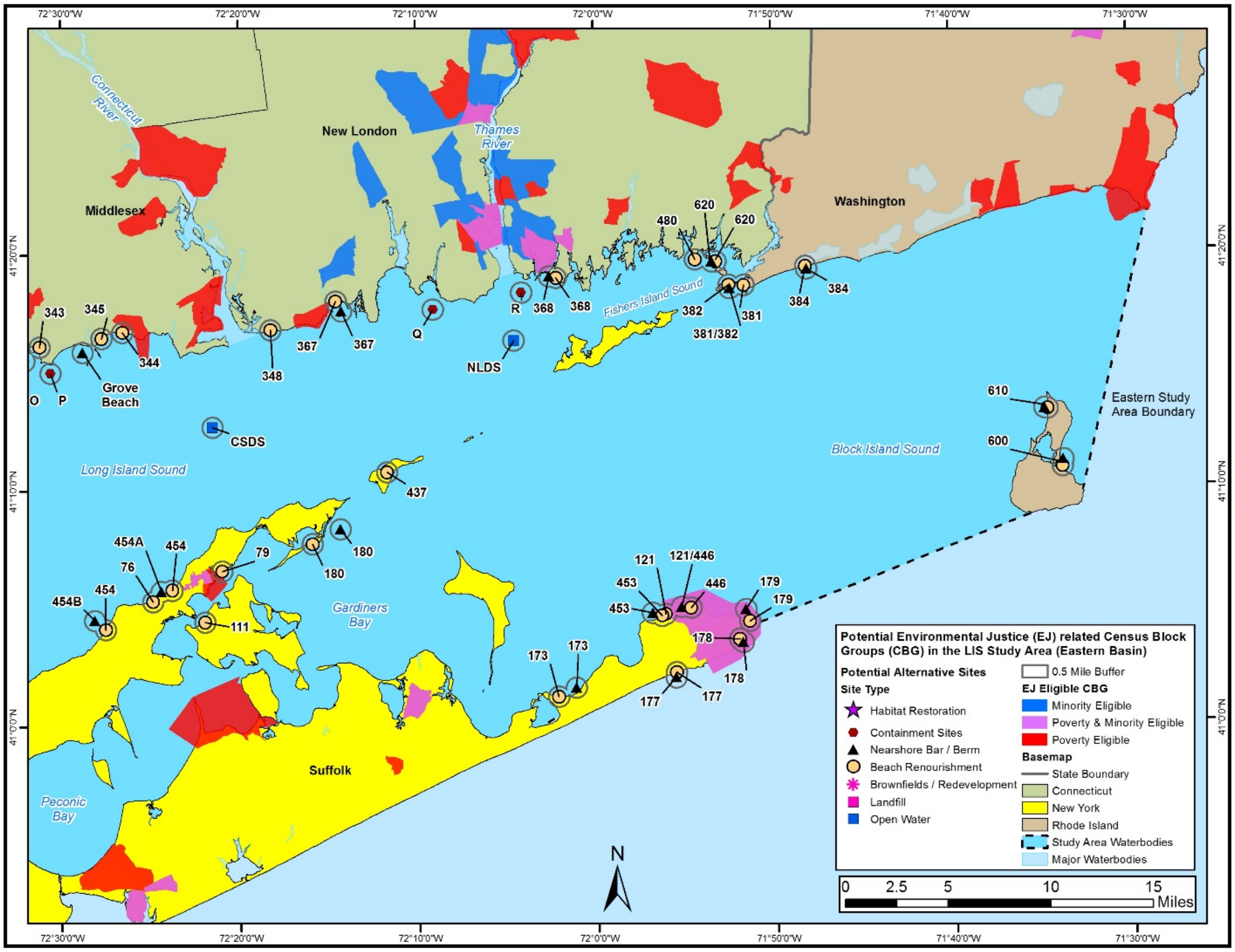
Source: U.S. Census Bureau (2011c).

Figure 4-81. Potentially Eligible EJ CBGs, Western Long Island Sound Study Area.



Source: U.S. Census Bureau (2011c).

Figure 4-82. Potentially Eligible EJ CBGs, Central Long Island Sound Study Area.



Source: U.S. Census Bureau (2011c).

Figure 4-83. Potentially Eligible EJ CBGs, Eastern Long Island Sound Study Area.

Table 4-89. Alternative Sites with 0.5-Mi Radius Buffers that Intersect a Potentially Eligible EJ CBG.

Alternative Site Type	Alternative Site ID	City	State
In-Harbor CAD Cell	G	Bridgeport	CT
	H	Bridgeport	CT
Island CDF	B	Greenwich	CT
Shoreline CDF	C	Norwalk	CT
	D	Norwalk	CT
	I	Bridgeport	CT
Beach Nourishment	121	East Hampton	NY
	178	East Hampton	NY
	179	East Hampton	NY
	325	West Haven	CT
	327	West Haven	CT
	329	West Haven	CT
	330	West Haven	CT
	331	West Haven	CT
	320	Norwalk	CT
	323	Bridgeport	CT
	332	West Haven	CT
	333	West Haven	CT
	344	Westbrook	CT
	367	East Lyme	CT
	436	Fairfield	CT
	441	Stamford	CT
	442	Stamford	CT
	445	Riverhead	NY
	446	East Hampton	NY
	447	West Haven	CT
	451	West Haven	CT
	453	East Hampton	NY
	79	Southold	NY
Nearshore Bar Placement/Nearshore Berm	121/446	East Hampton	NY
	178	East Hampton	NY
	179	East Hampton	NY
	323	Bridgeport	CT
	364b/364c	Milford	CT
	368	Groton	CT
	441	Stamford	CT
	445	Riverhead	NY
	447	West Haven	CT
	451	West Haven	CT
Landfill Cover/Capping	251	Manchester	CT
	272	Windsor	CT
	60	Islip	NY
	61	Brookhaven	NY
Brownfields and Redevelopment	422/423	Flushing	NY

Steps 4 through 6 of the EJ analysis could not be completed because specific sites have not been identified for placement activity. When an alternative site is selected for placement activity, a more thorough assessment of the potential environmental burden of a particular eligible CBG will be required.

4. develop a comprehensive environmental load profile for any community that is either minority or low income;

The environmental burden of a community can be represented by the concept of an environmental load profile. This profile is based on salient characteristics that serve as indicators of environmental burden and provide a consistent basis for comparison. The profile of the COC (in this case, CBG) is compared to that of the statistical reference area, the state total, and the salient characteristics (i.e., indicators of air quality, drinking water, etc.) are used to assess whether the COC is experiencing a disproportionately high and adverse burden.

Environmental Burden Indicators
Development of the environmental load profile for a COC includes the following components:

   a. Toxics Release Inventory air emissions
   b. Facility density/population density
   c. Land use index
   d. Ambient air quality mapping (attainment/non-attainment designation)
   e. Additional indicators as warranted

5. Assess whether the EJ burden is disproportionately high and adverse.

The evaluation of potential EJ communities is an iterative process; the defining characteristics of both the community and the actual analysis of that community are refined as the assessment moves toward a more detailed analysis.

6. Summarize and report the results (EPA, 2010c).

4.20.2 Socioeconomics of Open-Water Environment

Socioeconomic data, including infrastructure and navigation related resources, for the open water alternative sites are presented in Table 4-90 through Table 4-93.

Unconfined Open Water Placement

WLDS

Infrastructure **-** The only transportation infrastructure found within 0.5 miles of this open water sites are commercial shipping lanes (Table 4-91). Coastal infrastructure present at this alternative site includes the currently active placement site at this location (Table 4-92).

Pear Tree Point in Darian, Connecticut is the closest Connecticut beach to WLDS. It is due north and 2.8 nautical miles (5.1 kilometers) from the site. Caumsett Beach in Lloyd Neck, New York is the closest New York beach, approximately 2 nautical miles south of the site. Beaches in Noroton, Stamford, and Norwalk are also close to the site. Due to the proximity of the major population centers of Greenwich, Stamford, and Norwalk to the WLDS Alternative, it is assumed that coastal areas adjacent to the alternative receive significant recreational usage. These waterfront properties are the most expensive in the U.S. Western Long Island Sound is one of the heaviest trafficked boating areas in the Northeast (EPSA, 2004).

Commercial and Recreational Fisheries **-** Commercial shell and fin fishing ports within 10 nautical miles of the WLDS alternative include, Greenwich Harbor, Stamford Harbor, Darien, Norwalk Harbor, and Westport in Connecticut, and Oyster Bay, Cold Spring Harbor, Huntington Harbor, and Northport Harbor in New York (Table 4-93).

Prime lobster grounds were mapped in 1982 due west and east of the WLDS Alternative for at least five nautical miles (9.3 kilometers). Oyster beds have been observed off Port Chester, Oyster Bay, and Huntington, in New York, and offshore throughout the area from Greenwich to Fairfield, Connecticut. Other bivalve beds have been harvested between Manhasset and Huntington, as well as, offshore between New Rochelle, New York and Guilford, Connecticut. Mussels have been harvested off Lloyd’s Neck, New York. In addition, shellfish aquaculture beds are located off Lloyd’s Neck, New York (EPA, 2004). Commercial lobstering and fin fishing, near the WLDS Alternative is active. Fin fishing has historically occurred along the Connecticut and New York coasts. Prior to the lobster die-off the regions of the WLDS Alternative were known as very good lobstering areas. Commercial trawling activity occurs east of Eaton’s Neck, New York. Anecdotal evidence from lobsterman’s meetings suggests that the WLDS Alternative is an active lobstering area. In addition, lobstermen indicated that there is little bottom trawling in or near WLDS because of harvesting restrictions and bottom obstructions (EPA, 2004).

Recreational fishing occurs most often at artificial reefs off New York and reefs and areas of high relief off Connecticut. In Connecticut, reefs have been documented off Greenwich Point, Long Neck Point, Pine Point, and the Norwalk Islands. In New York, a state permitted artificial reef exists off of Matinecock Point, near Glen Cove. Historic recreational fishing areas occur off Lloyd’s Neck, Huntington Bay, and Eaton’s Neck, in New York, and offshore of Long Neck Point and Sheffield Island (Norwalk) in Connecticut. Three reefs in Connecticut are less than three nautical miles (5.5 kilometers) from the WLDS Alternative. Smith Reef is north, Cable and Anchor Reef are east, and Budd Reef is northeast of the WLDS Alternative. Major ports with party and charter boats near the WLDS Alternative include Huntington and Northport, New York and Norwalk and Stamford, Connecticut;

CLDS

Infrastructure **-** The only transportation infrastructure found within 0.5 miles of this open water site are commercial shipping lanes (Table 4-91). Coastal infrastructure present at this alternative site includes the currently active placement site at this location (Table 4-92).

Beaches in the vicinity of the CLDS alternative include Lighthouse Point (New Haven, CT) and Wildwood State Park Beach (Wildwood, NY). Of these two beaches, Lighthouse Point is the closest at approximately six nautical miles (11 kilometers) north of the CLDS Alternative. Recreational navigation, including those vessels engaged in sport fishing, sailing, motoring, and ferry activity, occurs throughout the region. Due to the proximity of the major population centers of New Haven, West Haven, and Milford to the CLDS Alternative, the alternative receives significant recreational usage.(EPA, 2004)

Commercial and Recreational Fisheries **-** Commercial shell and fin fishing ports within 10 nautical miles of the CLDS alternative include Milford, New Haven, Branford, and Guilford in Connecticut (Table 4-93).

Anecdotal evidence from lobsterman's meetings suggests that the lobstering around the CLDS alternative is good. Oyster beds occur off New Haven, Connecticut. Other bivalve beds are harvested offshore between Port Jefferson and Mattituck, as well as, between New Rochelle, New York and Guilford, Connecticut. Mussels have been harvested off Mt Sinai and Mattituck, New York. Shellfish aquaculture beds are located off Rocky Point and Mattituck, New York. The most active and successful trawling in Long Island Sound occurs near the CLDS Alternative. Trawling activity occurs along three transects, one north, south, and east of the CLDS Alternative. The transects north and south of the CLDS Alternative run parallel to the Connecticut shoreline while the third transect runs perpendicular to the Connecticut shoreline. Commercial fin fishing has historically occurred along both Connecticut and New York coasts (EPA, 2004).

Recreational fishing occurs most often at artificial reefs off New York and reefs and areas of high relief, off Connecticut. In Connecticut, reefs have been documented off Lighthouse Point in East Haven, Branford Harbor, and Vineyard Point in Guilford. The New Haven Breakwaters are used by divers as well as anglers. The Branford Reef is closest to the CLDS Alternative; approximately five nautical miles (9.3 kilometers) northeast of the site. Major ports with party and charter boats near the CLDS Alternative include Mt. Sinai and Mattituck, New York, and New Haven, Connecticut (EPA, 2004).

CSDS

Infrastructure **-** The only transportation infrastructure found within 0.5 miles of this open water site are commercial shipping lanes (Table 4-91). Coastal infrastructure present at this alternative site includes the currently active placement site at this location (Table 4-92).

Orient Beach State Park and Gull Pond Beach in New York; and Rocky Neck State Park, White Sands Beach, West Beach, and Grove Point Beach in Connecticut are within 10 miles of the alternative site.

Commercial and Recreational Fisheries **-** There are no active commercial shell and fin fishing ports within 10 nautical miles of the CSDS alternative (EPA, 2004) (Table 4-93). CSDS is within Essential Fish Habitat designation for several commercially important species (see Section 4.10 for more detail on fish resources at this site).

NLDS

Infrastructure **-** The only transportation infrastructure found within 0.5 miles of this open water site are commercial shipping lanes (Table 4-91). Coastal infrastructure present at this alternative site includes the currently active placement site at this location (Table 4-92).

The beaches at Ocean Beach State Park, Bluff Point State Park, Waterford Beach Park, Harkness Memorial State Park, and Eastern Point Beach in Connecticut are within 10 miles of the alternative site.

Commercial and Recreational Fisheries **-** There are no active commercial shell and fin fishing ports within 10 nautical miles of the NLDS alternative (EPA, 2004) (Table 4-93). NLDS is within Essential Fish Habitat designation for several commercially important species (see Section 4.10 for more detail on fish resources at this site).

Confined Open Water Placement

Infrastructure **-** No transportation or coastal infrastructure is present within 0.5 miles of the confined open water alternative site (E) (Table 4-91 and Table 4-92).

The beaches at Calf Pasture Beach, Sherwood Island State Park, Jennings Beach, Cedar Point, and Seaside Park in Connecticut are within 10 miles of the alternative site.

Commercial and Recreational Fisheries **-** Commercial shell and fin fishing ports within 10 nautical miles of this alternative include Darien, Norwalk, Westport, Southport, and Fairfield in Connecticut (EPA, 2004) (Table 4-93). Site E is within Essential Fish Habitat designation for several commercially important species (see Section 4.10 for more detail on fish resources at this site). Aquaculture and shellfish beds (oyster and hard clam) are mapped within a half mile of the alternative site (see Section 4.9 for more detail on shellfish resources at this site).

4.20.3 Socioeconomics of Nearshore/Shoreline Environment

Socioeconomic data, including infrastructure and navigation related resources, for the nearshore/shoreline alternative sites are presented in Table 4-94 through Table 4-97. Additional details about these alternative sites, such as surrounding land use and site access, can be found in the associated study reports (USACE, 2010b, 2012a, 2012b).

4.20.4 Socioeconomics of Upland Environment

Socioeconomic data, including infrastructure and navigation related resources, for the upland alternative sites are presented in Table 4-98 through Table 4-100. Additional details about these alternative sites, such as surrounding land use and site access, can be found in the associated study reports (USACE, 2010b, 2012a, 2012b).

Table 4-90. Geographic Setting and Population Statistics in the Open Water Environment.

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
Open Water Environment	**Unconfined Open Water Placement**	WLDS	CT	Fairfield	Darien	90019900000017	0	0
		CLDS	CT	New Haven	*	90099900000054	0	0
		CSDS	CT	Middlesex	*	90079901000001	0	0
		NLDS	CT	New London	*	90119901000030	0	0
	Confined Open Water Placement	E	CT	Fairfield	Westport	90019900000012	0	0

* no resources identified within 0.5 mile radius

Table 4-91. Transportation Infrastructure within the Open Water Environment.

Environment	Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
Open Water Environment	**Unconfined Open Water Placement**	WLDS	*	*	*	*	Commercial shipping lanes pass through the site.	420000, 421000, 420100, 421300	15,941,398
		CLDS	*	*	*	*	Commercial shipping lanes pass through the site.	396800	7,644,241
		CSDS	*	*	*	*	Commercial shipping lanes pass through the site.	393900	9,681,481
		NLDS	*	*	*	*	Commercial shipping lanes pass through the site.	392600, 392400, 392700	437,569
	Confined Open Water Placement	E	*	*	*	*	No commercial shipping lanes pass through the site.	*	*

* no resources identified within 0.5 mile radius

Table 4-92. Coastal Infrastructure within the Open Water Environment.

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ Utility Crossing	Mooring Areas	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
Open Water Environment	**Unconfined Open Water Placement**	WLDS	*	*	*	*	This is an active disposal site.	*	*
		CLDS	*	*	*	*	This is an active disposal site.	*	*
		CSDS	*	*	*	*	This is an active disposal site.	*	*
		NLDS	*	*	*	*	This is an active disposal site.	*	*
	Confined Open Water Placement	E	*	*	*	*	*	*	*

* no resources identified within 0.5 mile radius

Table 4-93. Commercial and Recreational Fisheries within the Open Water Environment.

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Fishing Ports	Shellfish
Open Water Environment	**Unconfined Open Water Placement**	WLDS	*	*	Commercial shell and fin fishing ports within 10 nautical miles of the alternative site.	*
		CLDS	*	*	Commercial shell and fin fishing ports within 10 nautical miles of the alternative site.	*
		CSDS	*	*	No commercial shell and fin fishing ports within 10 nautical miles of the alternative site.	*
		NLDS	*	*	No commercial shell and fin fishing ports within 10 nautical miles of the alternative site.	*
	Confined Open Water Placement	E	Aquaculture and shellfish beds are mapped within a half mile of the alternative site.	*	Commercial shell and fin fishing ports within 10 nautical miles of the alternative site.	Oyster/ Hard Clam

Table 4-94. Geographic Setting and Population Statistics in the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	CT	Fairfield	Bridgeport	90010704001022	0	0
		H	CT	Fairfield	Bridgeport	90010744003021	0	0
		M	CT	New Haven		90099900000020	0	0
	Island CDF	B	CT	Fairfield	Greenwich	90010113001026	0	0
		L	CT	New Haven		90099900000030	0	0
		N	CT	New Haven		90099900000007	0	0
		P	CT	Middlesex	Clinton	90076102002022	0	0
		Q	CT	New London	Waterford	90119901000014	0	0
		R	CT	New London	Groton	90119901000010	0	0
	Shoreline CDF	A	NY	Nassau	North Hempstead	360593014002002	0	0
		C	CT	Fairfield	Norwalk	90010444001014	0	0
		D	CT	Fairfield	Norwalk	90010444001014	0	0
		F	CT	Fairfield		90019900000006	0	0
		I	CT	Fairfield	Bridgeport	90010743005006	0	0
		J	CT	Fairfield		90019900000002	0	0
		K	CT	New Haven		90091509001038	0	0
		O	CT	Middlesex	Clinton	90076101002039	0	0
	Nearshore Bar Placement/ Nearshore Berm Sites	177	NY	Suffolk	East Hampton	361032010043033	0	0
		178	NY	Suffolk	East Hampton	361032010041024	0	0
		179	NY	Suffolk	East Hampton	361032010041001	36	63
		121/446	NY	Suffolk	East Hampton	361032010041000	0	0
		453	NY	Suffolk	East Hampton	361032010042001	64	116
		173	NY	Suffolk	East Hampton	361032010044017	0	0
		180	NY	Suffolk	Southold	361031702024006	65	72
		454A	NY	Suffolk	Southold	361031702015009	95	164
		454B	NY	Suffolk	Southold	361031702015000	0	0
		455/82	NY	Suffolk	Southold	361031700013000	0	0
		445	NY	Suffolk	Riverhead	361031699021000	0	0
		171	NY	Suffolk	Riverhead	361039901000038	0	0
		170	NY	Suffolk	Smithtown	361031347042000	0	0

Table 4-94. Geographic Setting and Population Statitics in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
		63	NY	Suffolk	Huntington	361031108012005	127	73
		456	NY	Nassau	Oyster Bay	360595179022000	0	0
		441	CT	Fairfield	Darien	90010219003016	0	0
		320	CT	Fairfield	Norwalk	90010443004019	6	3
		440	CT	Fairfield	Westport	90019900000012	0	0
		449	CT	Fairfield	Westport	90010506002038	0	1
		438	CT	Fairfield	Westport	90010506003035	38	37
		433	CT	Fairfield		90010606001060	112	49
		434	CT	Fairfield		90010616003000	47	26
		323	CT	Fairfield	Bridgeport	90010704001024	0	0
		467	CT	Fairfield		90010805001032	3	1
		364	CT	New Haven	Milford	90091502002010	153	120
		451	CT	New Haven	Milford	90099900000040	0	0
		447	CT	New Haven		90091548005000	3	1
		327/333/ 330						
		337	CT	New Haven		90091428003023	0	0
		457	CT	New Haven		90091941005011	29	31
		365	CT	New Haven		90099900000001	0	0
		GP						
		367	CT	New London	East Lyme	90119901000021	0	0
		368	CT	New London	Groton	90117029002032	0	0
		381/382	RI	Washington		440099901000046	0	0
		384	RI	Washington	Westerly	440099901000038	0	0
		600	RI	Washington	New Shoreham	440090415002002	108	328
		610	RI	Washington	New Shoreham	440090415002002	108	328
	Beach Nourishment	323	CT	Fairfield	Bridgeport	90010704001024	0	0
		433	CT	Fairfield		90010606001060	112	49
		434	CT	Fairfield		90010616003000	47	26
		436	CT	Fairfield	Fairfield	90010615003001	229	78
		365	CT	New Haven		90099900000001	0	0

Table 4-94. Geographic Setting and Population Statitics in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
		457	CT	New Haven		90091941005011	29	31
		364	CT	New Haven	Milford	90091502002010	153	120
		444	CT	New Haven	Milford	90091509001035	157	72
		451	CT	New Haven	Milford	90099900000040	0	0
		337	CT	New Haven		90091428003023	0	0
		320	CT	Fairfield	Norwalk	90010443004019	6	3
		441	CT	Fairfield	Darien	90010219003016	0	0
		442	CT	Fairfield	Stamford	90010219004014	21	8
		450	CT	Fairfield	Stratford	90010805001019	86	37
		447	CT	New Haven		90091548005000	3	1
		438	CT	Fairfield	Westport	90010506003035	38	37
		440	CT	Fairfield	Westport	90019900000012	0	0
		449	CT	Fairfield	Westport	90010506002038	0	1
		181	NY	Bronx	New York	360050504001018	4	1
		453	NY	Suffolk	East Hampton	361032010042001	64	116
		63	NY	Suffolk	Huntington	361031108012005	127	73
		456	NY	Nassau	Oyster Bay	360595179022000	0	0
		454E						
		454W						
		455/82	NY	Suffolk	Southold	361031700013000	0	0
		384	RI	Washington	Westerly	440099901000038	0	0
		367	CT	New London	East Lyme	90119901000021	0	0
		368	CT	New London	Groton	90117029002032	0	0
		171	NY	Suffolk	Riverhead	361039901000038	0	0
		173	NY	Suffolk	East Hampton	361032010044017	0	0
		177	NY	Suffolk	East Hampton	361032010043033	0	0
		178	NY	Suffolk	East Hampton	361032010041024	0	0
		179	NY	Suffolk	East Hampton	361032010041001	36	63
		170	NY	Suffolk	Smithtown	361031347042000	0	0
		180	NY	Suffolk	Southold	361031702024006	65	72
		445	NY	Suffolk	Riverhead	361031699021000	0	0

Table 4-94. Geographic Setting and Population Statitics in the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
		446	NY	Suffolk	East Hampton	361032010041001	36	63
		343	CT	Middlesex	Clinton	90076102002005	332	415
		474	CT	Fairfield	Fairfield	90010616003006	427	194
		339	CT	New Haven	Guilford	90091901003040	31	18
		459	CT	New Haven	New Haven	90091428002014	183	94
		348	CT	New London	Old Lyme	90116601023014	114	89
		480	CT	New London	Stonington	90117052002014	92	93
		467	CT	Fairfield		90010805001032	3	1
		468	CT	Fairfield	Stratford	90010805003000	12	7
		325	CT	New Haven	West Haven	90091551004001	95	77
		327	CT	New Haven	West Haven	90091551004001	95	77
		329	CT	New Haven	West Haven	90091551002003	0	0
		330	CT	New Haven	West Haven	90091551004001	95	77
		331	CT	New Haven	West Haven	90091551002003	0	0
		332	CT	New Haven		90091550001010	0	0
		333	CT	New Haven	West Haven	90091551004001	95	77
		344	CT	Middlesex	Westbrook	90076801004004	59	77
		345	CT	Middlesex	Westbrook	90076801004020	109	74
		121	NY	Suffolk	East Hampton	361032010041001	36	63
		64	NY	Suffolk	Huntington	361031108011021	0	0
		67	NY	Suffolk	Huntington	361031103005001	25	10
		68	NY	Suffolk	Huntington	361031102001002	0	0
		111	NY	Suffolk	Shelter Island	361031803001036	24	56
		76	NY	Suffolk	Southold	361031702014001	0	0
		79	NY	Suffolk	Southold	361031702025062	12	13
		381	RI	Washington	Westerly	440090510001009	0	25
		382	RI	Washington	Westerly	440090510001008	0	0
		437	NY	Suffolk	Southold	361031702024008	0	0
		600	RI	Washington	New Shoreham	440090415002002	108	328
		610	RI	Washington	New Shoreham	440090415002002	108	328

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment.

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
In-Harbor CAD Cell	G	*	*	Yes	Port of Bridgeport	Entrance channel to Bridgeport Harbor adjacent to CAD; high intensity vessel traffic in vicinity of harbor including Bridgeport - Port Jefferson ferry	398100	1009992
	H	*	*	Yes	Port of Bridgeport	Entrance channel to Bridgeport Harbor adjacent to CAD; high intensity vessel traffic in vicinity of harbor including Bridgeport - Port Jefferson ferry	398100	1009992
	M	*	*	*	Port of New Haven over 2 miles to north	New Haven Harbor Channel within 1 mile to west	*	*
Island CDF	B	*	*	*	*	*	396720	0
	L	*	*	*	Port of New Haven approximately 4 miles to northeast	New Haven Harbor Channel to east	*	*
	N	*	*	*	*	*	395300	0
	P	*	*	*	*	*	397400	0
	Q	*	*	*	*	*	*	*
	R	*	*	Yes	*	Entrance channel to New London Harbor and high density vessel traffic within 1/2 mile to west of CDF	*	*
Shoreline CDF	A	*	*	*	Port of Hempstead Harbor	Channel to 7 feet along eastern shore from Bar Beach to South Glenwood Landing	*	*
	C	*	*	*	*	Entrance channel to Norwalk Harbor within 1/2 mile northwest of CDF; medium intensity	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
						vessel traffic within channel and approach		
	D	*	*	*	*	Entrance channel to Norwalk Harbor within 1/2 mile northwest of CDF; medium intensity vessel traffic within channel and approach	*	*
	F	*	*	*	*	Medium to high intensity vessel traffic within 1/2 mile north and east of CDF associated with Black Rock Harbor; harbor entrance channel within 1/2 mile north of CDF	*	*
	I	Interstate Route 95	*	*	Port of Bridgeport	Bridgeport Harbor channels and Yellow Mill Channel are adjacent to and coincident with CDF; high intensity vessel traffic in vicinity of harbor including Bridgeport-Port Jefferson ferry	398300	0
	J	*	*	*	*	Medium intensity vessel traffic within 1 mile south of CDF; Stratford Harbor entrance channel within 1/2 mile north of CDF	*	*
	K	*	*	*	*	Entrance channel to Milford Harbor	397500	0
	O	*	*	*	*	Entrance channel to Clinton Harbor within 1/2 mile east of CDF	397400, 394400	0
	177	*	*	*	*	Light intensity vessel use 1/2 mile seaward of berm	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
Nearshore Bar Placement/ Nearshore Berm Sites	178	*	*	*	*	Light intensity vessel use 1/2 mile seaward of berm	*	*
	179	*	*	*	*	Light intensity vessel use 1/2 mile seaward of berm	*	*
	121/446	*	*	*	*	Entrance to Montauk Harbor at western end of berm, medium intensity vessel traffic within 1/2 mile of berm - including seasonal Block Island Ferry	*	*
	453	*	*	*	*	Entrance to Montauk Harbor at eastern end of berm, medium intensity vessel traffic within 1/2 mile of berm - including seasonal Block Island Ferry	405200	0
	173	*	*	*	*	Entrance to Napeague Harbor within 1 mile of berm	*	*
	180	*	*	*	*	Channel for Cross Sound Ferry within 1/2 mile of berm, medium density vessel traffic within 1/2 mile of berm	*	*
	454A	State Route 25	*	*	*	*	*	*
	454B		*	*	*	*		
	455/82		*	*	*	Mattituck Inlet within 1/2 mile of western end of berm	394900	0
	445		*	*	*	*	402500	3244015
	171		*	*	*	*	*	*
	170	Unlisted Access Highway	*	*	*	Channel to Nessequogue River within 1 mile east of berm	*	*
	63	*	*	*	*	Channel to Northport Basin within 1/2 mile east of berm		
	456	*	*	*	*	*	421600	0
	441	*	*	*	*	*	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
	320	*	*	*	0	Channel to Bermuda Lagoon within 1 mile north of berm	399933	96636
	440	*	*	*	*	*	399533, 2414100, 399566	0
	449	*	*	*	*	*	*	*
	438	*	Yes	*	*	*	*	*
	433	*	*	*	*	Channel to Southport Harbor within 1/2 mile to northeast of berm	399200	0
	434	*	*	*	*	Channel to Southport Harbor within 1/2 mile to northwest of berm	399200	0
	323	*	*	*	Port of Bridgeport within 1 mile northeast of berm	Channels to Black Rock Harbor and Bridgeport Harbor within 1 mile to west and east of berm; medium to high density vessel traffic to both harbors	398800, 398900, 407300	0
	467	*	*	*	*	*	*	*
	364	*	*	*	*	*	*	*
	451	*	*	*	*	*	*	*
	447	*	*	*	*	*	*	*
	327/333/ 330	*	*	*	*	*	*	*
	337	*	*	*	*	New Haven Harbor Entrance Channel within 1/2 mile west of berm; high density vessel traffic in vicinity of channel	396800	7644241
	457	US Route 1	*	*	*	*	*	*
	365	*	*	*	*	*	*	*
	GP	*	*	*	*	Entrance channel to Patchogue River within 1/2 mile of berm	*	*
	367	*	Yes	*	*	*	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
	368	*	*	*	*	Bayberry Lane Boat Launch and medium density vessel traffic in the vicinity of Avery Point	*	*
	381/382	*	*	*	*	Medium density vessel traffic within 1/2 mile seaward of berm	391500	0
	384	*	*	*	*	*	*	*
	600	*	*	Yes	Harbor of Refuge within 1 mile	Harbor of Refuge entrance channel within 1 mile	*	*
	610	*	*	*	*	*	*	*
	620	*	*	*	*	*	*	*
Beach Nourishment	323	*	*	*	n.d.	n.d.	398800, 398900, 407300	0
	433	*	*	*	n.d.	n.d.	399200	0
	434	*	*	*	n.d.	n.d.	399200	0
	436	*	*	*	n.d.	n.d.	*	*
	365	*	*	*	n.d.	n.d.	*	*
	457	US Route 1	*	*	n.d.	n.d.	*	*
	364	*	*	*	n.d.	n.d.	*	*
	444	*	*	*	n.d.	n.d.	397500	0
	451	*	*	*	n.d.	n.d.	*	*
	337	*	*	*	n.d.	n.d.	396800	7644241
	320	*	*	*	n.d.	n.d.	399933	96636
	441	*	*	*	n.d.	n.d.	*	*
	442	*	*	*	n.d.	n.d.	421000	494722
	450	*	*	*	n.d.	n.d.	397800	0
	447	*	*	*	n.d.	n.d.	*	*
	438	*	Yes	*	n.d.	n.d.	*	*
	440	*	*	*	n.d.	n.d.	399533, 2414100, 399566	0
	449	*	*	*	n.d.	n.d.	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
	181	*	*	*	n.d.	n.d.	*	*
	453	*	*	*	n.d.	n.d.	405200	0
	63	*	*	*	n.d.	n.d.	*	*
	456	*	*	*	n.d.	n.d.	421600	0
	454E	*	*	*	n.d.	n.d.	*	*
	454W	*	*	*	n.d.	n.d.	*	*
	455/82	*	*	*	n.d.	n.d.	394900	0
	384	*	*	*	n.d.	n.d.	*	*
	367	*	Yes	*	n.d.	n.d.	*	*
	368	*	*	*	n.d.	n.d.	*	*
	171	*	*	*	n.d.	n.d.	*	*
	173	*	*	*	n.d.	n.d.	*	*
	177	*	*	*	n.d.	n.d.	*	*
	178	*	*	*	n.d.	n.d.	*	*
	179	*	*	*	n.d.	n.d.	*	*
	170	Unlisted Access Highway	*	*	n.d.	n.d.	*	*
	180	*	*	*	n.d.	n.d.	*	*
	445	*	*	*	n.d.	n.d.	402500	3244015
	446	*	*	*	n.d.	n.d.	*	*
	343	*	*	*	n.d.	n.d.	*	*
	474	*	*	*	n.d.	n.d.	*	*
	339	*	*	*	n.d.	n.d.	395300	0
	459	*	*	*	n.d.	n.d.	*	*
	348	*	*	*	n.d.	n.d.	*	*
	480	*	*	*	n.d.	n.d.	392000	0
	467	*	*	*	n.d.	n.d.	*	*
	468	*	*	*	n.d.	n.d.	*	*
	325	*	*	*	n.d.	n.d.	*	*
	327	*	*	*	n.d.	n.d.	*	*
	329	*	*	*	n.d.	n.d.	*	*
	330	*	*	*	n.d.	n.d.	*	*
	331	*	*	*	n.d.	n.d.	*	*

Table 4-95. Transportation Infrastructure within the Nearshore/Shoreline Environment (continued).

Alternative Type	Alternative ID	Roads	Rail	Ferry	Ports	Navigational Channels	Waterborne Commerce LinkNo.	Waterborne Tonnage
	332	*	*	*	n.d.	n.d.	*	*
	333	*	*	*	n.d.	n.d.	*	*
	344	US Route 1	*	*	n.d.	n.d.	*	*
	345	US Route 1	*	*	n.d.	n.d.	394110	0
	121	*	*	*	n.d.	n.d.	405200	0
	64	*	*	*	n.d.	n.d.	*	*
	67	*	*	*	n.d.	n.d.	*	*
	68	*	*	*	n.d.	n.d.	*	*
	111	*	*	*	n.d.	n.d.	*	*
	76	State Route 25	*	*	n.d.	n.d.	*	*
	79	*	*	*	n.d.	n.d.	403400	0
	381	*	*	*	n.d.	n.d.	*	*
	382	*	*	*	n.d.	n.d.	391500	0
	437	*	*	*	n.d.	n.d.	*	*
	600	*	*	Yes	Harbor of Refuge within 1 mile	Harbor of Refuge entrance channel within 1 mile	*	*
	610	*	*	*	*	*	*	*
	620	*	*	*	*	*	*	*

* no resources identified within 0.5 mile radius

n.d. = no data available

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	Bridgeport Harbor and Seaside Park heavily armored; jetties at harbor entrance; multiple groins along Long Beach within 1 mile east of CAD	Cable area between Bridgeport and Long Beach within 1 mile northeast of CAD	Johnsons Creek anchorage area within 1 mile northeast of CAD	*	*	Multiple facilities around industrial harbor; LNG facility is within 1/2 mile north of CAD	*
		H	Bridgeport Harbor and Seaside Park heavily armored; jetties at harbor entrance; multiple groins along Long Beach within 1 mile east of CAD	Cable area between Bridgeport and Long Beach within 1 mile northeast of CAD	Johnsons Creek anchorage area within 1 mile northeast of CAD	*	*	Multiple facilities around industrial harbor; LNG facility is within 1/2 mile north of CAD	*
		M	Multiple groins, bulkheads, and seawalls along shoreline of Morris Cove within 1 mile of CAD	Cross Sound Cable within 1 mile west of CDF	*	*	* (besides Morris Cove)	Tweed New Haven Airport within 1 mile east of CAD	*
	Island CDF	B	Calf Islands have groins, majority of surrounding harbor is armored	Cable area within 1 mile south of CDF	Mooring fields in Byram Harbor within 1/2 mile north of CDF	*	*	*	*
		L	Breakwaters form southwestern and southeastern edges of CDF	Cross Sound Cable within 1/2 mile east of CDF	*	*	Morris Cove Disposal Site across channel within 2 miles to east	*	*
		N	*	*	*	*	*	*	*
		P	Kelsey Point Breakwater is western boundary of CDF; multiple groins along shoreline within 1/2	*	*	*	Clinton Harbor Disposal Site within 1/2 mile northwest of CDF	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
			mile north of CDF						
		Q	Armoring and multiple groins and bulkheads along shoreline of Jordan Cove within 1 mile north of CDF	*	*	*	* (although Niantic Bay Disposal Site over 1 mile southwest of CDF)	Millstone Power Plant within 1 mile northwest of CDF	*
		R	Armoring and multiple groins along shoreline of Avery Point within 1 mile north of CDF	Cable area from Avery Point intersects northwestem and eastern footprint of CDF	Pine Island and Avery Point Special Anchorage areas within 1 mile northeast of CDF; New London Anchorage C within 1 mile west of CDF; New London Anchorage E within 1 mile south of CDF	*	* (although New London Disposal Site over 1 mile south of CDF)	*	*
	Shoreline CDF	A	Bulkheads at South Glenwood Landing within 1/2 east of CDF	*	*	*	*	Multiple facilities around industrial harbor; Glenwood Landing Energy Center is within 1/2 mile east of CDF	*
		C	Multiple residential docks serve houses on Ram Bay islands within footprint of CDF	Cable area between Norwalk and Northport under western half of CDF	*	*	*	*	USFWS Sheffield Island Unit

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		D	Multiple residential docks serve houses on Ram Bay islands within footprint of CDF	Cable area between Norwalk and Northport under western half of CDF	*	*	*	*	USFWS Sheffield Island Unit
		F	Multiple groins and one jetty along shoreline within 1 mile of CDF	Cable area adjacent to and within footprint of eastern extent of CDF	*	*	*	Fairfield Water Pollution Control in upland within 1/2 mile west of CDF	*
		I	Shoreline of Bridgeport Shoreline of Bridgeport Harbor heavily armored within 1 mile southwest of CDF	Submerged cable and pipeline area adjacent to CDF from I-95 bridge south to Bridgeport Harbor	Johnsons Creek anchorage area within 1/2 mile east of CDF	*	*	Multiple facilities around industrial harbor; LNG facility is within 1/2 mile west of CDF	*
		J	Shoreline armoring at Stratford Point, multiple groins along shoreline at western end of CDF and within 1 mile west of CDF	*	*	*	*	Igor I Sikorsky Memorial Airport within 1 mile north of CDF	*
		K	Jetties at entrance to harbor; bulkheads throughout Milford Harbor within 1 mile northwest of CDF	*	Moorings along Milford Harbor Channel within 1/2 mile northwest of CDF	*	0	*	*
		O	Bulkheads within Clinton Inner Harbor within 1/2 mile north of CDF; groins at Town Beach and	Cable and pipeline area between Clinton and Cedar Island within 1/2	*	*	Clinton Harbor Disposal Site within 1/2 mile southeast of CDF	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
			residential area within 1 mile east of CDF	mile northeast of CDF					
	Nearshore Bar Placement/ Nearshore Berm Sites	177	*	*	*	*	*	*	*
		178	Shoreline armoring at Montauk Point within 1 mile northeast of berm	Submerged cable area within 1 mile northeast of berm	*	*	*	*	*
		179	Montauk Point is heavily armored in front of lighthouse	Cable area adjacent to Montauk Point	*	*	*	*	*
		121/446	Jetties at harbor entrance within 1/2 mile of berm	*	*	*	*	*	*
		453	Jetties at harbor entrance within 1/2 mile of berm	*	*	*	*	*	*
		173	*	*	*	*	*	*	*
		180	Shoreline armoring and multiple groins along park access road	Submerged cable area within 1 mile of berm	*	*	*	Ferry terminal for Plum Island Animal Disease Center within 1/2 mile of berm	*
		454A	Multiple groins and bulkheads along shoreline	*	*	*	*	Waterfront hotel and restaurant at eastern end of berm	*
		454B	Multiple groins and bulkheads along shoreline	*	*	*	*	*	*
		455/82	Mattituck Inlet jetties within 1/2 mile of western end of berm	*	*	*	*	*	*
		445	Multiple groins and bulkheads along shoreline, mostly west of berm	*	*	*	*	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		171	Bulkheads and groin at park concession stand, multiple bulkheads (to west) and groins (to east) along shoreline	*	*	*	*	*	*
		170	Large groin in front of park boardwalk, some bulkheads and groins along shoreline within 1 mile west of berm	*	*	*	*	*	*
		63	Multiple bulkheads and groins shoreward of berm; jetties for Northport Basin within 1/2 mile east of berm	Norwalk-Northport cable area and Iroquois Gas Pipeline within 1/2 mile east of berm	*	*	*	Northport Power Station within 1/2 mile east of berm	*
		456	Multiple bulkheads shoreward of berm; shoreline armoring within 1/2 mile east of berm	*	*	*	*	*	*
		441	Breakwater to northwest within 1 mile of berm, multiple shoreline armoring and groins within 1 mile of berm	*	Moorings in eastern Cove Harbor and Noroton Harbor special anchorage area within 1 mile of eastern end of berm	*	*	*	*
		320	Multiple groins and shoreline armoring approximately 1 mile from berm	*	Moorings at Sprite Island Yacht Club within 1 mile northwest of berm	*	*	Sprite Island Yacht Club within 1 mile northwest of berm	*
		440	Multiple groins and shoreline armoring within 1 mile of berm	*	*	*	*	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		449	Multiple groins within 1/2 mile of berms; jetties between Alvord Beach and Burial Hill Beach within 1/2 mile northeast of berms	*	*	*	*	*	*
		438	Jetties between Alvord Beach and Burial Hill Beach within 1/2 mile of berm; multiple groins within 1 mile northeast and northwest of berm	*	*	*	*	*	*
		433	Groins on Southport Beach; multiple groins and shoreline armoring, and jetty within 1 mile of berm	*	*	*	*	*	*
		434	Groin and bulkhead bounding Sasco Hill Beach; multiple groins and shoreline armoring, and jetty within 1 mile of berm	*	*	*	*	*	*
		323	Seawalls and shoreline armoring on either side of beach; Bridgeport Harbor jetty within 1 mile northeast of berm	Cable area near Black Rock Harbor channel within 1 mile west of berm	Black Rock Harbor behind Seaside Beach	*	*	Seaside Beach Park is a former landfill; Sikorsky Aircraft Company is adjacent to beach and park	*
		467	Multiple groins along shoreline within 1 mile of berm	*	*	*	*	*	*
		364	Multiple groins along shoreline within 1 mile north and west of berm	Iroquois gas pipeline within 1 mile northeast of berm	*	Silver Sands State Park Boat Launch	*	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		451	Multiple groins and armoring along shoreline within 1 mile north and west of berm	*	*	*	*	*	*
		447	Multiple groins and armoring along shoreline within 1 mile north and west of berm	*	*	*	*	*	*
		327/333/ 330	Multiple groins and armoring along shoreline within 1 mile north and west of berm	*	*	*	*	*	*
		337	Groins within 1/2 mile shoreward of berm; shoreline armoring within 1/2 mile east of berm; eastern breakwater within 1/2 mile seaward of berm	Cross Sound Cable within 1/2 mile west of berm; cable area within 1/2 mile east of berm	*	Lighthouse Point Boat Launch	Morris Cove Disposal Site within 1 mile to northeast	*	*
		457	Multiple groins, bulkheads and armoring along shoreline within 1 mile of berm; stone wharf adjacent to receiving beach	Cable area within 1 mile west of berm	*	*	*	*	*
		365	Pair of large groins bracket Hammonasset Beach	*	*	Hammonasset Beach Boat Launch	Clinton Harbor Disposal Site within 1/2 mile southeast of berm	*	*
		GP	Multiple groins along shoreline; jetty at entrance to Patchogue River within 1/2 mile northeast of berm; Duck Island breakwaters within 1 mile seaward of berm	*	*	*	*	*	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		367	Multiple groins along shoreline from Rocky Neck to Seal Rock	*	U.S. Coast Guard special anchorage area on west side of entrance to Pataguanset River	Four Mile River Boat Launch	*	*	*
		368	Shoreline armoring at Avery Point within 1 mile west of berm	Cable area within 1 mile seaward of berm	Special anchorage areas at Avery Point and Pine Island within 1/2 mile west of berm	Bluff Point Boat Launch	*	*	*
		381/382	Shoreline armoring at Watch Hill Lighthouse, groins at Watch Hill Beach within 1/2 mile shoreward of berm	Cable area intersects berm and within 1/2 mile seaward of berm	Special anchorage area in Watch Hill Cove behind receiving barrier beach	*	*	*	*
		384	Shoreline armoring at one parcel within 1/2 mile of eastern end of berm	*	*	*	*	*	*
		600	n.d.	n.d.	n.d.	Old Harbor Boat Launch	n.d.	n.d.	Yes
		610	n.d.	n.d.	n.d.	*	n.d.	n.d.	Yes
		620	n.d.	n.d.	Stonington Harbor Special Anchorage Area No. within 1 mi.2	*	n.d.	n.d.	*
	Beach Nourish-ment	323	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		433	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		434	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		436	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		365	n.d.	n.d.	n.d.	Hammonas-set Beach Boat Launch	n.d.	n.d.	*
		457	n.d.	n.d.	n.d.	*	n.d.	n.d.	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		364	n.d.	n.d.	n.d.	Silver Sands State Park Boat Launch	n.d.	n.d.	*
		444	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		451	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		337	n.d.	n.d.	n.d.	Lighthouse Point Boat Launch	n.d.	n.d.	*
		320	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		441	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		442	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		450	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		447	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		438	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		440	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		449	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		181	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		453	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		63	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		456	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		454E	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		454W	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		455/82	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		384	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		367	n.d.	n.d.	n.d.	Four Mile River Boat Launch	n.d.	n.d.	*
		368	n.d.	n.d.	n.d.	Bluff Point Boat Launch	n.d.	n.d.	*
		171	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		173	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		177	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		178	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		179	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		170	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		180	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		445	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		446	n.d.	n.d.	n.d.	*	n.d.	n.d.	*

Table 4-96. Coastal Infrastructure within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Coastal Structures	Cable/Power/ UtilityCrossing	Moorings	Boat Launches	Dredged Material Disposal Sites	Commercial/ Industrial Facilities	Open Space
		343	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		474	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		339	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		459	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		348	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		480	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		467	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		468	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		325	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		327	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		329	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		330	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		331	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		332	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		333	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		344	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		345	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		121	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		64	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		67	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		68	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		111	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		76	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		79	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		381	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		382	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		437	n.d.	n.d.	n.d.	*	n.d.	n.d.	*
		600	n.d.	n.d.	n.d.	Old Harbor Boat Launch	n.d.	n.d.	Yes
		610	n.d.	n.d.	n.d.	*	n.d.	n.d.	Yes
		620	n.d.	n.d.	n.d.	Barn Island Boat Launch	n.d.	n.d.	*

* no resources identified within 0.5 mile radius

n.d. = no data available

Table 4-97. Commercial and Recreational Fisheries within the Nearshore/Shoreline Environment.

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Shellfish
Nearshore/ Shoreline Environment	**In-Harbor CAD Cell**	G	Shellfish	*	Oyster
		H	Shellfish	*	Oyster / Hard Clam
		M	Shellfish	*	Oyster / Hard Clam
	Island CDF	B	Shellfish	*	Oyster / Hard Clam
		L	Shellfish	*	Hard Clam
		N	Shellfish	*	*
		P	Shellfish	*	*
		Q	Shellfish	*	Hard Clam
		R	Shellfish	*	Hard Clam
	Shoreline CDF	A	*	*	*
		C	Shellfish	*	Oyster / Hard Clam
		D	Shellfish	*	Oyster / Hard Clam
		F	Shellfish	*	Hard Clam
		I	Shellfish	*	*
		J	Shellfish	*	Oyster
		K	Shellfish	*	Oyster / Hard Clam / Soft Clam
		O	Shellfish	*	Oyster / Hard Clam
	Nearshore Bar Placement/ Nearshore Berm Sites	177	*	*	*
		178	*	*	*
		179	*	*	*
		121/446	*	*	*
		453	*	*	*
		173	*	*	*
		180	*	*	*
		454A	*	*	*
		454B	*	*	*
		455/82	*	*	*
		445	*	*	*
		171	*	*	*
		170	*	*	*
		63	*	*	*

Table 4-97. Commercial and Recreational Fisheries within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Shellfish
		456	*	*	*
		441	Shellfish	*	Oyster / Hard Clam / Soft Clam
		320	Shellfish	*	Oyster / Hard Clam
		440	Shellfish	*	Oyster / Hard Clam
		449	Shellfish	*	Hard Clam
		438	Shellfish	*	Hard Clam
		433	Shellfish	*	Oyster / Hard Clam / Soft Clam
		434	Shellfish	*	Oyster / Hard Clam / Soft Clam
		323	Shellfish	Yes	Oyster
		467	Shellfish	*	Oyster / Hard Clam
		364	Shellfish	*	Oyster / Hard Clam / Soft Clam
		451	Shellfish	*	Oyster / Hard Clam / Soft Clam
		447	Shellfish	*	Oyster / Hard Clam / Soft Clam
		327/333/ 330	*	*	*
		337	Shellfish	Yes	Oyster / Hard Clam / Soft Clam
		457	Shellfish	*	Oyster / Hard Clam
		365	Shellfish	*	*
		GP		*	*
		367	Shellfish	*	Oyster / Hard Clam / Soft Clam
		368	Shellfish	Yes	Oyster / Hard Clam / Soft Clam
		381/382	*	*	Hard Clam
		384	*	*	*
		600	Yes	*	*
		610	*	*	*

Table 4-97. Commercial and Recreational Fisheries within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Shellfish
		620	Shellfish	*	Hard Clam
	Beach Nourishment	323	Shellfish	Yes	Oyster
		433	Shellfish	*	Oyster / Hard Clam / Soft Clam
		434	Shellfish	*	Oyster / Hard Clam / Soft Clam
		436	Shellfish	*	Oyster / Hard Clam
		365	Shellfish	*	*
		457	Shellfish	*	Oyster / Hard Clam
		364	Shellfish	*	Oyster / Hard Clam / Soft Clam
		444	Shellfish	*	Oyster / Hard Clam / Soft Clam
		451	Shellfish	*	Oyster / Hard Clam / Soft Clam
		337	Shellfish	Yes	Oyster / Hard Clam / Soft Clam
		320	Shellfish	*	Oyster / Hard Clam
		441	Shellfish	*	Oyster / Hard Clam / Soft Clam
		442	Shellfish	*	Oyster / Hard Clam
		450		*	Oyster / Hard Clam / Soft Clam
		447	Shellfish	*	Oyster / Hard Clam / Soft Clam
		438	Shellfish	*	Hard Clam
		440	Shellfish	*	Oyster / Hard Clam
		449	Shellfish	*	Hard Clam
		181	*	*	*
		453	*	*	*
		63	*	*	*
		456	*	*	*
		454E	*	*	*

Table 4-97. Commercial and Recreational Fisheries within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Shellfish
		454W	*	*	*
		455/82	*	*	*
		384	*	*	*
		367	Shellfish	*	Oyster/Hard Clam/Soft Clam
		368	Shellfish	Yes	Oyster/Hard Clam/Soft Clam
		171	*	*	*
		173	*	*	*
		177	*	*	*
		178	*	*	*
		179	*	*	*
		170	*	*	*
		180	*	*	*
		445	*	*	*
		446	*	*	*
		343	Shellfish	*	Oyster/Hard Clam
		474	Shellfish	*	Oyster/Hard Clam
		339	Shellfish	*	Oyster/Hard Clam/Soft Clam
		459	Shellfish	Yes	Oyster/Hard Clam
		348	*	*	*
		480	Shellfish	Yes	Hard Clam
		467	Shellfish	*	Oyster/Hard Clam
		468	Shellfish	*	*
		325	Shellfish	*	Oyster / Hard Clam
		327	Shellfish	*	Oyster/Hard Clam/Soft Clam
		329	Shellfish	*	Oyster / Hard Clam
		330	Shellfish	*	Oyster/Hard Clam/Soft Clam
		331	Shellfish	*	Oyster/Hard Clam
		332	Shellfish	*	Oyster

Table 4-97. Commercial and Recreational Fisheries within the Nearshore/Shoreline Environment (continued).

Environment	Alternative Type	Alternative ID	Aquaculture	Fishing Communities	Shellfish
		333	Shellfish	*	Oyster/Hard Clam/Soft Clam
		344	*	*	Hard Clam
		345	Shellfish	*	Hard Clam
		121	*	*	*
		64	*	*	*
		67	*	*	*
		68	*	*	*
		111	*	*	*
		76	*	*	*
		79	*	*	*
		381	*	*	Hard Clam
		382	*	*	Hard Clam
		437	*	*	*
		600	Yes	*	*
		610	*	*	*
		620	Shellfish	*	Hard Clam

* no resources identified within 0.5 mile radius

Table 4-98. Geographic Setting and Population Statistics in the Upland Environment.

Environment	Alternative Type	Alternative ID	State	County	City	Census Block 2010	Population 2010	Housing 2010
Upland Environment	**Landfill Placement**	59	NY	Suffolk	Huntington	361031122061032	2	1
	Landfill Cover/Capping	60	NY	Suffolk	Islip	361031458033000	324	156
		61	NY	Suffolk	Brookhaven	361031591061002	104	23
		251	CT	Hartford	Manchester	90035151021015	0	0
		272	CT	Hartford	Windsor	90034735011007	3	1
	Brownfields & Other Redevelopment	422/423	NY	Queens	New York	360810907001001	0	0
	Habitat Restoration/ Enhancement or Creation	427	NY	Kings	New York	360470666001010	0	0
		429	NY	Kings	New York	360470702030001	0	0

Table 4-99. Transportation Infrastructure in the Upland Environment.

Environment	Alternative Type	Alternative ID	Roads	Rail	Ferry
Upland Environment	**Landfill Placement**	59	*	*	*
	Landfill Cover/Capping	60	State Route 454, Interstate Route 495	*	*
		61	State Route 27	*	*
		251	US Route 6, US Route 44	*	*
		272	*	*	*
	Brownfields & Other Redevelopment	422/423	*	*	*
	Habitat Restoration / Enhancement or Creation	427	Unlisted Access Highway	*	*
		429	*	*	*

* no resources identified within 0.5 mile radius

Table 4-100. Coastal Infrastructure in the Upland Environment.

Environment	Alternative Type	Alternative ID	Cable/Power/ Utility Crossings	Boat Launches	Open Space	Aquaculture	Fishing Communities	Shellfish
Upland Environment	**Landfill Placement**	59	*	*	*	*	*	*
	Landfill Cover/Capping	60	*	*	*	*	*	*
		61	*	*	*	*	*	*
		251	*	*	*	*	*	*
		272	*	*	*	*	*	*
	Brownfields & Other Redevelopment	422/423	*	*	*	*	*	*
	Habitat Restoration/ Enhancement or Creation	427	*	*	Gateway National Recreation Area	*	*	*
		429	*	*	Gateway National Recreation Area	*	*	*

* no resources identified within 0.5 mile radius

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5 ENVIRONMENTAL CONSEQUENCES

This chapter forms the scientific and analytic basis for comparing the effects of the potential placement alternatives considered in this PEIS. It presents information about the generally known impacts of dredged material placement at the various alternative types (Section 5.1). Environmental and socioeconomic impacts that could result from taking no action (Section 5.2) and from placement of dredged material at each of the potential alternative sites (Section 5.3) are also considered. In addition, cumulative impacts of past, current, and future actions are described, as well as possible mitigation steps to avoid, minimize, or reduce potential impacts.

This PEIS evaluates and compares the direct, indirect, and cumulative impacts from a qualitative perspective, commensurate with the programmatic level of detail within which this document was developed.

5.1 KNOWN IMPACTS FROM DREDGED MATERIAL PLACEMENT

There are several options for the placement of dredged material removed from USACE navigation projects within the Long Island Sound study area: confined and unconfined open ocean placement, confined nearshore placement, landfill placement, and beneficial use. While the compatibility of dredged material for the various placement options will need to be determined on a project-by-project basis, the options that would have the lowest impact and greatest benefit are likely to be preferred. Over the past decades, several events have had devastating and costly consequences for Long Island Sound coastal communities and habitats. These events include Hurricanes Gloria, Bob, Sandy, and Irene. The increased storm frequency and sea level rise associated with climate change also threaten coastal communities and habitats. Restoration of the coastal habitats would benefit much of Long Island Sound's wildlife and fisheries species, and the livelihoods of the people in these coastal areas.

Comparisons of the direct and indirect impacts for the alternative types that may be used by USACE and other Federal agency navigation projects in Long Island Sound are presented in this section. Direct impacts are those effects that are caused by the action and occur at the same time and place (Section 1508.8(a) of 40 CFR Parts 1500-1508). For example, beneficial use of dredged material could directly convert acres of nearshore habitat to beach or island habitat. Indirect impacts are those effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (Section 1508.8(b) of 40 CFR Parts 1500-1508). An example of this would be sedimentation that indirectly results from changes in sediment supply or transport by littoral currents.

This section discusses established, known impacts from dredged material placement by alternative type, based on information presented in the Affected Environment chapter (Chapter 4) of this PEIS and other established documents. Because this is a programmatic assessment, general impacts are addressed by alternative types that may be utilized by USACE and other Federal agency navigation projects within the Long Island Sound study area, rather than on a site-specific or project-specific basis. A summary table of resource impacts by alternative type (USACE, 2015a) lists the resources that may be impacted through the placement of dredged material. Resources were grouped into four categories: physical, environmental, infrastructure, and cultural resources. This grouping was developed by USACE in several of its background reports written to support the Long Island Sound DMMP. The environmental resources impacted will depend on the type of alternative. Resources that were not relevant for a given alternative type (such as terrestrial wildlife at open-water sites) were identified as "Not Applicable." Where resources were relevant, resource impacts were assessed and summarized as "Yes," "Potential," or "No." In addition, anticipated positive impacts, or benefits, through the use of dredged material by each alternative type are summarized for each group of resources.

Socioeconomic impacts were also assessed for each alternative type. Socioeconomic impacts were projected based on parameters identified in Section 122, River and Harbor and Flood Control Act of 1970, P.L. 91-611. These parameters are as follows:

- Destruction/disruption of man-made/natural resources
- Aesthetic values
- Community cohesion
- Availability of public facilities and services
- Employment effects
- Tax and property value losses
- Injurious displacement of people, businesses, and farms
- Disruption of desirable community and regional growth

Because the impacts are assigned to the alternative *type* of dredged material placement activity rather to specific dredged material placement sites, impacts are generalized. Positive and negative impacts or consequences are projected and may be short- or long-term in duration depending, in part, upon the material placement schedules for alternative types. The following sections describe these general impacts to physical, environmental, infrastructure, cultural, and socioeconomic resources by alternative type.

5.1.1 Open-Water Placement Impacts

The Open-Water Alternative would involve the placement of dredged material in the aquatic environment using a variety of equipment (Chapter 3). Pipeline or hydraulic dredges, hopper dredges, and bottom-release barges and scows may be used to store and/or transport material for placement, depending upon the location of the placement site in relation to the dredging location and the characteristics of the dredged material. Each release of dredged material would occur as a discrete discharge of material, which may have impacts to the resources present.

Unconfined Open-Water Placement

Physical Impacts

During placement at designated sites, dredged material released from a barge physically impacts the water column and then the seafloor over a limited area. Most of the sediment falls rapidly to the seafloor, but approximately 1% to 5% of the discharged sediment remains suspended in a plume and then settles to the seafloor (Ruggaber & Adams (2000); Tavolaro (1984); USACE, (1986)). Field studies have confirmed that these plumes are transient and have short-term (i.e., hours in duration) impacts on water quality (Dragos & Lewis (1993); Dragos & Peven (1994); SAIC (2004); SAIC (2005a); SAIC (2005b); ENSR (2008)).

Dredged material placed in open water may result in physical changes to the seafloor, altering the grain size and/or TOC if the sediment properties of the dredged material are different from the ambient seafloor sediments. Dredged material from the Long Island Sound region generally has consisted of very fine sand to silt and clay that has filled in navigational channels in harbor regions and medium to fine sand from some outer-harbor entrance channels. Circular ring structures and pits have been evident in acoustic survey images at several of these sites and indicate individual placement event impacts (ENSR, 2007; AECOM, 2013; Carey, et al., 2015).

Dredged material is typically placed at a target area buoy or precision navigation coordinates. The overlap of multiple dredged material placement events at a designated location ultimately builds discernible, low-profile mounds within a placement site, altering the topography of the area. Multiple placement events may result in sediment accumulations several inches to several feet high with a radius of about 70 to 700 ft. The accumulation of dredged material thus has a physical impact by decreasing the relative water depth above the dredged material placement site, which has the potential to modify ambient currents and sediment transport. However, each site has been selected, and is managed, to control the number and elevation of mounds created to avoid interferences with shipping and navigation, as well as to avoid sediment transport and major alterations of bottom currents and dynamics. The only exception to this practice is the one dispersive site, the CSDS, which is located in a region of sand transport and is managed to allow dispersion of material placed at the site. Mound formation at the placement sites has not been found to interfere with regional flow patterns and transport or substantially impact bottom currents or other physical dynamics in Long Island Sound (ENSR, 2007).

The most prevalent process occurring right after placement is reconsolidation of the sediment due to the weight of the material in the mound. As a result of this settling process, a portion of the water trapped in the dredged material is expelled, reducing the mound’s total volume. The amount of water released and rate of this process depends on the properties of the sediment, including grain size and water content. Most consolidation has been found to occur within the first year or two of placement (Silva, et al., 1994).

In addition, once deposited on the seafloor, dredged material may potentially physically impact the surrounding area through potential sediment transport from currents, storm activity, or disturbance by fishing activity. These impacts have been observed to be minimal at placement sites studied under the DAMOS program (Fredette & French, 2004). Monitoring has documented major sediment transport of placed sediments to surrounding areas only at CSDS, where hydrodynamic conditions transport ambient sediments as well (ENSR, 2005a). At the non-dispersive sites (WLDS, CLDS, and NLDS), tidal current regimes are insufficient to significantly erode deposited dredged material (Fredette & French, 2004); (O'Donnell, 2014a). Episodic conditions (e.g., when spring tidal currents are amplified by wind events) have resulted in resuspension and transport of only small amounts of fine-grained sediments. Where erosion does winnow fine sediments from surface sediment, lag deposits of coarser sediment and shell deposit have been observed to armor the remaining sediment from erosion (Fredette & French (2004); AECOM (2009); Carey, et al. (2012)). Studies over the last 35 years, including those of the DAMOS program, have documented the general stability of dredged material mounds by recording bathymetry before and after active placement operations, and periodically thereafter

(EPA (2004); ENSR (2007); Carey, et al. (2015)). Modeling studies have predicted bottom shear stress from storm conditions as well as Hurricane Sandy conditions at CSDS and NLDS (O'Donnell, 2014b). Because of complexities in setup and residual circulation 'storm conditions' differed from Hurricane Sandy conditions (see Section 4.3.2). CSDS was predicted to have lower bottom shear stress during storms and Hurricane Sandy while NLDS was predicted to have higher bottom shear stress during storm conditions and lower bottom shear stress during Hurricane Sandy (O'Donnell, 2014b). These predictions are supported by empirical evidence collected over many years (e.g., Waddell et al. (2001); AECOM (2010); O'Donnell (2014a).

Environmental Impacts

For over 40 years, studies and monitoring efforts have been conducted in Long Island Sound to understand the consequences of dredged material placement to benthic habitats and to the local food web (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, 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 in Long Island Sound 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 mounds. 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.

The rate of benthic recolonization and the recovery rate of dredged material placement mounds have been intensively studied in New England and other marine environments. SPI has been used since 1982 to test the model of benthic succession in response to physical disturbance from dredged material placement (Rhoads, et al. (1978); Germano, et al. (2011)) (additional information is presented in Section 4.8 and Figure 4-30). SPI depicts a vertical cross section of sediment up to 8 inches deep, providing visual evidence of organism-sediment interactions and the sediment-water interface. A process-based model (Rhoads and Germano (1982), (1986)) has been used to interpret the ecological effects of dredged material in Long Island Sound (Germano, et al., 1994) and minimize the impacts of disturbance through tiered monitoring (Fredette (Fredette, 1998); Fredette & French (2004)). Initially, there may be an absence of visible species, called Stage 0. According to the successional model (Rhoads & Germano, 1986), within a few days to weeks of physical disturbance or deposition of dredged material, Stage 1 organisms (small, tube-dwelling surface deposit feeders) settle on the surface sediment. Stage 2 infaunal deposit feeders gradually replace the Stage 1 organisms, and then larger Stage 3 infaunal deposit feeders (which feed in a head-down orientation, creating distinctive feeding voids) inhabit the sediment (Germano, et al., 2011). The dredged material characteristics and the benthic community composition and structure affect the rate of succession, which typically results in a deepening of the bioturbated mixed sediment layer and convergence with the surrounding benthic habitat conditions (Zajac, 2001). The successional model has not been developed for coarse sediments or cohesive clays (Germano, et al., 2011). The timing of disturbance relative to seasonal pulses of settlement and growth of larvae also strongly influence the nature and rate of recolonization (Zajac & Whitlatch (1982); Wilber, et al. (2007)). The establishment of a mature community may take months to years to complete and depends in part on whether additional physical disturbances interrupt the successional process.

DAMOS and other programs have repeatedly documented recolonization of mound surfaces with surface and infaunal assemblages typical of the sediments surrounding the placement site (Germano, et al., 2011). The outer region of the dredged material mound, known as the apron, can introduce higher organic sediment content than the ambient sediment, supplying a new food source for deposit feeders (Lopez, et al., 2014). The apron has been found to extend 300 ft to 1,600 ft beyond the acoustically detectable margin of the mound (multibeam surveys can reliably detect accumulations greater than 4 inches, and single-beam fathometers can detect greater than 8 inches of accumulated sediment (Fredette & French (2004); Carey, et al. (2012)). Within months, high settlement densities of opportunist species (polychaetes, amphipods, bivalves, and meiofauna) occur, and rapid bioturbation that mixes the deposit with seafloor sediments usually makes the apron area indistinguishable (Germano, et al. (2011); Lopez, et al. (2014)). These studies also have found that the recovery of the mound apex, which is generally the most disturbed area, tends to be slower than at the mound apron, where deposited sediments are thinner and burial impacts are fewer. Mounds that have been in place for two or more years consistently support mature benthic assemblages that are similar to reference areas outside of the open-water placement site and are stable over time.

Both short- and long-term impacts to shellfish could potentially occur from the placement of dredged material in Long Island Sound. While these impacts can range from acute mortality associated with the burial of shellfish to the temporary displacement of shellfish or reduced filtration rates during periods of high turbidity, direct impacts to these organisms from the placement of dredged material are generally limited to the footprint of the placement mound (EPA, 2004). Potential long-term impacts include the potential alteration of the community as a result of changes to habitat type (grain size) and food resources. The American lobster is the primary shellfish resource inhabiting the designated dredged material disposal sites. As dredging windows restrict placement during vulnerable life stages of lobsters, burial impacts are expected to have limited short-term impacts on shellfish resources (EPA, 2004). Studies of lobster abundance at the RISDS showed declines in lobster abundance between the 1999 and 2005 sampling events, but these declines are consistent with those seen throughout the southern New England region as a whole. In 2005, 1.5 years after the placement of dredged material at the RISDS, lobsters were captured in relative abundance compared to nearby areas of Rhode Island Sound indicating the lobster population at the RISDS did not appear to have experienced significant adverse impacts (Valente, et al. (2007).

Benthic community and productivity changes may in turn affect higher trophic levels (a feeding stratum in the food chain) by providing more or less prey at a given location or prey that is more or less suitable for a variety of species. Erosion of silts and clays and sediment changes also may provide positive attributes, such as armoring the surface against further erosion and creating microhabitats within the placement site that provide greater variability in benthic habitat, leading to continued, if not greater, utilization of the area by fish and shellfish (SAIC, 2001a).

Abrupt changes in topography or bottom type can create rich habitat for finfish and motile shellfish like lobster, and artificial structures (artificial reefs) can also provide such typically rich habitat (Ries & Sisk, (2004); Macreadie, et al., (2010); Macreadie, et al. (2012)). Clark & Kasal (1994) explored the concept of stable dredged material mounds providing substantial fisheries resource benefits as a long-term management objective for dredged material placement. Anecdotal fishery reports have indicated that mounds and berms create conditions conducive to enhanced fisheries production. Few definitive scientific studies have been conducted to support this claim, although limited data from the Rockland Disposal Site off the coast of Maine suggest that the placement mound supports an active population of megafauna (SAIC, 2001b). Lobstermen from Long Island Sound repeatedly and consistently report that lobstering is more productive near active open-water placement sites (EPA, 2004). Lobster gear is frequently encountered during monitoring surveys. Interviews with fishermen and available reports also confirm that fishing in the vicinity of mounds is similar to or better than areas away from the mounds.

There is potential for short-term impacts to plankton from dredged material entrainment and sediment plumes in the water column. Most of the discharged dredged material quickly falls to the seafloor, which entrains a small volume of planktonic organisms (e.g., phytoplankton, zooplankton, and larval stages of fish and invertebrates) and displaces others with the movement of water. Increased turbidity resulting from discharged dredged material would temporarily alter water quality; this has short-term impacts on plankton which could be detrimental or beneficial, depending on the species and composition of the dredged material. The suspended solids may reduce light penetration in limited spatial areas, which may temporarily reduce photosynthesis (Kraus (1991); Dragos & Lewis (1993); Dragos & Peven (1994)). Most phytoplankton productivity occurs in surface waters above the most turbid portion of the sediment plumes that typically occur closer to the seafloor at open-water sites (ENSR, 2008).

Potential intermittent, short-term impacts to fish include the direct destruction and burial of bottom-dwelling species and disturbance of fish throughout the water column within the localized area. Due to their mobility, most fish would be expected to move out of a dredged material burial area. The sediment plume following 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)). However, fish species may avoid placement areas during periods of high turbidity (Packer, et al., 1999).

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); Wilber & Clark (2001)). However, 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. Following these turbid periods, finfish and shellfish may be drawn back to a placement site by irregularities in the substrate and the presence of new material containing infaunal organisms and other forage (EPA, 2004).

Physical changes to sediment characteristics would potentially result in habitat impairment or enhancement, depending on the type of change and the benthic response. All of Long Island Sound is mapped as EFH, and there are three listed endangered fish species that potentially could occur at the unconfined open-water placement alternative sites. Previously, NMFS and USFWS concurred with the findings of the 2004 Final EIS designation of the WLDS and CLDS stating that the dredged material placement at these sites is not likely to adversely affect listed species or EFH (EPA, 2005).

Unconfined open-water placement has the potential to impact marine mammals and reptiles, which includes five endangered or threatened species of both whales and sea turtles, directly by vessel strikes or by harassment during placement due to noise and sediment discharge. Temporary sediment plumes may also cause avoidance of the local area. USFWS noted in the designation of CLDS and WLDS that "no habitat in the project impact area is currently designated or proposed 'critical habitat' in accordance with provisions of the Endangered Species Act (87 Stat. 884 as amended; 16 U.S. C. 1532 et seq.)." About 20 species of marine mammals and reptiles may occur at these sites. The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions imposed on all vessels 65 ft and greater in length have been found to be effective in reducing strikes to whales (Conn & Silber (2013); NOAA (2013)). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. Potential adverse impacts would be limited and of short duration.

The primary impacts to the water quality following dredged material placement are associated with the residual particles that remain suspended from minutes to a few hours after the majority of sediment has reached the seafloor. These impacts may be adverse (light reduction, interference with biological processes) or beneficial (increased productivity of specific species as the suspended sediment may serve as a food source). The impacts of suspended solids on DO water column concentrations are expected to be minimal. Although DO levels may temporarily decline following placement in offshore areas, no major declines or persistent impacts have been observed for the placement of general sediment classes found in the northeast region (Fredette & French (2004); Johnson, et al. (2008)).

Other potential effects on the water column could include the release of nutrients from discharged sediments. Nutrients in sediments are generally bound to the sediment and organic particles and can occur in the pore water (water within the sediments) depending on the physical and chemical properties of the sediment. In general, offshore coastal waters are nitrogen-limited and not as biologically sensitive to placement-related nutrients compared to inshore lakes, which are phosphorus-limited (Johnson, et al., 2008). The nitrogen TMDL for Long Island Sound, a management tool to decrease nutrient loading and improve DO concentrations, does not even mention material dredging or placement as a potential nutrient source (NYSDEC and CTDEP, 2000), as these are apparently insignificant relative to other sources such as rivers, wastewater treatment facilities, and atmospheric deposition.

Similar to nutrients, water quality may be impacted by the release of contaminants from sediment during placement; these impacts are expected to be limited and short-term. Sediment testing of dredged material limits the degree of sediment contamination that is allowed at designated sites and is designed to limit the potential release of contaminants during discharge and placement. Contaminants may be sediment-bound or in pore water, and the sediment affinity and release into the water column is influenced by characteristics of the contaminant (several are hydrophobic), as well as environmental conditions (Jones-Lee & Lee (2005); Eggleton & Thomas (2004)).

Available studies (Arimoto & Feng (1983); Gentile et al (1984); Peddicord (1988); Lee & Jones-Lee, (2000); Fredette, et al. (1993)) conducted prior to the application of the current testing requirements (EPA and USACE, 1991) demonstrate that some dredged material may result in short-term, spatially limited increases in the bioavailability of contaminant compounds at or near dredged material mounds. These studies did not find adverse impacts to organisms from dredged material placement. In addition, extensive research by USACE from the 1970s on the release of dredged material from hopper dredging found that "…of the over 30 chemical parameters…measured, including heavy metals a variety of organics and other constituents, only ammonia and manganese were released from the sediments" as long as the sediment water slurry was oxic (contained dissolved oxygen) (Lee & Jones-Lee, 2000). These studies also found that if sediment slurry stayed anoxic, many contaminants were released. Due to the short exposure time and limited release from even contaminated sediments, it was concluded that placement from hoppers or mechanical dredging would not result in water quality problems (Lee & Jones-Lee, 2000). During plume studies of Providence River dredged material placed at the RISDS, water samples were collected and analyzed for toxicity within the first two hours; the analysis found that “Neither the mysid (*Americamysis bahia*) nor juvenile silverside (Menidia spp.) test organisms exhibited a lethal response” after four days of exposure (ENSR, 2008).

Although benthic recolonization and resuspension of deposited sediments may potentially contribute to bioaccumulation of contaminants, sediments associated with unacceptable risks are not accepted for open-water placement. Through the use of risk-based evaluations to select the appropriate management practices, it is expected that bioaccumulation of contaminants in tissues (and subsequent risks) would not increase significantly over ambient conditions as the result of placement of dredged material. Therefore, it is expected that potential risks associated with open-water placement alternative would either remain the same or possibly be reduced through the addition of material with lower chemical concentrations than those currently existing in surface sediments at sites that contain historic dredged material.

Under the unconfined open-water placement site alternative, transporting dredged materials for placement would involve tug and/or workboat operations. Dredged material placement would involve operation of dump scows during periods of placement activity resulting in air pollutant emissions and potential adverse noise impacts. However, given the short duration of the activity and great distances between sensitive receptors and the alternative sites, potential air quality and noise impacts would not be significant relative to background levels.

The Field Verification Program (FVP) Mound: A key source of data for effects of dredged material placement in Long Island Sound

Dredged material placed in Long Island Sound must pass chemical and biological testing protocols, but an evaluation of potential effects of contaminants in Long Island Sound is available as a worst-case assessment. During 1982-1983, as part of the joint EPA/USACE FVP, the FVP mound was created in the CLDS. Just over 72,000 CY of organic-rich, fine-grained sediment from Black Rock Harbor, CT (BRH) which was contaminated with heavy metals, PAHs, and PCBs was placed at the site as part of a series of experiments. The mound was not capped and has been used to evaluate a monitored natural recovery process of contaminated sediments over the past three decades (Myre & Germano, 2007).

Toxicity and bioaccumulation testing from the early 1980's demonstrated limited mortality in test organisms, but did show significant bioaccumulation of lab-exposed tissue relative to controls (Rogerson, et al., 1985); (Peddicord, 1988); (USACE, 1982). Field-collected tissue from FVP (suspended *M. edulis* and field-collected *N. incisa*) shortly after disposal also showed evidence of bioaccumulation of organic and inorganic contaminants. PCB measurements were best correlated between laboratory and field measurements (Lake, et al., 1988).

Comparison of acoustic surveys conducted in 1983, 2011, and 2014 demonstrated that the mound has been stable with little physical change in over 30 years. Signs of active sediment transport have been limited; no changes in large-scale features have occurred, and about 2 to 4 inches of new sediment from natural deposition was observed over the mound in 2005 and in 2011.

Contaminant concentrations above the effects level were measured in 2000, however, toxicity testing and benthic community analyses indicated no significant differences in effects between the FVP mound and reference stations (EPA, 2005). Biological testing data from a 2000 survey showed no significant toxicity to *A. abdita*, and much lower concentrations in sediment and field-collected organisms (ENSR, 2001). Triad analysis including benthic infauna showed little impact on biological indicators despite slightly elevated chemical levels. In 2005, contaminant concentrations at the center of the mound were higher than reference areas and tended to increase with depth, with the highest levels observed 6 to 8 inches below the surface (Myre & Germano, 2007). Even though some of the contaminants were above projected effects levels, the maximum contaminant concentrations at the FVP mound in 2005 were found to be less than the concentrations in the original dredged material; PAH concentrations declined from 142,000 µg/kg dw in the source dredged material to a maximum of 27,570 µg/kg dw at the FVP mound in 2005.

The reduction in contaminants was attributed to active sedimentation combined with bioturbation, which in effect dilutes the sediment with cleaner sediments from the water column, as well as sediment microbial metabolism, which breaks down and transforms compounds (Myre & Germano, 2007).

Results from a sediment sample located on the flank of the FVP mound in 2011 were relatively consistent with those observed in 2000 as part of the investigation for the EIS for site designation (Myre & Germano, 2007). In addition, benthos and seafloor conditions observed in 2011 were consistent with those at the reference areas, showing advanced recovery at the mound and no indication of impairment (AECOM, 2013).

Infrastructure Impacts

Placement of dredged material in open water can potentially affect existing or future infrastructure within Long Island Sound. Submerged utility lines (electrical, telecommunications, gas pipeline) transit the Sound along approved corridors (Figures 4-68 thru 4-70) (EPA, 2004). Utility corridors are established to restrict disturbance of the seafloor above the buried lines and to allow utility access to repair or inspect lines. Any utility lines that exist within open-water alternatives could be buried by dredged material, which would make inspection and repair more difficult but is not likely to directly affect buried lines. Designation of open-water sites will restrict the establishment of new utility corridors in order to avoid disturbing placement sites.

The temporary transit of barges from harbor regions to and from the alternative sites and discharge at the site may displace shipping as well as recreational and commercial vessels in the transit area and at the alternative site, resulting in potential short-term impacts. Navigation lanes can be established across placement sites. In practice, all open-water placement sites need to be managed to ensure that adequate water depths are maintained to minimize impacts to navigation.

Cultural Impacts

Cultural resources that were assessed for impacts from placement of dredged material include shipwrecks, historic districts and buildings, and archaeological sites. Shipwrecks located in or adjacent to potential open-water placement site alternatives would be affected by burial from dredged material placement. Shipwrecks that have not been clearly located or identified could be obscured by burial but would also be protected from disturbance. The use of sites for dredged material placement is not likely to result in increased erosion or displacement of cultural artifacts, but site locations should be sited to avoid conflicts. Any cultural and archaeological resources that may have been present within existing placement sites have been previously disturbed or are currently protected from any further impacts resulting from prior placement activities.

Socioeconomic Impacts

Under the open-water placement alternatives, potential adverse impacts could occur from competing uses of the water system from nearby shipping lanes or aquaculture sites. During material placement, special precautions may need to be imposed during shipping activity near the alternative sites. Population concentrations near the open-water sites support heavy boat traffic and recreational use of the water system in which the sites are located. Material placement activities at the site could disrupt recreational use or pose boating hazards to the public unless proper precautions were taken. Placement activities could disturb the aesthetic quality of open-water views in the short term; however, long-term aesthetics are not expected to be impacted because the sites would be submerged under water.

Beneficial Impacts

Potential benefits from the implementation of open-water alternatives could accrue to infrastructure resources and to regional employment. An indisputable long-term beneficial consequence of any dredged material placement activity is that dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long

Island Sound. Placement of material for open-water alternatives may increase employment for tug/barge operators and operators of heavy machinery during periods of placement activity.

Placement of dredged material could reduce surface sediment contaminants and potential bioavailability by burying historic dredged material. Introducing fresh dredged material into an area may serve as a food source for the benthic community and benefit the marine food web. Increasing the diversity of the seafloor topography may also benefit demersal marine life.

Confined Open-Water Placement

Confined placement refers to areas where a low mound of dredged material on the seafloor is covered with additional layers of dredged material to ‘cap’ or confine the initial placement (Fredette, et al., 1992). One such site identified during the containment site study (USACE, 2012a) occupies a former borrow pit approximately ½-mi offshore of Sherwood Island State Park near Westport, Connecticut. Therefore, the existing depression in the seafloor would contain or confine the dredged material placed at that location. However, since this site is located outside of a harbor within the waters of Long Island Sound, it is subject to MPRSA and is considered an open-water alternative site. Therefore, this site can accept only suitable material for base fill material.

Physical Impacts

Physical impacts from confined open-water placement would be similar to those associated with unconfined open-water placement, except for impacts to water depth and sediment transport. Because this alternative type involves placing material within an existing depression in the seafloor or a low area created by the circular placement of sediment mounds, the material is expected to be more stable and less subject to transport away from the site. In cases where a pit is being filled, there would be no impact to water depth or resulting impacts to boat traffic or navigation after placement operations were complete.

Environmental Impacts

Environmental impacts from confined open-water placement would be similar to those associated with unconfined open-water placement, described above.

Infrastructure Impacts

Infrastructure impacts from confined open-water placement would be similar to those for unconfined open-water placement.

Cultural Impacts

Cultural impacts from confined open-water placement would be similar to those for unconfined open-water placement.

Socioeconomic Impacts

Socioeconomic impacts from confined open-water placement would be similar to those for unconfined open-water placement. In addition, nearby oyster and clam beds may be disturbed or destroyed by material placement actions, with a subsequent loss of employment in the commercial or recreational fisheries dependent upon those sites.

Beneficial Impacts

Potential benefits from the use of confined open-water placement alternatives would be similar to those for unconfined open-water placement.

In cases where confined open-water placement occurs in an existing pit or depression on the seafloor, there exists the potential to increase or enhance habitat for benthic invertebrates and shellfish when the depth of the pit is restored to the ambient depth by filling the depression with dredged material. The potential for an increase in habitat diversity for fish species also exists because placement activities could create bathymetric variations.

5.1.2 In Harbor CAD Cell Impacts

CAD cells have become a preferred option for the management of dredged material that is contaminated and not suitable for open-water placement or beneficial use (Fredette, 2006). CAD cells are constructed to reduce the risk from exposure to contaminated sediments by storing them in a depression in the bottom of an aquatic system, then isolating them with a capping layer of sediment. They may be constructed from naturally occurring bottom depressions or from sites from previous mining operations (e.g., beach nourishment borrow sites); alternatively, they may be created expressly for containment by sediment excavation (Fredette, 2006). Other than some minor consolidation, CAD cells have been shown to be physically stable, with benthic recovery consistent with ambient areas in the Boston Harbor and four other New England harbors: Norwalk and New London, Connecticut; Providence, Rhode Island, and Hyannis, Massachusetts (ENSR (2007); USACE (2012a); USACE (2012b)). CAD cells have also been used in Newark, New Jersey; Los Angeles, California; Bremerton, Washington; and Hong Kong, China (Fredette, 2006). There are impacts associated with construction (where required), and there are impacts associated with the placement of dredged material within CAD cells for both constructed and natural depressions. Creation of CAD cells may preclude future uses that require excavation of the seafloor. However, useful habitat (shellfish) may be created where CADs are created using existing gravel mining holes.

Physical Impacts

The CAD cell alters the existing sea floor and may change the existing sediment grain size and TOC through the potential removal of sediments during construction (which would have to be moved and placed elsewhere) as well as placement of the dredged material. For example, there would likely be impacts to sediments where native fine-grained sediments are replaced by more granular, sandy material used to cap the CAD cell. Anchoring of dredges during construction would temporarily physically disturb the seafloor and may have long-lasting impacts if compaction occurs, which would depend on the seafloor characteristics. There may be increased turbidity after dredged material discharge, but this has been previously found to dissipate rapidly (Lyons, et al., 2006), (ENSR, 2008). .

Because operations at the CAD cell would be below the sea floor elevation, modification of wave energy regimes would be limited compared to a structure rising above mean high water.

Therefore, there would generally be no impacts to littoral drift patterns/rates, currents, and waves as CAD cells were filled to ambient sea floor elevation.

Environmental Impacts

Excavation of the CAD cell and operation (dredging, filling, and capping) under the in-harbor CAD cell alternatives would destroy and/or bury any bottom-dwelling resources living within the footprint area. Resources in the adjacent areas (i.e., the surrounding environment) have the potential to be indirectly affected through sedimentation and increased water column turbidity. These impacts would be greatest for sedentary/immobile resources (e.g., wetlands, SAV, benthic infauna, shellfish). Species such as fish and lobster are mobile enough to avoid the descending material and could burrow out from beneath a modest thickness of deposited material. During construction of the CAD cells in the Providence River channel, sediments were found to dissipate quickly, with the bulk of plumes settling within the cell (ENSR, 2008). The benthic community would also experience short-term impacts from anchoring disturbance and possibly long-lasting localized habitat impacts if anchoring compacts sediment. It is anticipated that the reduction in diversity and abundance of benthic infauna and shellfish populations within the site would be short-term. Recovery to levels similar to pre-placement would likely occur within months to several years, as documented at other dredged material alternative sites in Long Island Sound (USACE, 2012b).

Federal and state-listed species, including marine mammals and reptiles, may experience harassment during construction and operation of the CAD cells. However, these organisms are not likely to be found in the nearshore area, particularly in harbor areas, and the same vessel traffic that would create noise and disturb these animals would also likely deter them from entering the area as well. Turbidity would increase during construction or dewatering; however, best management practices would limit the potential for this effect to impair water quality and habitat.

CAD cell operations have the potential to permanently change the habitat if the CAD cell were capped with sediment that differs from the native material. The eventual placement of a cap of suitable dredged material on the CAD cells would limit bioaccumulation of any contaminants in the dredged material and would allow a stable benthic community to develop. There is also a potential for habitat enhancement for fish and shellfish because bathymetric variations could potentially increase habitat diversity. For example, CAD cells created using an existing depression would create habitat by filling the depression to ambient depth.

Placement of dredged material could increase turbidity and contaminant concentrations within the residual plumes, potentially leading to intermittent, short-term changes in water quality. Under worst-case conditions, the potential for such water quality impacts would rise. During construction of the Boston CAD cells, all of the resuspension was relatively low, with the most significant resuspension occurring during the initial capping of uncapped sediments and decreasing resuspension in subsequent capping layers (Lyons, et al., 2006). CAD cells are generally constructed in environments where hydrodynamic characteristics are relatively static (i.e., limited wave action and wave-induced currents); under such conditions, dispersion of dredged material during placement or capping would likely be reduced when compared with more dynamic conditions. The thickness of the sediment cap (where a cap is deemed necessary), the equipment and dredging techniques selected, and the placement schedule with respect to tidal currents could be used to minimize water quality impacts at the in-harbor CAD cell alternative sites.

Construction and operation of in-harbor CAD cell sites would involve the use of tugs to haul CAD cell materials; tugs with dredges to dredge CAD cells during construction; and tugs and/or workboats to transport dredged materials, dump scows, and commuting vehicles for workers traveling to and from the dredging site during placement activities. These equipment and vehicle operations would generate air pollutant emissions and noise impacts in areas around these cells. However, given the short duration of the activity around the alternative sites, potential air quality and noise impacts are anticipated to be less than significant.

Infrastructure Impacts

Impacts to infrastructure resources (e.g., mooring areas, navigation channels, ports, coastal structures, cable/power/utility crossings, recreational areas, aquaculture, and dredged material alternative sites) present within the footprint of the CAD cell could include direct interference or burial. However, these impacts are not likely, since cell sites would ideally be located to avoid coastal areas where such infrastructure resources are present. Vessel traffic may be impinged at mooring areas, navigation channels, ports, and recreational areas at or near the alternative site during CAD cell construction and operation. This impact would be short-term and would cease once placement operations were completed. Particle settling during placement operations could potentially deposit sediment at resources adjacent to the CAD cell. Filling the CAD cell to ambient sea floor would have no undermining/erosion impacts to nearby infrastructure resources.

Cultural Impacts

Excavation and operation (dredging, filling, and capping) under the in-harbor CAD cell alternatives would destroy and/or bury any cultural resources (such as shipwrecks and archaeological resources) present within the footprint area. However, CAD cells would not be sited or constructed on a footprint that contained cultural resources, so these impacts would be avoided with proper project planning. Because the CAD cells would not protrude from the seafloor surface, there would be no visual impacts associated with this alternative type. While the CAD cell was being filled, increased sedimentation could impact cultural resources; however, this impact is expected to be of short duration and would be confined to the immediate vicinity of the CAD cell. Historic districts would not likely be impacted by CAD cells because changes in bathymetry would not result in wave focusing or increased erosion along the shoreline where these resources would be located.

Socioeconomic Impacts

Under the in-harbor CAD cell alternatives, adverse socioeconomic impacts could occur. Nearby major ferry routes and shipping lanes may be interrupted by construction of CAD cell sites. Recreational boating could be interrupted during construction activity. Aquaculture of shellfish could potentially be lost or disturbed, with subsequent loss of employment from commercial or recreational fisheries dependent upon those sites. Placement activities could disturb the aesthetic quality of harbor views in the short term; however, long-term aesthetics are not expected to be impacted because the cells would be submerged under water.

Beneficial Impacts

Over time, potential benefits from use of in-harbor CAD cells could accrue to man-made resources and to regional employment. A long-term beneficial consequence of any dredged material placement activity is that dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Also, potential positive employment impacts could accrue to the region from construction and use of in-harbor CAD cell sites for tug/barge operators and operators of heavy machinery.

In cases where CAD cells are constructed using existing pits or depressions on the seafloor, there exists the potential to increase or enhance habitat for benthic invertebrates and shellfish when the depth of the pit is restored to the ambient depth by filling the depression with dredged material. The potential for an increase in habitat diversity for fish species also exists because placement activities could create bathymetric variations.

5.1.3 CDF Impacts

Island and Shoreline CDF Impacts

Like CAD cells, CDFs are a means for managing contaminated sediments. A CDF is a diked enclosure having structures that retain dredged material solids. Because of their location in shallow water environments, impacts from dredged material placement in island CDFs and shoreline CDFs are generally anticipated to be similar, except for habitat conversion (see below). Differences between individual alternatives would be expected when different resources are present. In cases where resources unique to a specific alternative are present, more specific assessments of environmental consequences will need to be performed.

Physical Impacts

The CDF would alter the existing sea floor topography and shoreline. It may also change the existing sediment grain size and TOC, if the physical properties of the cap material were different from the native sediments. For example, there would likely be impacts to sediments where native fine-grained sediments are replaced by more granular, sandy material used to cap the CDF. Because CDFs change the shoreline and the nearshore sea floor elevation, wave energy regimes are altered; therefore, littoral drift patterns/rates, currents, waves, and sediment transport are impacted as the CDFs are filled to elevations above mean sea level. In some cases, island CDFs may decrease littoral drift landward of the CDF. Shoreline CDFs may even disrupt littoral drift rates by creating a barrier to sediment transport. However, both alternatives may also result in increased channelization by increasing currents and scouring through narrow channels between the island CDF and the shoreline or, in the case of shoreline CDFs, by deflecting currents. Lastly, nearshore wave energy may increase or decrease, depending on whether the CDF creates a steeper or shallower beach profile and whether the CDF provides shelter for other nearby shoreline areas.

Environmental Impacts

Dike construction and operation (dredging, filling, and capping) of the island and shoreline CDF alternatives would destroy and/or bury any bottom-dwelling resources living within the footprint area. Resources in the adjacent areas (i.e., the surrounding environment) have the potential to be indirectly affected through sedimentation and increased water column turbidity during CDF construction. These impacts would be greatest for sedentary/immobile resources (e.g., wetlands, SAV, and benthic infauna, including shellfish). Mobile species, such as fish and lobster, may be able to avoid dike construction, but any organisms within the diked footprint would be buried by the descending material being placed within the dike. Impacts to plankton during construction are anticipated to be temporary and short-term.

CDF construction and operations are expected to permanently change habitat within the project footprint, creating habitat for terrestrial and intertidal ecological communities. Outside of the project footprint, impact to the diversity and abundances of subtidal benthic invertebrates is anticipated to be temporary and short-term. Recovery to levels similar to pre-placement would likely occur within months to several years, as documented at other dredged material placement sites in Long Island Sound. Recovery of vegetative resources in the project area would depend on changes in geomorphology and hydrology (wetland plants) or water depth and turbidity (SAV), as well as the specific design objectives, which may include habitat restoration.

Marine mammals and reptiles may experience harassment during construction and operation of the CDFs. However, their occurrence in nearshore areas, particularly in harbor areas, is unlikely. Furthermore, the noise created by operations and vessel traffic would likely deter these animals from entering the area. Turbidity and contaminant leaching would increase during construction or dewatering; however, best management practices would limit the potential for these effects to impair water quality and habitat. Construction of CDFs could also permanently alter or convert any EFH that is present. Impacts to Federal and state-listed terrestrial species are not expected because project footprints are currently inundated.

Under the island/shoreline CDF alternatives, there could be direct impacts to MPAs if the project footprint and an MPA overlap. However, the creation of island CDFs could also provide protection from wave energy, and shoreline CDFs could enlarge a coastal MPA. Both shoreline and island CDFs could also create bird feeding and nesting habitat, although construction and operation of a shoreline CDF could also result in short-term impacts to shorebird feeding and nesting areas from harassment and displacement.

When contaminated dredged material is placed in a CDF, contaminants could be mobilized in leachate that could be transported to the site boundaries by seepage. Subsurface drainage and seepage through dikes may reach adjacent surface water and groundwater and act as a source of contamination, if not properly managed. Intermittent, short-term changes in water quality could potentially occur within the residual plumes following placement of unsuitable dredged material, with a greater potential for water quality impacts under worst-case conditions. However, CDFs are usually effective at containing sediments within the dike during placement, and these impacts are unlikely. Wildlife could experience direct short-term exposure to unsuitable sediments within the CDF during placement before the CDF cap is in place; however, the noise and activity during operation would most likely deter wildlife from entering the CDF area. Operational controls can also be used to minimize releases and exposures.

Construction and operation of island and/or shoreline CDFs could involve the use of tugs to haul CDF materials; tugs with dredges to construct CDFs during construction; and tugs and/or workboats to transport dredged materials, dump scows, and commuting vehicles for workers traveling to and from the CDF sites. Dredged material may also be pumped directly to the CDF using pipelines or may be pumped directly from a hopper dredge to a CDF. These placement-related activities would generate air pollutant emissions around the CDF sites, and noise from these activities could potentially affect sensitive receptors along shorelines. Adverse impacts would likely be greater around the shoreline CDF sites because sensitive receptors are more likely to be found along shorelines; however, potential air quality and noise impacts would be short in duration and are anticipated to be less than significant.

Infrastructure Impacts

Impacts to infrastructure resources (e.g., mooring areas, navigation channels, ports, coastal structures, cable/power/utility crossings, recreational areas, aquaculture, and dredged material alternative sites) present within the footprint of the CDF could include direct and permanent interference or burial. Direct impacts to ports, however, are not anticipated, since shoreline CDFs would be sited to avoid coastal areas where ports are present. Vessel traffic could be impinged at mooring areas, navigation channels, ports, and recreational areas near, but not within, the alternative site during CDF construction and operation. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

Construction and operation of island and shoreline CDFs would destroy and/or bury shipwrecks present within the footprint area. Impacts to archaeological sites are not anticipated because no archaeological sites were identified at any of the island or shoreline CDF alternative sites. There would be short-term visual impacts to historic districts during CDF construction and operation. Historic districts could also be impacted by CDFs because changes in bathymetry could result in wave focusing or increased erosion and channelization along the shoreline where these resources are located.

Socioeconomic Impacts

Under the island/shoreline CDF alternatives, adverse socioeconomic impacts could occur. Island and shoreline CDFs could disrupt or destroy shellfish aquaculture by creating land masses in open water, and commercial or recreational fisheries that harvest those sites could experience consequential loss of employment. Short- and long-term degradation of an open-water visual aesthetic is possible from land mass creation. Recreational boating may be interrupted during construction or precautions may be required to ensure public safety during construction of island or shoreline CDFs.

Beneficial Impacts

Over time, potential benefits could accrue to man-made resources, regional employment, and revenue from creation of CDFs. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Potential positive employment impacts may occur from construction and use of site for tug/barge operators and operators of heavy machinery. No change to tax revenue/property values is expected during the lifespan of island or shoreline CDFs. However, depending on their proximity to other land uses and demand for available vacant land, created land masses may produce opportunities for development at the end of the facility's useful life as a placement area.

The construction of shoreline and island CDFs may potentially create a physical benefit by modifying the littoral drift, currents, and waves at the CDF location, depending on engineering of the site. These changes may decrease shoreline wave energy and erosion, thus increasing SAV habitat, for example. Shoreline accretion due to wave sheltering could also enhance other shoreline habitats, including those found in MPAs. Bathymetric variations resulting from the creation of CDFs have the potential to increase habitat diversity for fish species, which has the potential to provide new or enhanced fisheries habitat and feeding areas for marine mammals. Depending on the specific project, there may be the option to incorporate habitat enhancement for upland and coastal wildlife and birds and for Federal and state-listed species into the final project design. Creation of CDFs can also result in increased land for port and other infrastructure projects.

5.1.4 Landfill Placement Impacts

Landfills are facilities licensed and operated to accept waste. Some landfills are licensed to accept hazardous materials; others will accept only clean fill or construction and demolition material. In the past, unlined landfills were common, but these types of facilities have become increasingly rare due to increased water resource protection regulations.

Commercial fill material typically requires testing to characterize potential contaminants before placement is approved; during operation, freshly added waste material is generally covered daily (daily cover). Landfill areas that are inactive are covered to a greater extent (intermediate or temporary cover); after a landfill reaches its design capacity, a final cover is placed over the waste for long-term environmental protection after the material to be covered has stabilized. Final cover designs must address infiltration, drainage, vegetation, and erosion considerations.

Physical Impacts

Dredged material placed at a landfill site as waste would be placed along with other waste streams entering the facility. The dredged material would reduce the remaining landfill capacity and may require the placement of cover material to meet final design specifications. Landfills considered as alternative placement sites are active, disturbed locations so there would generally be no additional physical impacts associated with the dredged material placement beyond the current operation and management of the landfill.

Environmental Impacts

Landfill placement of dredged material is unlikely to have direct impacts to wetlands, birds, terrestrial wildlife, or threatened and endangered species since the alternative site would already be an established and operating landfill.

Dredged material placed at landfill sites as waste could potentially affect groundwater and surface water quality in the immediate area. In the case of coastal marine dredged material, additional salt and any leachable chemicals in the dredged material may require leachate management practices that prevent erosion or the deposition of material in adjacent resources.

Cover specifications may be necessary to minimize risk to environmental resources and would vary, depending on whether the design requires a daily, intermediate, or final cover. For example, daily cover is a minimal covering to deter wildlife scavenging and to control odor, wind-blown dust, and litter. An intermediate cover is generally a thicker, more permanent covering and may be designed to allow infiltration to enhance bioreactions. Final cover designs would address a more complete encapsulation of internal waste material while minimizing (precipitation) infiltration and cover erosion.

Secondary impacts associated with landfill placement would include the effects associated with material dewatering (dewatering fluid management, possible equipment emissions at the dewatering site) and transportation (emissions). Impacts from construction equipment emissions at the alternative sites are not considered because landfill operations will take place whether the waste material used is dredged material or is fill and debris from non-dredging sources.

This potential alternative would involve various activities associated with construction and placement elements. These activities could cause the following air quality effects:

- Criteria pollutant emissions, hazardous air pollutants (HAPs), and GHG emissions would result from construction and placement activities such as:
  - Use of diesel- and gas-powered equipment such as tug, dredge, dozer, loader, booster pump, work boat, dump scow engine, etc.
  - Material delivery and dump trucks.
  - Construction workers’ commute vehicles.
- Fugitive dust would be generated by on-land construction and placement operations.

Impacts on local noise levels during placement activities would include noise from equipment operating at the project site and delivery vehicles traveling to and from the site. These impacts would also vary during placement, with the highest impacts likely occurring during any necessary earth movement phases due to the use of heavy construction equipment such as excavators, loaders, etc.

The noise impacts from operation of equipment and vehicles would be essentially temporary. Noise levels related to the equipment activities would vary with the type of equipment being used. Table 5-1 shows typical noise levels for various types of heavy construction equipment. It is anticipated that the principal equipment types that would be used include compressors, excavators, dredgers, and cranes. Because not every type of equipment would be used at a given time, noise levels would vary over the duration of placement activities.

Noise levels generated by construction equipment (or by any point source) decrease at a rate of approximately 6 dB per doubling of distance away from the source. For instance, at a distance of 200 ft from a noise source, the noise levels would be about 12 dB lower than the 50-ft reference distances shown in Table 5-1.

Dewatering of dredged material would potentially involve the operation of loaders, dozers, and workers’ commuting vehicles at dewatering and landfill sites under this alternative. Trucks would be used to transport dredged materials for landfill placement. These equipment and vehicle operations would result in air pollutant emissions and noise impacts around the selected alternative site and along truck routes. Depending upon the scale and duration of landfill placement and/or landfill cover/capping activities at the selected sites and the sensitivity of the land around these sites, adverse air quality and noise impacts could be of concern.

Table 5-1. Typical Construction Equipment Noise Levels (dBA at 50 Ft).

Equipment Type	Typical Noise Levels[1]
Earthmoving:	
Loaders	85
Backhoes	80
Dozers	85
Scrapers	89
Graders	85
Truck	88
Pavers	89
Roller	74
Material Handling:	
Concrete Mixers	85
Concrete Pumps	82
Cranes	83
Derricks	88
Stationary:	
Pumps	76
Generators	81
Air Compressors	81
Impact:	
Pile Drivers (impact)	101
Pile Drivers (Sonic)	96
Jack Hammers	88
Pneumatic Tools	85
Other:	
Saws	76
Rock Drill	98
Tug[2]	85
Workboat[2]	84
Dredger[2]	85

Source: Federal Transit Administration (2006).

[1] dBA at ~50 ft.

[2] USACE and Los Angeles Harbor Department (2014).

On-road truck operations associated with material transport to and from landfill sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck routes.

Infrastructure Impacts

Any dredged material placed at landfill locations could require the use of significant overland transportation resources, depending on the distance between the project site and the landfill location. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

It is unlikely that historic districts or archaeological resources are located at landfill placement sites; therefore, no direct destruction of, or visual impacts to, cultural resources are anticipated under these alternatives.

Socioeconomic Impacts

Potential adverse effects from the transport of clean material to landfill sites would depend on the dewatering site location and the length of travel routes, routes taken, and volume of material transported. The increased number of trucks along the route could produce additional traffic congestion, noise, and air quality impacts to surrounding areas.

Beneficial Impacts

Over time, potential benefits could accrue to man-made resources, regional employment, and personal revenue from the placement of dredged material at landfill sites. A long-term beneficial consequence of any dredged material placement activity is that dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Employment of truck drivers and heavy equipment operators at origin and destination sites could increase but would be limited to the extent that material is available or quantity is needed for a site. Some sites require daily capping, which could increase employment among truck drivers and operators of heavy machinery handling the material; however, the increase would be temporary. Some sites could require only final capping, while other sites could receive material over the long term. Employment would correlate with the quantity and use of material placed at specific sites. Revenue from tipping fees would accrue to the owner/operator of the site.

Environmental benefits that could result from placing dredged material within an existing landfill include the isolation of potentially contaminated material and the placement of material within a location that is already disturbed and has existing infrastructure to effectively contain and isolate the material.

5.1.5 Coastal Beneficial Use Impacts

Nearshore Bar/Berm Placement Impacts

Nearshore berms are submerged, high-relief mounds, generally built parallel to the shoreline. They are commonly constructed of sediment removed from a nearby dredging project. There are typically two types: feeder berms and stable berms. Feeder berms are transient features that contain predominantly clean sand placed in the nearshore zone directly adjacent to a beach. Stable berms are generally longer-lasting features constructed in deeper water or low-energy environments, where sediment transport is limited. These berms could be constructed with finer-grained material since the environment is not conducive to wave or current-induced sediment transport.

Physical Impacts

The greatest physical impact associated with nearshore bar and berm placement would be the intentional change in bottom topography associated with placement. The change in bottom topography would in turn result in decreased wave energy, nearshore current patterns, and littoral sediment transport. In some cases, feeder berms would be created in areas where sustained landward transport of sediment would result in beach accretion. However, this could also reduce or increase littoral transport of sediment. There is also a potential for channelization of tidal flow because the bar or berm would divert tidal flow through the deeper areas between bars or berms. This channelization could potentially result in greater erosion through the deeper channels as the increased current energy causes more scouring. Depending on the distance from shore, bars and berms could also result in greater wave energy (as the shoaling would cause waves to break over the bars and berms) or decreased wave energy (since the energy would be dissipated over the bars and berms rather than at the shoreline).

Under the nearshore bar/berm placement alternatives, the placed material must first be determined to be compatible with the nearshore and beach sediments at the placement location. However, it would still be possible to have changes in sediment grain size distribution and TOC. Grain size distribution would also be influenced by any changes in tidal current and wave energy, which would affect sediment transport.

Environmental Impacts

Dredged material resuspension would result in short-term impacts to water quality, and material placement would increase turbidity. Turbidity could also increase as a result of increased sediment transport caused by channelized currents or focused wave energy. Phytoplankton could be impacted by the decreased light penetration that would result from the increase in turbidity, and both phytoplankton and zooplankton could sustain short-term impacts from entrainment during placement.

Direct destruction of SAV, wetlands, and benthic invertebrate populations, including shellfish populations, would occur through burial when material is deposited directly on these resources. In addition, there is the potential for direct destruction of fish that are Federally managed and for habitat impairment from the physical change in sediment characteristics or water depth. For SAV and wetlands outside of the bar or berm footprint and for nearby MPAs, there is the potential for increased sedimentation from changes in sediment transport processes or increased erosion from increased tidal or wave energy, both of which can also temporarily impact water quality because of increased turbidity.

During placement of dredged material, marine mammals and reptiles could potentially be subjected to strikes or harassment. Other threatened and endangered species could also be destroyed or buried if the species were immobile and were located within the bar or berm footprint. Habitat impairment could also occur under certain conditions: if resource habitat were located within the bar/berm footprint; if the migration of bar/berm material changed shoreline substrate, or if the bar/berm caused sedimentation or erosion.

Nearshore bar/berm placement could be accomplished in close proximity to a dredging site. Dredged materials could be transported by pumping or by barge/tug and could be placed using equipment at the site. Air quality and noise impacts could be of potential concern, depending on factors such as:

- The volume of material to be placed
- The distance to the alternative site
- The duration of placement activity
- The sensitivity of land uses immediately adjacent to the selected sites and/or transporting routes

Air quality and noise impacts would likely be of short duration and would be less than significant.

Infrastructure Impacts

Nearshore berm sites close to navigation channels could have an adverse impact on navigation due to shoaling. Utilities could also be buried during placement. Another potential impact would be changes in current patterns and wave energy that could result in erosion or deposition around docks, recreational areas, dredged material facilities, aquaculture facilities, and other coastal structures.

Cultural Impacts

During dredged material placement, cultural resources could potentially be destroyed, buried, or disturbed. Changes in local sedimentation or erosion due to changes in littoral drift, shoreline erosion due to wave-focusing, or runoff during dewatering could also result in burial or disturbance. These changes could impact local aquaculture operations, recreational activities, and waterborne commerce. In addition, during placement activities, there would be a temporary adverse impact to aesthetic quality.

Socioeconomic Impacts

Under the nearshore bar/berm alternatives, shellfish aquaculture could potentially be disrupted or destroyed, resulting in a consequential loss of employment dependent on those aquatic resources. Waterborne commerce and recreational boating activity could also be disrupted. Submerged pipelines could be within the construction area of the sites and could be at risk if they were disturbed by construction activities. Some short-term aesthetic value losses would be possible during construction of the nearshore bars/berms. Nourishment of public beaches could result in more visitations and increased traffic in the immediate area.

Beneficial Impacts

Under the nearshore bar/berm alternatives, potential benefits could accrue over time to man-made resources, visual aesthetics, public services and facilities, regional employment, and public revenue. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Allowing littoral drift to nourish beaches would likely result in a more developed beach profile, thereby reducing damage to properties bordering the beach during coastal storm events. Nourishment and reestablishment of beach areas could result in long-term visual aesthetic benefits, as well as contribute to greater recreational utility and public enjoyment of sites. Other ecosystem services could accrue to the population at large. Employment could increase for barge and tug operators and heavy machinery operators involved in the placement of material. If nourishment of beachfronts produced additional usable beach area and encouraged recreational usage, public revenues could increase from associated visitation fees.

A number of physical benefits would result from the construction of both feeder berms and stable berms. If feeder berms were constructed, new sediment would be introduced to the littoral system, beaches would be nourished through onshore sediment transport, and nearshore wave energy, and therefore shoreline erosion, would be reduced. If stable berms were constructed, wave energy along the shoreline would be reduced, resulting in lower shoreline erosion.

These physical benefits could lead to environmental benefits, such as increasing SAV habitat through wave sheltering. Shoreline accretion due to reduced wave energy and erosion could also enhance other shoreline habitats, including those found in MPAs. Bathymetric variations resulting from the creation of nearshore berms have the potential to increase habitat diversity for fish species, which has the potential to provide new or enhanced fisheries habitat and feeding areas for marine mammals. Depending on the specific project, there could be the option to incorporate habitat enhancement for upland and coastal wildlife and birds into the final project design.

Nearshore berms also could result in beneficial impacts to nearby cultural resources and infrastructure through reduced wave energy and shoreline accretion, thereby reducing the risk of storm damage and erosion to these resources.

Beach Nourishment Impacts

The term “beach nourishment” generally refers to the process of adding sediment, also known as “beach fill,” to a beach and/or dune system. In general, there are two types of beach nourishment projects:

- the beneficial use of clean, compatible sediment from a nearby dredging project to augment the volume of a beach or dune by directly placing sand either on the beach/dune or in the nearshore, where it can act as a source of sediment for the beach/dune system, and
- a designed, engineered project where a specified volume of sand is added to a beach/dune system to provide a desired level of storm damage protection and flood control.

Physical Impacts

The greatest impact associated with beach nourishment is the change in beach profile. Although the profile change is intentional, it can either dissipate or focus wave energy, change littoral currents and sediment transport, and result in shoaling.

The most important factor for beach nourishment projects is the grain size distribution of the source material as compared to the native beach material, also referred to as sediment compatibility. For dredging projects, state policy requires that clean, compatible sediment be placed on adjacent beaches to keep the material in the littoral system. Although the placed material must first be determined to be compatible with the nearshore and beach sediments at the placement location, it would still be possible to have changes in sediment grain size distribution and TOC. Grain size distribution would also be influenced by any changes in littoral current and wave energy, which would also affect sediment transport. Note that location is important. If sediment were placed where it would not be stable due to its incompatibility, then unintended adverse impacts on eelgrass, shellfish beds, salt marshes, or the dredge channel could result.

Environmental Impacts

Dredged material resuspension would result in short-term impacts to water quality, and material placement would increase turbidity. Turbidity could also increase as a result of increased sediment transport caused by channelized currents or focused wave energy. Phytoplankton could be impacted by the decreased light penetration that would result from the increase in turbidity, and both phytoplankton and zooplankton could sustain short-term impacts from entrainment during placement.

Direct destruction of SAV, wetlands, and benthic invertebrate populations, including shellfish populations, would occur through burial when material is placed directly on these resources. In addition, there is the potential for short-term impacts to fish that are Federally managed (from the temporary decrease in water quality) and for habitat impairment (from the physical change in sediment characteristics or water depth). For SAV and wetlands located outside of the placement footprint and for nearby MPAs, sedimentation could increase or decrease as a result of changes in the littoral transport of sediment.

Under the beach nourishment alternatives, marine mammals and reptiles could be subjected to strikes or harassment during placement of dredged material. Other threatened and endangered species could also be destroyed or buried if the species are immobile and are located within the placement footprint, and shorebird nesting habitat could experience adverse impacts. During dredged material placement, wildlife that use the beach could be temporarily displaced.

Beach nourishment could be accomplished in close proximity to a dredging site. Dredged materials could be transported by pumping or by tug or truck for placement if needed, and materials could be placed using equipment at the site. Air quality and noise impacts could be of potential concern, depending on typical factors such as:

- The volume of material to be placed
- The distance to the alternative site
- The duration of placement activity
- The sensitivity of land uses immediately adjacent to the selected sites and/or transporting routes

Air quality and noise impacts would likely be of short duration and would be less than significant.

Infrastructure Impacts

Impacts to infrastructure from beach nourishment include potential impacts to utilities, mooring areas, aquaculture beds, and coastal structures from burial or increased sedimentation. Upland dewatering of material could require truck hauling and the use of public roadways for transit, resulting in potential increased traffic congestion. Nourishment could encourage more visitations and increased traffic in the immediate area.

Cultural Impacts

Where archaeological sites are present nearby, there is the potential for increased sedimentation or erosion from changes in current and wave energy and changes in sediment transport. Aesthetic quality would be temporarily reduced and recreational activities would be temporarily disrupted. Impacts to aquaculture could occur as a result of burial or increased sedimentation over shellfish beds. Waterborne commerce and recreation could also be temporarily disrupted. Improvements to recreational beaches would ultimately draw more revenue from visitors.

Socioeconomic Impacts

Under the beach nourishment alternatives, shellfish aquaculture could potentially be disrupted or destroyed, resulting in a consequential loss of employment dependent on those aquatic resources. Waterborne commerce and recreational boating activity could also be disrupted. Submerged pipelines could be within the construction area of the sites and could be at risk if they were disturbed by construction activities. Some short-term, adverse aesthetic impacts would be possible during nourishment activities. Upland truck hauling would require dewatering of material and use of public roadways for transit, resulting in potential increased traffic congestion and air quality impacts. Nourishment of beaches could encourage increased visitations and traffic in the immediate vicinity of the sites.

Beneficial Impacts

Under the beach nourishment alternatives, potential benefits could accrue over time to man-made resources, visual aesthetics, public services and facilities, regional employment, and public revenue. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Nourishment of beaches would result in a more developed beach profile, thereby reducing damage to properties bordering the beach during coastal storm events. Nourishment and reestablishment of beaches could result in long-term visual aesthetic benefits and could contribute to greater recreational utility and public enjoyment of sites. Other ecosystem services could accrue to the population at large from beach nourishment. Employment could increase for barge and tug operators or truck drivers and heavy machinery operators involved in the placement of material. If reestablishment of beachfront produced additional usable beach area and encouraged recreational usage, public revenues could increase from associated visitation fees.

Beneficial use projects are designed to keep dredged sediment in the littoral system but not necessarily to provide any specific level of protection, while engineered projects are designed to provide a specific level of storm damage protection. Shoreline accretion due to beach nourishment has the potential to enhance a variety of shoreline habitats, including those found in MPAs. Depending on the specific project, there could be the option to directly incorporate habitat enhancement for upland and coastal wildlife and birds into the final project design. Beach nourishment also could result in positive impacts to nearby cultural resources and infrastructure through reduced wave energy and shoreline accretion, thereby reducing the risk of storm damage and erosion to these resources.

5.1.6 Upland Beneficial Use Impacts

Landfill Cover/Capping Impacts

Landfills require capping material to sequester waste material from the environment. In most cases, dredged material would be used in some form of cover application (daily, intermediate, or final cover).

Physical Impacts

Dredged material placed at a landfill site as daily or intermediate cover would be placed along with other waste streams entering the facility. Final cover material could be placed during the closure process of the site or at portions of the site. Landfills considered as alternative placement sites are active, disturbed locations, so there would generally be no additional physical impacts associated with dredged material placement beyond the current operation and management of the landfill.

Environmental Impacts

The use of dredged material as a landfill cap or cover would likely not result in direct impacts to wetlands, birds, terrestrial wildlife, or threatened and endangered species since the alternative sites are already established and operating landfills.

Dredged material placed as cover could potentially impact groundwater and surface water quality in the immediate area. Dredged material used in this manner would need to be characterized to determine whether it meets specific design criteria to limit impacts on adjacent resources from increased salt content, leachable contaminants, or increased sediment load in stormwater runoff.

Secondary impacts associated with landfill cover applications would include the effects associated with material dewatering (dewatering fluid management, possible equipment emissions at the dewatering site) and transportation (emissions). Impacts from construction equipment emissions at the alternative sites are not considered because landfill cover operations will take place whether the capping material used is dredged material or is excavated from non-dredging sources.

Under the landfill capping/cover alternatives, dewatering of dredged material would potentially involve operation of loaders, dozers, and workers' commuting vehicles at dewatering and landfill sites. Trucks would be used to transport dredged materials for landfill placement. These equipment and vehicle operations would result in air pollutant emissions and noise impacts around the selected placement site and along truck routes. Depending upon the scale and duration of landfill cover/capping activities at the selected sites and the sensitivity of the land around these sites, adverse air quality and noise impacts could be of concern.

On-road truck operations associated with material transport to and from landfill sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck routes.

Infrastructure Impacts

Any dredged material used as cover material at landfills could require the use of significant overland transportation resources, depending on the distance between the project site and the landfill location. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

It is unlikely that historic districts or archaeological resources are located at landfill placement sites; therefore, no direct destruction of, or visual impacts to, cultural resources are anticipated under these alternatives.

Socioeconomic Impacts

Potential adverse effects from the transport of clean material to landfill sites would depend on the dewatering site location and the length of travel routes, routes taken, and volume of material transported. The increased number of trucks along the route could produce additional traffic congestion, noise, and air quality impacts to surrounding areas.

Beneficial Impacts

Over time, potential benefits could accrue to man-made resources, regional employment, and personal revenue from the placement of dredged material at landfill sites. A long-term beneficial consequence of any dredged material placement activity is that dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Employment of truck drivers and heavy equipment operators at origin and destination sites could increase but would be limited to the extent that material is available or quantity is needed for a site. Some sites require daily capping, which could increase employment among truck drivers and operators of heavy machinery handling the material; however, the increase would be temporary. Some sites could require only final capping, while other sites could receive material over the long term. Employment would correlate with the quantity and use of material placed at specific sites. Revenue from tipping fees would accrue to the owner/operator of the site.

Depending on the specific project, there could be the option to directly incorporate habitat enhancement for upland and coastal wildlife and birds into the final project design.

Brownfields and Other Redevelopment

Dredged material could be used beneficially to redevelop Brownfield sites within the study area. For example, the site of a former airport in Flushing, New York (Site 422/423) was identified as a potential redevelopment site at the time of this PEIS publication. The site has both wetland and upland components and could receive clean fill for capping purposes following the remediation of any contaminated sediments or soils.

Physical Impacts

Brownfield sites are already highly disturbed, remediated sites. Placement of dredged material at these sites as clean fill or capping material is not likely to generate additional physical impacts beyond the remediation operations at the site. However, there would be potential impacts from an increased sediment load in stormwater runoff and changes in grain size and TOC, depending on source material and the project design.

Environmental Impacts

The use of dredged material as fill or cap material at Brownfield sites is unlikely to harass mobile resources such as birds or terrestrial wildlife, but these resources could be temporarily displaced during placement activities.

Where wetlands or critical habitats are located within or near a Brownfield redevelopment site, these resources could potentially be buried or destroyed. However, a Brownfield redevelopment project presents the opportunity to improve previously degraded environmental resources by removing invasive species, reconstructing wetland hydrology, reintroducing native vegetation, and improving sediment and soil quality.

Dredged material placed as fill or cover has the potential to impact groundwater and surface water quality in the immediate area. Dredged material used in this manner would need to be characterized to determine whether it meets specific design criteria to limit impacts on adjacent resources from increased salt content, leachable contaminants, or increased sediment load in stormwater runoff.

Secondary impacts associated with Brownfield redevelopment applications would include the effects associated with material dewatering (dewatering fluid management, possible equipment emissions at the dewatering site) and transportation (emissions). Impacts from construction equipment emissions at the alternative sites are not considered because Brownfield remediation and restoration activities will take place whether the fill and capping material used is dredged material or is excavated from non-dredging sources.

Dewatering of dredged material would potentially involve the operation of loaders, dozers, and workers' commuting vehicles at dewatering and Brownfield sites under this alternative. Trucks would be used to transport dredged materials for upland placement. These equipment and vehicle operations would result in air pollutant emissions and noise impacts around the selected placement site and along truck routes. Depending upon the scale and duration of placement activities at the selected sites, the distance to the placement site, and the sensitivity of the land around these sites, adverse air quality and noise impacts could be of concern.

On-road truck operations associated with material transport to and from Brownfield sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck routes.

Infrastructure Impacts

Dredged material placed at Brownfield sites would likely require the use of overland transportation and construction resources, depending on the distance between the project site and the alternative location. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

It is unlikely that historic districts are located within Brownfield sites; therefore, no adverse impacts from direct destruction of cultural resources are anticipated under these alternatives. Where archaeological resources are present, these resources could be destroyed if they are within areas excavated for remediation or removal of subsurface contaminants. No adverse visual impacts to cultural resources are anticipated since the site aesthetics would be improved as part of the redevelopment project.

Socioeconomic Impacts

Under the Brownfields/redevelopment alternatives, adverse socioeconomic impacts could occur. Some short-term, adverse aesthetic impacts would be possible during construction. Potential adverse effects from the transport of clean material to redevelopment sites could occur; the impacts would depend on the dewatering site location and length of travel routes, the route taken, and the volume of material transported. An increase in the number of haul trucks along the route taken could produce additional traffic congestion, noise, and air quality impacts within the surrounding area.

Beneficial Impacts

Over time, the use of Brownfields or other redevelopment sites for material placement could result in benefits to man-made resources, aesthetics, public facilities, and regional employment. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Conversion of a degraded site to a publicly accessible natural park area would benefit the public at large by providing increased recreational opportunities and decreasing the risk of exposure to site contamination. The visual aesthetics of the site would be improved over the long term. Employment could increase with the need for truck drivers and heavy machinery operators at origin and destination sites to handle placement material.

Depending on the specific project, there could be the option to directly incorporate habitat enhancement for wetlands and for upland and coastal wildlife and bird species into the final project design.

Mines and Quarries

Dredged material could be used beneficially to reclaim open mines and quarries. Within the region, typical mining operations include sand, gravel, limestone, granite, iron ore, and copper ore. Unlike a managed landfill, these sites are not likely to be lined disposal areas; therefore, additional characterization of the source material could be required to ensure that fill material meets applicable regulations and design specifications.

Physical Impacts

Mines or quarries considered as alternative placement sites are disturbed locations, so additional physical impacts associated with the placement of dredged material would not be expected. However, there could be potential impacts from an increased sediment load in stormwater runoff and changes in grain size and TOC content depending on the source material and the project design.

Environmental Impacts

The use of dredged material as a fill for open mines and quarries is unlikely to have direct impacts to wetlands, birds, terrestrial wildlife, or threatened and endangered species because the alternative sites are already established excavation and mining areas.

Dredged material placed in mines or quarries could potentially impact groundwater and surface water quality in the immediate area. Dredged material used for this purpose would need to be characterized to determine whether it meets specific design criteria to limit impacts on adjacent resources from increased salt content, leachable contaminants, or increased sediment load in stormwater runoff.

Secondary impacts associated with the placement of dredged material in a mine or quarry would include the effects associated with material dewatering (dewatering fluid management, possible equipment emissions at the dewatering site) and transportation (emissions). Impacts from construction equipment emissions at the alternative sites are not considered because reclamation activities will take place whether the fill material used is dredged material or is excavated from non-dredging sources.

Dewatering of dredged material would potentially involve the operation of loaders, dozers, and workers' commuting vehicles at dewatering and mine/quarry sites under this alternative. Trucks or rail lines would be used to transport dredged materials for upland placement. These equipment and vehicle operations would result in air pollutant emissions and noise impacts around the selected placement site and along truck/rail routes. Depending on the scale and duration of placement activities at the selected sites, the distance to the placement site, and the sensitivity of the land around these sites, adverse air quality and noise impacts could be of concern.

On-road truck or rail operations associated with material transport to and from mine/quarry sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck/rail routes.

Infrastructure Impacts

Any dredged material placed at quarry or mine locations could require the use of significant overland transportation resources, depending on the distance between the project site and the alternative location. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

It is unlikely that historic districts or archaeological resources are located at mine or quarry sites; therefore, no impacts from direct destruction of, or visual impacts to, cultural resources are anticipated under these alternatives.

Socioeconomic Impacts

A basic assumption under the mine and quarry alternatives is that dredged material would be transported by rail for the long haul as opposed to trucking the material. This assumption influences the projection of socioeconomic and other impacts.

Rail service adjacent to quarry and mine sites is assumed based on the original use of these sites. Adverse impacts could accrue from an increased number of trucks used to move material from dewatering sites to railways, which may result in traffic congestion and adverse air quality and noise impacts. Rail access from potential dewatering sites, particularly on Long Island, could prove problematic since freight rail service is limited east of the Hudson River in New York City and on Long Island. However, at the quarry and mine sites, truck hauling would likely be confined within the site or nearby, so public roadway use would not be required.

Beneficial Impacts

Over time, potential benefits could accrue to man-made resources, regional employment, and personal revenue. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Transport of material is expected to be by rail for long hauls, with no change to employment from rail mode. For short hauls, additional truck drivers and heavy machinery operators could be employed to handle the material at the origin and destination. Revenues from tipping fees are expected to accrue to the owner/operator of the site.

Depending on the specific project, there could be the option to directly incorporate habitat enhancement for wetlands and for upland wildlife and bird species into the final project design.

Habitat Restoration/Enhancement or Creation

Certain alternative placement sites present opportunities to beneficially use dredged material to enhance or restore degraded habitat. These sites could involve shoreline or island restoration, wetland restoration activities, or upland habitat projects.

Physical Impacts

Using dredged material for habitat restoration projects could have impacts on physical resources by altering stormwater drainage patterns as well as currents, littoral drift, and wave action for coastal sites. These impacts could be either mitigated or engineered to result in beneficial impacts, depending on the project design.

Environmental Impacts

There would be potential environmental impacts from the use of dredged material at habitat restoration sites. Benthic habitat and wetlands could be buried or destroyed, plankton could be entrained, and turbidity could increase during placement and construction operations. Birds, marine mammals and reptiles, and terrestrial wildlife could potentially be harassed during construction, but this would be unlikely because most of these resources are mobile.

Dredged material could adversely impact groundwater and surface water quality in the immediate area of the restoration site. Dredged material used in this manner would need to be characterized to determine whether it meets specific design criteria to limit impacts on adjacent resources from increased salt content, leachable contaminants, or increased sediment load in stormwater runoff.

Adverse impacts to water quality and aquatic habitats would likely be of short duration, with invertebrate communities recovering to pre-disturbance levels within months or years of placement. Short-term impacts to currently degraded coastal, wetland, and upland resources at these sites could be mitigated or improved following project completion. The final design could include ecosystem enhancements such as removing invasive species, reintroducing native species, and increasing the quality and extent of historically abundant habitats such as maritime forests, coastal grasslands, dunes, and salt marshes.

Secondary impacts associated with the use of dredged material at habitat restoration sites would include the effects associated with material dewatering (dewatering fluid management, possible equipment emissions at the dewatering site) and transportation (emissions). Impacts from construction equipment emissions at the alternative sites are not considered because restoration activities will take place whether the fill material used is dredged material or is excavated from non-dredging sources.

Dewatering of dredged material would potentially involve the operation of loaders, dozers, and workers' commuting vehicles at dewatering and habitat restoration sites under this alternative. Trucks would be used to transport dredged materials for upland placement. These equipment and vehicle operations would result in air pollutant emissions and noise impacts around the selected placement site and along truck routes. Depending on the scale and duration of placement activities at the selected sites, the distance to the placement site, and the sensitivity of the land around these sites, adverse air quality and noise impacts could be of concern.

On-road truck operations associated with material transport to and from habitat restoration sites would also result in adverse air quality and noise impacts, particularly at sensitive land areas immediately adjacent to truck routes.

Infrastructure Impacts

Dredged material used for habitat restoration could require the use of overland or overwater transportation resources, depending on the project site and alternative location. This impact would be short-term and would cease once placement operations were completed.

Cultural Impacts

It is unlikely that historic districts are located within habitat restoration sites; therefore, no impacts from direct destruction of cultural resources are anticipated under these alternatives. Where archaeological resources are present within or near the site, there is the potential for changes in sedimentation/erosion, which could adversely impact these resources by burying them or exposing them through erosion of the covering material. Visual impacts to cultural resources would be unlikely at habitat restoration sites because the material to be used for restoration would likely be similar to existing beach material.

Socioeconomic Impacts

Under the habitat restoration alternatives, adverse socioeconomic impacts could occur. The impacts of transporting clean material to alternative sites would depend on the origin of the dewatering site and the length of travel routes, the route taken, and the volume of material transported. The number of trucks required to move material could result in additional traffic congestion. Aesthetic quality could be reduced during construction. Reestablishment of recreational beachfront could encourage more visitations and consequently increased traffic in the immediate area, based on the site's recreational appeal.

Beneficial Impacts

Over time, potential benefits could accrue to man-made resources, aesthetics, public facilities and services, regional employment, and revenue. Dredging (and therefore dredged material placement) allows for the continued operation of the ports and harbors within Long Island Sound. Beach-compatible sand placement would remediate erosion along the beachfront, protect nearby infrastructure, and enhance the beach and dune habitat for greater recreational and other ecosystem service opportunities for the population at large. Nourishment of a wetland site would restore wetlands and improve habitat quality for greater recreational opportunities and other ecosystem services to the population at large. A long-term effect could be an improved visual aesthetic. Employment could increase with the need for barge operators, truck drivers, and heavy machinery operators to handle material at origin and destination sites. Enhancement of upland sites could increase revenue by encouraging visitation to public parks and nearby wetlands.

Depending on the specific project, dredged material placement could be used to alter the physical characteristics of a site to provide physical benefits such as reduced wave energy and erosion and increased shoreline accretion. The goal of these types of projects would be to restore degraded habitats so that they could once again support healthy, functioning natural ecosystems. The restored habitats and the ecosystems they support could include Federal and state-listed species, benthos, fish, shellfish, terrestrial wildlife, and birds, depending on the location of the site and the final project design.

5.1.7 Innovative Treatment Technologies

Innovative treatment technologies (see Chapter 3) could be used to neutralize or remove contaminants from sediment and create products with beneficial use applications, such as manufactured soil for Brownfield remediation, public landscaping, highway projects, landfill daily cover and closure, and a growing medium. The impacts associated with both the treatment processes themselves and the use and application of the resulting products in the environment are described below.

Physical Impacts

Innovative treatment technologies would likely be located in upland sites in former or existing industrial areas and would not result in physical impacts to the environment. Innovative treatment products could be used in a variety of settings, depending on the end products of the technology used. Any physical impacts to the environment would need to be assessed on a site-specific basis and would depend on the use of the end product.

Environmental Impacts

Impacts to aquatic resources from the use of chemical or thermal innovative treatment technologies would be limited to spills during handling, runoff from storage piles, and discharges of effluent. Technologies that involve placing dredged material on soil for natural or enhanced natural treatment (composting, land farming, land tilling, and bioremediation) could potentially impact surface water or wetlands. Runoff could entrain dredged material (raw or finished product), and contaminants or chemicals such as fertilizers or surfactants used as additives for treatment could leach or dissolve from the material. These impacts, however, are technology-specific, and a mass balance of the process systems would usually be able to foresee what impacts could result and how they could be potentially mitigated. Spills during handling and discharged effluent from dewatering are additional sources of potential impacts. However, dredged material suitable for these technologies either would have relatively low contaminant levels or would contain contaminants that are easily biodegradable.

Permit requirements would stipulate on-site treatment systems, and runoff controls combined with best management practices would minimize the potential for discharges from runoff and control potential spills. The effects of spills, if they did occur, would be localized. Dredged material handling, coupled with best management practices in the industry, has significantly progressed over the last several years to be able to minimize and quickly mitigate any spills.

Discharges from effluent and runoff that reach surface water bodies could have far-reaching impacts because surface water or tidal currents could widely distribute contaminants. Permitting requirements would specify appropriate controls and treatment for the overall operation of such facilities so that effluent met water quality standards. It is assumed that effluent would be monitored for compliance with the permit requirements.

Contaminants could also leach into groundwater as a result of gravity draining excess moisture from stockpiles; the exposure of stockpiles to rainfall; dredged material spread over land for composting, land farming, land tilling, and bioremediation; and spills. The potential effects would be site-specific and would depend on many factors that would need to be evaluated prior to implementation. Potential impacts to groundwater could be minimized by using impermeable liners, enclosures, runoff collection systems, and leachate collection systems as determined by permitting requirements. It should be noted that usually the dredged material is not placed in an “as is” dredged state owing to the fluidity of the material. Raw dredged material is difficult to move on upland areas without some form of dewatering prior to upland placement.

Technologies such as composting, land farming, land tilling, and bioremediation involve spreading dewatered dredged material over large areas. Vegetation could need to be cleared from some sites. Spread dredged material would be exposed to foraging species such as birds and small mammals; these species may attract predators, including protected species such as peregrine falcons. Though contaminant loads for such technologies would be relatively low or the contaminants would be biodegradable, contaminants could potentially enter the food web. Site-specific studies would need to be conducted and specific contaminants present in the raw material would need to be evaluated prior to the use of these technologies. Stockpiles and processing areas for material containing volatile contaminants could need to be enclosed.

An innovative treatment technology facility using chemical or thermal technologies would likely be sited in an existing industrial area, thereby limiting the potential for exposure of terrestrial wildlife. Stockpiled unprocessed dredged material could contain organic matter or eventually become vegetated over time, which could attract foraging species and their predators. Because the dredged material could potentially contain relatively high levels of contaminants and contaminants that volatilize, there is a potential for contaminants to enter the food web. Though large volumes of dredged material in stockpiles are typically stored uncovered, storage under a protective covering or roofed structure could reduce or eliminate that potential.

Processing sites for innovative treatment technologies would likely be located in upland industrial areas or highly disturbed sites. These areas generally are not habitat for threatened or endangered species. Consequently, the use of innovative treatment technologies would not impact threatened or endangered species or EFH. However, predatory birds such as peregrine falcon, which are sometimes found in urban areas, could inhabit the area and could potentially be impacted by these technologies.

Air quality impacts would vary depending on the technology. These impacts would need to be evaluated specifically for the contaminants present in the material to be processed, the site location and its proximity to sensitive receptors, and the treatment process train. Innovative treatment processes include specialized air handling equipment and monitors to comply with applicable air quality requirements.

Sediment could contain contaminants that are volatile. Volatilization of contaminants in the dredged material could occur in stockpile areas, during handling, and during treatment. An example is the addition of Portland cement for dewatering or stabilization, which causes an exothermic reaction with the dredged material that can potentially release volatile metals and organics. Enclosures or other controls to contain and treat volatilized contaminants could be needed. Dust from stockpiles and handling, particularly from composting, land farming, and land tilling, could affect air quality or potentially disperse contaminants. Dust control measures also could be needed.

Emissions from equipment, fuel burning, or temperature-based treatment processes would be subject to air quality standards. Permitting for such facilities would require air pollution control systems and strict compliance monitoring.

Innovative treatment technologies use machinery, industrial processes, yard equipment, and trucks. Siting such facilities in industrial areas and using controls, such as noise-damping components on machinery and generators, could minimize or eliminate potential noise impacts to surrounding areas and sensitive receptors.

Infrastructure Impacts

Traffic generated from the use of innovative treatment technologies would vary greatly depending on the technology, the location of the processing facility, and the end use of the processed dredged material. In general, the tendency among innovative treatment technology vendors is to minimize the use of over-the-road vehicles. However, the technology would need to be sited near a major road/highway in the pre-construction stages to haul in large equipment.

During the operations stages, a portion of traffic flow would be generated by shift workers. The majority of traffic would likely result from trucks needed to transport dredged material to processing facilities, then transport the processed material to final deposition.

The selected technology and site location would have a considerable effect on traffic impacts to local road networks. Where treatment involved multiple technologies that are not co-located, truck trips would be required to transport material between processing sites. Intermediate trips could be avoided by using a processing facility that employs multiple technologies in a treatment train approach. Truck traffic could be reduced by siting the processing facility on waterfront parcels to allow barge transport or on sites with railroad access. Technologies that involve highly efficient dewatering techniques, such as sand separation and/or high temperatures (Cement-Lock, for example) also could reduce traffic generation and weight through the volume reduction intrinsic to the technologies.

The demand for services such as energy, water, and wastewater treatment for operation of innovative treatment technologies would vary depending on the technology and the volume of material processed by the facility. The sufficiency of local suppliers to provide such services would be determined in the siting and permitting processes.

Cultural Impacts

Innovative treatment technologies themselves (apart from composting, land tilling, and land farming, which require dredged material to be spread over large land areas) would not impact cultural resources. Potential impacts to cultural resources would not be anticipated if the innovative technology facilities were sited in previously impacted areas. In any case, potential impacts to cultural resources from any innovative treatment technology facility at a specific location would be reviewed and addressed during the permitting process and by the SHPO.

Socioeconomic Impacts

Innovative treatment technologies would likely be sited within existing industrial zones and/or facilities. Siting facilities in existing areas of compatible land use could alleviate or minimize adverse social impacts, EJ concerns, and visual impacts. Evergreen vegetation and visually appealing architectural designs are commonly used to reduce the adverse visual impacts of industrial facilities. In Europe and Scandinavia, these techniques have been used successfully to locate industrial high temperature processes in downtown areas of populated urban areas.

Beneficial Impacts

The use of innovative treatment technologies could potentially yield significant direct and indirect beneficial impacts through the generation of jobs and tax revenues. By neutralizing or removing contaminants from sediment, innovative technologies create products that can be used beneficially as manufactured soil for Brownfield remediation, public landscaping, highway projects, landfill daily cover and closure, structural fill, or a growing medium. Furthermore, many of these end products could partially offset project costs through tipping fees or as marketable commodities such as Portland cement replacement or potting soil. Recycling dredged material through treatment would allow the material to replace nonrenewable “greenfield” deposits of topsoil, sand, and shale.

The beneficial impacts of using soil manufactured from dredged material in Brownfield remediation would be cumulative as more fallow sites were remediated and returned to active use. The revenue generated from the fee charged for dredged material placement would provide an economic incentive to remediate contaminated sites. As blighted sites were restored, new businesses would be attracted, further increasing local economic growth. Costs to monitor, maintain, protect, and insure contaminated sites would be reduced or avoided.

Brownfields contribute pollutants to waterways through runoff and groundwater discharge. Remediation using soil manufactured from dredged material by innovative treatment technologies could reduce the discharge of contaminants to waterways and consequently reduce costs related to the impairment of resources, such as fisheries, and the human health effects of contaminants. Additionally, improved sediment quality resulting from reducing pollutant loading to waterways could reduce long-term dredging and sediment management costs.

5.2 IMPACTS ASSOCIATED WITH THE NO ACTION ALTERNATIVE

As discussed in Section 3.1, NEPA requires that an EIS evaluate the “No Action Alternative.” Evaluation of the No Action Alternative involves assessing the environmental and socioeconomic effects that would result if the proposed action did not take place. These effects are then assessed and compared with the effects of the proposed action and the other “action” alternatives. As described in Section 3.1, the No Action Alternative for the Long Island Sound PEIS is defined as the absence of a comprehensive plan for dredged material management in Long Island Sound (i.e., no DMMP would be in effect).

Under the No Action Alternative, the current process of dredging and placement would continue to occur on a project-by-project basis, subject to available funds, and the long-term designated open-water placement sites (CLDS and WLDS) would expire as scheduled on April 30, 2016, or at some later time as determined by EPA, for projects regulated under MPRSA (i.e., either Federal projects of any size or private projects involving greater than 25,000 CY of material). Projects regulated under the CWA would not be affected. In addition, the two USACE-selected sites (CSDS and NLDS) are scheduled to expire on December 23, 2016. As a result, no open-water placement of MPRSA-regulated dredged material projects could occur in Long Island Sound after December 23, 2016.

Without available designated open-water placement sites for MPRSA-regulated projects in Long Island Sound, or practicable cost-effective alternative placement sites and methods, maintenance and periodic improvement of the region’s waterways would become more costly and uncertain. However, several scenarios might reasonably be considered. First, placement site authorization for private projects involving less than 25,000 CY of material would continue to be evaluated on a project-specific basis under CWA Section 404. Second, for projects subject to MPRSA § 106(f) (i.e., either Federal projects of any size or private projects involving greater than 25,000 CY of material), project proponents would need to pursue one or more of the following courses of action:

(1) Use an alternative open-water site, either inside or outside of Long Island Sound, that has been “selected” by the USACE under MPRSA §103. Such a site would need to be one that

has not been in use since the 1992 amendments to MPRSA, or has not had its second five-year period of use expire. EPA would need to concur with the selection.

(2) Use an existing EPA-designated (MPRSA §102) open water site outside of the Long Island Sound study area (e.g., RISDS, HARS). EPA would need to concur with any placement at such sites.
(3) Delay dredging until EPA designation (MPRSA §102) of a different open water placement site within Long Island Sound.
(4) Cancel proposed dredging projects.
(5) Study, design, authorize, construct, and use practicable and cost-effective land-based, in-harbor, nearshore, beneficial use, or CDF placement/use alternatives. The type of alternative would vary depending on the size of the project, nature of the material to be dredged, any additional non-navigation benefits of the alternative, non-Federal sponsorship and funding, and the level of Federal participation warranted.

The No Action Alternative for projects subject to MPRSA § 106(f) poses a different set of problems over the long term. For the first scenario above, involving the use of USACE-selected sites, such use is limited to no more than two five-year periods, as explained in Chapter 3. Over the long term, this approach would require the USACE to select sites as needed around Long Island Sound, or elsewhere, thus spreading any environmental effects throughout and possibly outside Long Island Sound. This would be contrary to the MPRSA principle that favors the continued use of historically used sites. In addition, as discussed above, under this approach CLDS and WLDS would soon become unavailable. To the extent that the use of these sites would be environmentally preferable to the use of other sites, this No Action Alternative scenario would preclude that outcome. Moreover, to the extent that other sites within the Sound were considered for selection by the USACE, the greater haul distances for projects located in the Central and Western Basins would increase the cost and duration of each project. This could potentially render many projects infeasible (see the discussion below for the fifth No Action Alternative scenario, which addresses the ramifications if necessary dredging in the central and western regions of the Sound were not implemented). Although of less significance, it is also worth noting that increased haul distances could also increase any risk of mishap in transit, increase project air emissions, and require greater fuel consumption. Finally, over the long term, this approach would pose the additional administrative difficulty of requiring multiple site selection studies.

With respect to the second No Action Alternative scenario, the currently existing EPA-designated dredged material disposal sites located outside of the Long Island Sound study area are all too far away from most of the dredging projects located within Long Island Sound to constitute reasonable alternatives. Reliance on such sites would greatly increase the cost, duration, and transportation safety risk of dredged material placement projects from Long Island Sound. This would likely render the vast majority of dredging projects prohibitively expensive to conduct. As a result, needed dredging would not be able to take place (see the discussion below for the fifth No Action Alternative scenario, which addresses the ramifications if necessary dredging in the central and western regions of the Sound were not implemented).

The third No Action Alternative scenario identified above presents long-term uncertainty. An ongoing effort to designate a new placement site in New England involves a possible placement site designation in eastern Long Island Sound. The site alternatives under consideration are too far away to make them reasonable alternatives for dredging projects in the central and western regions of the Sound. It is also not yet known when the process will be completed, or what the results may be. No other site designation evaluation process is currently under consideration for Long Island Sound.

The fourth No Action Alternative scenario – simply canceling the majority of the dredging that would otherwise take place – would have adverse effects on navigational safety and marine-dependent commerce. It could also have adverse environmental ramifications if shoaling in the navigation channels resulted in more marine accidents and spills and forced the use of other transportation methods (such as truck and rail) to move products, which could result in greater air emissions (including GHGs), traffic congestion, and other impacts from increased truck traffic on the region's highways and roads.

The fifth No Action Alternative scenario identified above has short- and long-term limitations. Both New York and Connecticut have some limited land-based, in-harbor, nearshore, beneficial use, or CDF placement/use alternatives sites which could provide some capacity for dredged material placement, but these sites would not be reasonable, long-term alternatives to open-water placement (see Chapter 3 for the description of potential alternative sites evaluated in this PEIS). Although both state and Federal agencies are pursuing alternatives to open-water placement, the potential areas identified either do not have sufficient long-term dredged material placement capacity or are not cost-effective or practicable alternatives to open-water placement. For example, the estimated capacity of beneficial use and other land-based alternatives evaluated in this PEIS that could potentially accept suitable material that could otherwise go offshore is about 25 million CY; the currently available capacity at the four open-water alternatives in Long Island Sound is 248 million CY. For comparison, the total dredging needs of USACE and other Federal navigation projects within the Long Island Sound study area is projected to be almost 32 million CY. Complete reliance on land-based or beneficial use placement would also likely raise the cost and increase the duration of dredging projects, possibly rendering some infeasible. Impacts associated with the various types of land-based and beneficial use placement alternatives are described in Section 5.1.

The specific types of impacts that might arise from No Action Alternative Scenarios 1 through 4 are discussed in more detail below; impacts under Scenario 5 are described in Section 5.1 for the various alternative types. For all types of impacts associated with the selection of new open-water sites within Long Island Sound (Scenario 1), the level of impact would vary depending on the number of sites selected and the volume of dredged material placed. The existing conditions at the selected sites would first need to be assessed.

5.2.1 Physical Impacts

Under the No Action Alternative, the selection of new open-water sites either within or outside of Long Island Sound (Scenario 1) could increase the potential for adverse environmental impacts because new open-water locations would likely be in areas where placement has not previously occurred. Sedimentation and erosion would be more likely under this scenario because material would be dispersed over a greater area within or outside of Long Island Sound. Under Scenario 2 (use an existing EPA-designated site) and Scenario 3 (delay dredging until

EPA designation of a different site), potential adverse impacts to sedimentation would likely decrease because less material would be placed in Long Island Sound. Erosion conditions, however, would remain unchanged, since erosion is based on the hydrodynamics of Long Island Sound. If projects were cancelled (Scenario 4), significant sedimentation and shoaling would occur in rivers and harbors. This would result in decreased water depths and potential changes in nearshore hydrodynamics.

Physical impacts under Scenario 5 (develop and use alternatives other than open-water alternatives) are described in Section 5.1 for each alternative type.

5.2.2 Environmental Impacts

Under the No Action Alternative, the selection of new open-water sites within Long Island Sound (Scenario 1) could increase the potential for impacts to benthos, shellfish, fish, sediment quality, and water quality (specifically to the water column), since it is likely that material would be dispersed over a greater area or over new areas. In addition, there is a potential for increased bioaccumulation because the dispersion of dredged material across a greater area could expose more individual organisms or species to chemical concentrations, depending on the existing sediment quality at the selected sites. The extent of impacts would depend on the environmental quality at the selected sites.

The potential for impacts to marine and coastal birds and to marine mammals and reptiles would remain unchanged if newly selected sites were used under the No Action Alternative. However, coordination with NMFS and USFWS would be necessary to assess potential impacts to these species, regardless of the placement scenario chosen. The potential for impacts on endangered or threatened species could either increase or decrease, depending upon the use of the selected site, since each alternative site could have different ESA listed species. As discussed in Chapter 4, endangered and threatened species likely to be present within Long Island Sound on more than an occasional basis are the Atlantic sturgeon and several species of turtles. Coordination with NMFS and USFWS would be necessary to assess potential impacts to these species regardless of the placement scenario chosen.

The potential for adverse environmental impacts to benthos, shellfish, fish, marine and coastal birds, marine mammals and reptiles, water quality, sediment quality, and bioaccumulation potential would remain unchanged under Scenario 2 (use EPA-designated sites outside of Long Island Sound), Scenario 3 (delay dredging until EPA designation), or Scenario 4 (cancel dredging projects) because less material would be placed in Long Island Sound under these scenarios. The potential for impacts on endangered or threatened species could either increase or decrease, depending upon the cancellation of projects. As discussed in Chapter 4, endangered and threatened species likely to be present within Long Island Sound on more than an occasional basis are the Atlantic sturgeon and several species of turtles. Coordination with NMFS and USFWS would be necessary to assess potential impacts to these species regardless of the placement scenario chosen.

Environmental impacts under Scenario 5 (develop and use alternatives other than open-water alternatives) are described in Section 5.1 for each alternative type.

Some increased level of air emissions could result from vessels or vehicles used to haul dredged material to a placement site. If the USACE selected other open-water sites in the region (Scenario 1), the travel distances, and therefore emissions, for placement would be similar to current conditions. If existing EPA-designated open-water sites much farther away had to be used for placement (Scenario 2), the longer vessel trips could result in greater air emissions due to the need to use larger barges and more powerful tugs with larger engines. Under Scenarios 1 and 2, dust and volatilization would not occur and there would be no long-term effects on air quality because the material would be placed under water. Scenario 3 (delay dredging until EPA designation) and Scenario 4 (cancel dredging projects) would decrease air emissions associated with the transport and placement of dredged material in Long Island Sound.

If designated open-water placement sites were not available, leading to greater land-based placement (Scenario 5), air emissions could increase under the following circumstances: (1) emissions resulting from equipment needed to transfer material from barges to dewatering sites and then to trucks, and (2) emissions resulting from the large number of truck trips needed to transport the material on land. Obviously, the level of emissions would vary depending on the distances trucks would have to travel to reach land-based placement site(s). In addition, heavy construction equipment would generate and emit pollutants during placement on land. Activity and equipment would have to comply with Connecticut Air Pollution Control Regulations[1], Vehicle Emission Standards[2], and Fugitive Dust Regulations[3] to minimize impacts. In addition, if no open-water sites were used and land-based placement became necessary, odor problems could result depending on how the materials were handled and where they were placed in relation to sensitive receptors.

5.2.3 Infrastructure Impacts

Under the No Action Alternative, the selection of new open-water sites within Long Island Sound (Scenario 1) could increase impacts to infrastructure resources because placement would occur over a greater area within the Sound. Proposed dredged material placement would likely require additional investigations of infrastructure resources at newly selected sites. With regard to placement at previously used sites within Long Island Sound, impacts to infrastructure resources would likely remain unchanged from current conditions, as these sites would have undergone previous evaluations for the presence of these resources. Under Scenario 2 (use EPA-designated sites outside of Long Island Sound), Scenario 3 (delay dredging until EPA designation), or Scenario 4 (cancel dredging projects), the potential for adverse impacts to infrastructure resources would remain unchanged because less material would be placed in Long Island Sound under these scenarios.

Infrastructure impacts under Scenario 5 (develop and use alternatives other than open-water alternatives) are described in Section 5.1 for each alternative type.

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[1] Connecticut Air Pollution Control Regulations: § 22a-174 of the CGS.

[2] Connecticut Air Pollution Control Regulations: § 22a-174-27.

[3] Connecticut Air Pollution Control Regulations: § 22a-174-18(b).

5.2.4 Cultural Impacts

Under the No Action Alternative, the selection of new open-water sites within Long Island Sound (Scenario 1) would potentially increase impacts to historic and archaeological resources because placement would occur over a greater area within the Sound. Proposed dredged material placement would likely require additional investigations of potential historic and archeological resources at newly selected sites. With regard to placement at previously used sites within Long Island Sound, impacts to historic and archaeological resources would likely remain unchanged from current conditions because these sites would have undergone previous evaluations for the presence of these resources. Regardless of the placement option selected, coordination with SHPOs and Tribal Historic Preservation Offices would be required. Under Scenario 2 (use EPA-designated sites outside of Long Island Sound), Scenario 3 (delay dredging until EPA designation), or Scenario 4 (cancel dredging projects), the potential for adverse impacts to historic and archaeological resources would remain unchanged because less material would be placed in Long Island Sound under these scenarios.

Cultural impacts under Scenario 5 (develop and use alternatives other than open-water alternatives) are described in Section 5.1 for each alternative type.

5.2.5 Socioeconomic Impacts

The regional economic impacts under the No Action Alternative were assessed separately and were estimated by modeling these impacts assuming a “worst-case” scenario—complete cessation in dredging activity over a 20-year period (USACE, 2010). In essence, the assumption used to assess socioeconomic impacts is similar to Scenario 4 of the No Action Alternative for the assessment of physical, environmental, infrastructure, and cultural impacts. As described in Section 4.20.1, marine transportation provides the largest contribution to GSP (59%) for all activities analyzed, followed by recreational boating (22%).

Under the No Action Alternative, socioeconomic impacts would accumulate over time as shoaling continued and vessels lost access to harbors and waterways. Impacts on marine transportation and recreational boating would account for the greatest loss in economic activity, together representing 93% of the estimated reduction in GSP. In addition, ferry-dependent tourism would be expected to bear a somewhat disproportionate impact, accounting for 4% of the estimated loss in annual GSP for the study region. Other impacts not quantified in this analysis include increased costs related to tidal delays for cargo traffic and an increased likelihood of vessel collisions and oil spills. In addition, loss of access to ports could cause commercial and recreational fishermen to abandon fishing altogether, which would have negative social and cultural impacts on the communities that rely on such activity. Losses in annual GSP in the 20th year of the No Action Alternative are anticipated to be approximately $853 million, or approximately 15% of the current regional GSP, from navigation-dependent economic activities. Eastern and western Connecticut, as well as western Long Island, would likely bear the largest impacts in terms of GSP, each experiencing more than $200 million in reduced GSP after 20 years (Table 5-2).

Table 5-2. Regional Economic Impacts in the 20th Year of the No Action Alternative (2009 dollars)[1].

Region[2]	Annual Output (millions)	Annual GSP (millions)	Annual Employment[3]	Annual Tax Revenues (millions)[4]
Rhode Island	-$41.4	-$12.5	-215	-$3.5
Eastern Connecticut	-$386.8	-$237.8	-3,525	-$71.9
Western Connecticut	-$338.1	-$209.8	-2,554	-$65.1
New York Mainland	-$57.9	-$36.9	-461	-$11.7
Western Long Island	-$450.4	-$232.6	-1,644	-$68.7
Eastern Long Island	-$108.6	-$68.5	-1,284	-$22.6
All Long Island Sound[5]	-$1,467.8	-$853.0	-9,655	-$262.5

[1] All figures reported represent the sum of the direct impacts (output of navigation-dependent industries themselves), indirect impacts (output of other industries that supply goods and services to those industries), and induced impacts (changes in household consumption due to employment and income changes from direct and indirect effects) for each category.

[2] Regions are defined as follows: Rhode Island--Washington County; Eastern Connecticut--Hartford, Middlesex, and New London Counties; Western Connecticut--Fairfield and New Haven Counties; New York Mainland--Westchester and Bronx Counties; Western Long Island--Kings, Queens, and Nassau Counties; and Eastern Long Island--Suffolk County. Note that Queens and Kings counties are included only for purposes of measuring indirect and induced effects. Navigation-dependent activity on waterways in these counties is not considered when measuring direct effects. Similarly, waterways in Washington County, outside of Westerly and Block Island, are not considered when measuring direct effects.

[3] Employment is defined by the Bureau of Labor Statistics as “the total number of persons on establishment payrolls employed full or part time who received pay for any part of the pay period that includes the 12th day of the month” (BLS, 2015). Temporary and intermittent employees are included. Data exclude proprietors, those who are self-employed, unpaid family or volunteer workers, farm workers, and domestic workers. Because fishing employment is likely to be underestimated in BLS data, we utilize an alternative method (combining data on ex-vessel revenues in the commercial fishing sector with an estimate of output per worker) to estimate employment in this industry. Nonetheless, this estimate may be skewed, and employment, payroll, and output for the commercial fishing sector may be understated.

[4] The tax impacts include all payments to government, and represent the sum of direct, indirect, and induced taxes paid by employees, businesses, and households. As such, tax impact measurements somewhat overlap with other measures and should not be summed (e.g., value added and output include payments made by industries to payroll taxes).

[5] Note that due to leakage effects (i.e., economic activity across study regions that is not captured in the models run for each region but is captured in the larger Long Island Sound area model), the sum of the output, GSP, and annual tax revenue values reported for the six sub-regions is less than the activity reported for the study area as a whole. The difference in measured impacts of the No Action Alternative varies from 5% to 8%, depending on the output measure. In the case of employment, however, the figures reported for the six regions sum to a value greater than that indicated for the Long Island Sound study area. This anomaly may result from independent specification of the regional purchase coefficients within each IMPLAN model (i.e., regional purchase coefficients for one or more sub-regions that are different than the regional purchase coefficient for the study area as a whole). In addition, the output per worker that IMPLAN specifies may be lower in some sub-regions, causing the model to estimate greater relative employment impacts within these regions than for the study area as a whole.

5.3 IMPACTS ASSOCIATED WITH PLACEMENT ALTERNATIVE SITES

This section addresses the potential impacts to the physical, environmental, infrastructure, and cultural resources that could occur as a result of dredged material placement at each of the potential alternative sites. The site-specific resource data used to assess these impacts are summarized in Chapter 4 of this PEIS. Site-specific data are currently not available to support the assessment of socioeconomic impacts at each potential placement location. While general impacts by alternative type are provided in USACE (2015a), future use of these alternative sites for the placement of dredged material would require a detailed assessment of the impacts at the site on a project-by-project basis.

5.3.1 Open-Water Placement Alternatives

Site-specific impacts associated with the placement of dredged material at the open-water placement alternative sites are described below.

Unconfined Open-Water Placement

Western Long Island Disposal Site

Physical Impacts
The seafloor at the WLDS grades into an east-to-west axial depression, or trough, in the lower half of the site. Water depths range from 75 ft to 85 ft along the northern boundary, down to a 118-ft-deep cut of the axial depression, and slopes up to 98 ft along the southern boundary corners and up to 75 ft in the middle of the southern boundary to a sediment-covered incised platform (ENSR, 2007). Given the depths of the site and limitations on mound height, dredged material placement at WLDS would not impact surface waves.

WLDS is located in a depositional area where the seafloor consists of sandy fine-grained sediment with areas overlain with historic and more recently placed dredged material consisting of sand-silt-clay deposits. The site is flanked by transitional and sand habitats. The sediment properties are similar to ambient sediments in the vicinity of the site. Potential impacts to WLDS are unlikely given the previous changes from historic dredged material at the site and the lack of major differences in the dredged material and ambient sediments.

Sediment accumulation in the area is indicative of a low current regime. In addition, the shoal areas and lack of furrows in the vicinity of WLDS appear to reflect the complex topography and lack of directionally stable currents (ENSR, 2007). Impacts to bottom currents are unlikely due to management of the site and limited currents at the site. There are potential impacts to sediment transport during extreme storm events and/or when high easterly winds combine with spring tidal currents, depending on dredged material mound height and placement location. However, modeling has shown that 2- and 10-year storms would not erode bottom sediments at WLDS or cause sediment transport (EPA, 2004). Modeling studies have also shown that limiting mound height can prevent sediment transport (EPA, 2004).

Bathymetric surveys conducted at WLDS before Hurricane Gloria (August 1985) and afterward (October 1985) revealed no large-scale changes in the bottom topography at the site as a result of the storm. Subsequent monitoring surveys also showed long-term stability of the dredged material mounds and no evidence of erosion of dredged material (USACE (1989); ENSR (2005b); ENSR (2007)).

Environmental Impacts

Burial by dredged material would cause short-term impacts to the abundance and diversity of the benthic community at WLDS. Recovery to levels and species similar to pre-placement could be delayed or prevented if dredged sediment characteristics were different from native material. There is a potential for short-term impacts to the benthic community (respiration and feeding) associated with water quality impairment from the sediment plume following placement. Recolonization to pre-placement levels would be likely, and no long-term effects would be expected as long as dredged material placed at the site was similar to the sandy and fine-grained sediments currently at the site.

The potential area of direct impacts (death and burial) to the benthic community at the WLDS Alternative is estimated to be from 2 to 7.6 acres per year based on average annual mound sizes at the existing WLDS (EPA, 2004). This area represents much less than 0.1% of the available deep fine-grained habitat in this part of the Western Basin (over 9 nmi^2). The direct impacts to the community in an area of this scale are not expected to cause a measurable reduction in the population of any of the species potentially affected within the Western Basin.

Short-term impacts to shellfish could occur from the placement of dredged material at WLDS. The primary shellfish resource inhabiting WLDS is the American lobster, which feeds and burrows there and has been found to occur in high abundance at the site relative to abundances observed in other parts of the Western Basin (EPA (2004); Giannini & Howell (2010)). Dredging windows restrict placement during vulnerable life stages of lobsters (EPA, 2004). Placement of dredged material at WLDS would not be expected to cause major alterations to the seafloor habitat that is currently available for lobster, crabs, or potential bivalves at WLDS. Minor changes in topography and potential organic content could improve shellfish habitat by creating diversity in seafloor conditions and supporting prey populations. Placement would disrupt the habitat and result in short-term impacts to shellfish resources in the immediate area due to burial. Water quality impacts of the sediment plume could potentially impact shellfish filtration and respiration.

Short-term impacts to plankton could occur from dredged material entrainment and sediment plumes in the water column. Most of the discharged dredged material would quickly fall to the seafloor, which could entrain a small area of planktonic organisms (e.g., phytoplankton, zooplankton, and larval stages of fish and invertebrates) and displace others with the movement of water. Increased turbidity resulting from discharged dredged material would temporarily alter water quality, which would have potential short-term impacts on plankton. The impact could be detrimental or beneficial, depending on the planktonic species. The amount of organisms affected would be small compared to the size of the overall community at WLDS.

The majority of finfish species in the WLDS area are migratory, and recovery to levels similar to pre-placement has been documented at this site and throughout Long Island Sound (EPA, 2004). The predicted direct impacts (death or burial) of placement on fish populations in the western Sound would most likely include the potential burial of juvenile red hake within the central footprint of the mound, although some direct impacts would be possible with any demersal (bottom-water-dwelling) fish present at the site. Demersal fish species that could be present during some portion of the period when placement could occur include winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling (EPA, 2004). The impacts resulting in habitat disruption would be short term. Water quality impacts associated with temporary increased turbidity could potentially have direct short-term impacts on fish respiration.

Indirect impacts would likely include temporary displacement of finfish from benthic foraging areas and refuge on fine-grained habitat from late fall to early spring (October to April), as well as occasional displacement of migrating adults in spring and adults and young of the year in fall. The species most likely to experience indirect effects include cunner, winter flounder, and striped searobin. Other species that could also experience indirect effects include fourbeard rockling, fourspot flounder, scup, smooth dogfish, summer flounder, tautog, weakfish, and windowpane flounder. These predictions are based on the migration of the majority of the finfish species out of western Long Island Sound for the period when placement usually occurs (winter months) and the life history patterns and relative abundance of selected species (EPA, 2004).

Placement of dredged material at WLDS would not be expected to cause major alterations to the seafloor habitat at WLDS. Minor changes in topography and potential organic content could improve demersal fish habitat by creating diversity in seafloor conditions and supporting prey populations.

All of Long Island Sound is mapped as EFH, and there are three listed endangered fish species that potentially could occur at WLDS. There are 15 Federally managed species according to the NOAA EFH square designations. Previously, NMFS and USWFS concurred with the findings of the 2004 Final EIS designation of the WLDS and CLDS stating that dredged material placement at these sites is not likely to adversely affect listed species or EFH (EPA, 2005).

About 20 species of marine mammals and reptiles have been identified as possibly occurring at WLDS, which includes five endangered or threatened species of both whales and sea turtles. Sea turtles, whales, and other marine mammals typically migrate into Long Island Sound from the Atlantic Ocean and would thus have a higher probability of occurring in the eastern portion near ocean waters than in the Western Basin where WLDS is located. Open-water placement could potentially impact marine mammals and reptiles, either directly by vessel strikes or indirectly by harassment during placement due to noise and sediment discharge. Temporary sediment plumes could also cause these creatures to avoid the local area. In the designation of WLDS, USFWS noted that “no habitat in the project impact area is currently designated or proposed ‘critical habitat’ in accordance with provisions of the Endangered Species Act (87 Stat. 884 as amended; 16 U.S. C. 1532 et seq.)”. The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions have been found to be effective in reducing strikes to whales (Conn & Silber (2013); NOAA (2013)). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. Potential adverse impacts would be limited and of short duration.

The primary impacts to water quality following dredged material placement at WLDS would be associated with the residual particles that remain suspended from minutes to a few hours after most of the sediment has reached the seafloor. These intermittent, short-term impacts to water quality could potentially include light reduction, interference with biological processes, and contaminant exposure. Suspended sediment could also potentially promote productivity of specific species by serving as a food source (Wilber & Clarke, 2001). The impacts of suspended solids on DO water column concentrations would likely be minimal (mostly in the lower part of the water column) and short-term.

Low DO conditions are a widespread problem in western Long Island Sound and in parts of the Central Basin during summer. Studies of Welsh & Eller (1991) and others have shown that the sediment oxygen demand imparted by the sediments of western Long Island Sound does not significantly influence or drive the observed hypoxic conditions. Instead, the hypoxia is related to the large input of nutrients to the water column and the resultant eutrophic conditions in the water column coupled with summer stratification. Thus, it is not expected that the sediment oxygen demand exerted by dredged material placed at WLDS or any of the alternative sites would have significant impact on the hypoxia in this region or in other areas of Long Island Sound. In addition, dredged material placement usually occurs during the fall and winter months when hypoxic conditions are not likely to exist. The spatial map of the frequency of low-DO years from 1991-2013 (see Figure 4-22) supports the lack of impact on DO conditions, as the WLDS area is within the regional trend for deeper waters and is not anomalously higher than other areas. The links between anthropogenic and terrigenous inputs of organic carbon and sediment oxygen demand and anoxic conditions within sediments are complex (Cuomo, et al., 2014). Seasonal occurrences of anoxic sediments have been mapped in western Long Island Sound and could potentially contribute to a feedback loop with depressed oxygen levels in bottom waters, but WLDS has not been mapped as a hot spot of sediment TOC (Cuomo, et al., (2005); Poppe, et al. (2000)).

For WLDS, model simulations have shown that the vast majority of released dredged material settled to the bottom in close proximity to the point of release (EPA, 2004). The higher-than-typical current conditions chosen for the simulation were the most significant factor in determining residual plume conditions. This might be expected given that a current of 0.9 ft per second would cross half the width of WLDS in less than one hour, and release was at the center of the site. All dilutions were well within the toxicity criteria limits after the four-hour initial mixing period. However, toxicity criteria exceedances occurred when the plume passed out of the site boundaries under high currents, which occurred approximately 90 minutes after release and returned to permissible levels within another 20 minutes beyond the site boundary (EPA, 2004). The results suggest that dilution of contaminants below the prescribed 1/100th LC_{50} level (Median Lethal Concentration) for the worst-case scenario could potentially be achieved simply by adjusting the management approach—either by limiting barge size, limiting operations to times other than during spring tide, positioning the release point according to the ambient currents, or expanding the site boundaries.

Many metals (silver, cadmium, copper, nickel, lead, and zinc) appear to occur in a form that is not biologically available, and laboratory toxicity test data indicate that sediments from WLDS are not acutely toxic to amphipods. Bioaccumulation rates for lobster and finfish at WLDS were generally within the range of levels in similar organisms in other non-placement areas of Long Island Sound. Advanced benthic recovery has been documented following dredged material placement. These results show that the sediment quality within the sites is not significantly degraded and that irreversible or significant adverse impacts from the placement of dredged material in the sites have not occurred (EPA, 2004).

For the purpose of future placement activities, any dredged material taken to the alternative sites would be tested and evaluated in accordance with applicable regulations, as described in the Regional Implementation Manual (EPA and USACE, 2013). As a result, dredged sediments that are toxic or that contain statistically significant levels of contaminants most likely would not be found suitable for unconfined open-water placement without further testing that demonstrated limited bioaccumulation. Therefore, adverse effects to sediment quality as a result of dredged material placement would likely not occur at WLDS.

Impacts to local air quality are expected to consist mainly of exhaust fumes from tugs and other equipment used during operations. These impacts would be intermittent and short in duration and would have to comply with air quality regulations. Tugs would generate some noise while transporting the barges, but this impact would likely not be substantially different from background noise levels in the area.

Infrastructure Impacts

The open-water placement of dredged material at WLDS would not impact most infrastructure resources (e.g., mooring areas, ports, coastal structures, cable/power/utility crossings, and aquaculture) because these are not present at the site. The temporary transit of barges from harbor regions to and from the alternative site could potentially cause short-term impacts by displacing shipping as well as recreational and commercial vessels at WLDS and/or the transit area. Alteration of bottom depths could also potentially impact navigation. However, navigational channels are not present at WLDS, and management of dredged material placement at the site would ensure that adequate water depths were maintained to minimize impacts to navigation.

Cultural Impacts

No cultural resources (e.g., shipwrecks, archaeology sites, and historic districts) are known to exist at the WLDS Alternative site. The Connecticut State Historic Preservation Office also determined that there are no known aboriginal artifacts at the WLDS (EPA, 2005). Two of the region's Indian tribes (the Eastern Pequot Indians of Connecticut and Narragansett Indian Tribe) participated as cooperating agencies during the development of the designation EIS (EPA, 2004), and neither of them identified any natural nor cultural features of historical significance at this site. Therefore, no impacts to cultural resources would occur at WLDS. The only potential visual impacts would be of short duration as vessels and barges traveled to and from the alternative site.

Central Long Island Disposal Site

Physical Impacts

The ambient seafloor at CLDS is a gently sloping plane from a depth of 59 ft at the northwest corner to 72 ft in the southeast corner, with distinct dredged material mounds from past dredged material placement activities rising to depths as shallow as 46 ft (AECOM, 2013). The site is not as deep as WLDS and has a less complex, more even natural topography. Given the depths of the site and management limitations on mound height, dredged material placement at CLDS would not impact surface waves.

Located in a depositional area, CLDS has fine-grained ambient sediments with sand-silt-clay deposits of historic and more recently placed dredged material. The sediment properties at CLDS are similar to, though in some areas more sandy than, ambient sediments in vicinity of the site. Potential physical impacts to CLDS would be unlikely given the previous changes from historic dredged material at the site and the lack of major differences in the dredged material and ambient sediments.

Sediment accumulation and a low current regime that are characteristic of deep areas of the Western and Central Basins are also observed at CLDS. However, currents are faster than observed at WLDS, and there are large, east-west sedimentary furrows at CLDS that appear to be generated by mobilization of the seafloor during infrequent storms or extreme tidal events (Poppe, et al., 2002). Acoustic surveys from 1997, 2000, 2005, and 2011 show that the furrows have been stable over time, providing strong evidence for the lack of sediment transport at the site (ENSR (2007); AECOM (2013)). The processes responsible for the formation of the furrows either were not actively modifying these sedimentary features or were not modifying them at a scale observable in acoustic images within this 14-year timeframe (ENSR, 2007). This also suggests that mound formation at CLDS has not impacted regional flow patterns and sediment transport, as changes to the seafloor topography would be evident over time.

There are potential impacts to sediment transport during extreme storm events and/or when winds combine with spring tidal currents, depending on dredged material mound height and placement location. In addition, waves tend to be larger at CLDS than at WLDS under the most frequent wind conditions (from the west-southwest). Under storm conditions that typically have winds from the east or northeast, wave heights tend to be similar for the Western and Central Basins. Model predictions of sediment transport show that when dredged material mounds are several feet high, waves and currents associated with 2- and 10-year storms would not erode bottom sediments (EPA, 2004). Modeling has also shown that mound placement and limited mound heights can reduce the potential for erosion (EPA, 2004). These results are consistent with survey observations of historical sediment stability.

Environmental Impacts

The benthic community at the CLDS Alternative consists primarily of the three major taxonomic groups, Annelida, Mollusca, and Crustacea. Many species belonging to these groups have shown the ability to burrow up through deposited dredged material. At the CLDS Alternative, the numbers of species per sample and the diversity of species were found to be similar to those at WLDS (EPA, 2004). Impacts from dredged material placement at CLDS would likely be similar to impacts at WLDS, with short-term impacts to the benthic community due to burial and potential water quality impairment.

The potential area of direct impact to the benthic community at the CLDS Alternative is estimated to be between 85,000 and 1,039,000 ft^2 based on average annual mound sizes at the existing CLDS (EPA, 2004). This area of between 2 and 24 acres represents much less than 0.1% of the available deep mud habitat in this part of the Central Basin (over 40 nmi^2).

Similar to WLDS, there would likely be potential short-term impacts to shellfish from dredged material placement at CLDS. According to NOAA (2014), the CLDS is within 2.2 mi of American lobster and blue crab habitat. Past trawl and benthic surveys have observed lobsters and the potential for hard clams at CLDS; however, no evidence of the presence of hard clams was found (EPA, 2004). Temporary potential impacts would include burial of shellfish and water quality impairments as well as potential benefits from increased variation in topography.

Similar to WLDS, there is the potential for short-term impacts to plankton from dredged material entrainment and sediment plumes in the water column at CLDS.

The location of the CLDS Alternative in the Central Basin of Long Island Sound places the site in an area with broadly distributed fish resources. The central area of the Sound has relatively homogeneous bottom habitat and encompasses an area with some open ocean characteristics (long fetch, areas of deep water) and access to nearshore resources and reef habitats. The predicted direct impacts of dredged material placement at CLDS would most likely include red hake within the central footprint of the mound, although some direct impacts would be possible with any demersal fish present at the site during discharge. Demersal fish species that could be present during some portion of the period when placement occurred include summer flounder, winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling. The direct impacts of death and burial on this scale would not be expected to cause a measurable reduction in the regional population of any of the species potentially affected within the Central Basin (EPA, 2004).

Indirect impacts would likely include temporary displacement of finfish from benthic foraging areas and refuge on fine-grained habitat from late fall to early spring (October to May), as well as displacement of migrating adults in spring and adults and young of the year in fall. The species most likely to experience indirect effects include red hake, scup, and winter flounder. Winter flounder could be present during placement due to the overwintering of young flounder and spawning migration into the Sound of mature and immature flounder. Other species that could experience indirect effects include black sea bass, bluefish, butterfish, fourbeard rockling, fourspot flounder, hogchoker, silver hake, smooth dogfish, striped searobin, summer flounder, tautog, weakfish, and windowpane flounder. Bluefish could use a sediment plume to increase predation as the turbid water can hide their presence (and the presence of prey). This finding is based on the migration of most finfish species out of central Long Island Sound for the period when placement usually occurs, and the life history patterns and relative abundance of selected species (EPA, 2004). These indirect impacts would be localized and short-term and would be partially offset by increased topographic relief within the site and recolonization by benthic food sources.

Winter flounder, a species with an above average occurrence at the CLDS Alternative, may not migrate out of the central Sound in winter and may be at the greatest risk of adverse impacts. They are most likely to experience some disruption of food sources from the placement of dredged material; however, they could also be attracted to disturbed sediments and recolonizing benthos or they could prey upon scavengers attracted to the disturbed sediments. In the fall, weakfish are also abundant and could overlap with a part of the placement season; they may avoid the water column near dredged material discharge. However, weakfish do migrate out of the Sound from December to April and may miss most dredged material placement (EPA, 2004).

Placement of dredged material at the CLDS Alternative is not expected to cause major alterations to the seafloor habitat. Minor changes in topography and fresh sediment could improve demersal fish habitat by creating diversity in seafloor conditions and supporting prey populations.

All of Long Island Sound is mapped as EFH, and there are three listed endangered fish species that potentially could occur at CLDS. There are 17 Federally managed species according to the NOAA EFH square designations. Previously, NMFS and USWFS concurred with the findings of the 2004 Final EIS designation of the WLDS and CLDS stating that the dredged material placement at these sites is not likely to adversely affect listed species or EFH (EPA, 2005).

About 20 species of marine mammals and reptiles have been identified as possibly occurring at CLDS, which includes five endangered or threatened species of both whales and sea turtles. Open-water placement could potentially impact marine mammals and reptiles, either directly by vessel strikes or indirectly by harassment during placement due to noise and sediment discharge. Temporary sediment plumes could also cause these creatures to avoid of the local area. In the designation of CLDS, USFWS noted that "no habitat in the project impact area is currently designated or proposed 'critical habitat' in accordance with provisions of the Endangered Species Act (87 Stat. 884 as amended; 16 U.S. C. 1532 et seq.)". The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions have been found to be effective in reducing strikes to whales (Conn & Silber (2013); NOAA (2013)). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. Potential adverse impacts would be limited and of short duration.

Water quality impacts at CLDS would likely be similar to those at WLDS. As with WLDS, CLDS model simulations showed that the high current conditions chosen for the simulation were the most significant factor in determining the spread of the residual plume. The dilutions were all well within the toxicity criteria limits after the four-hour initial mixing period. Toxicity criteria exceedances occurred when the plume passed out of the site boundaries, approximately 90 minutes after release, although the dilution returned to permissible levels within another 30 minutes beyond the site boundary. As with WLDS, the spring tide current (the worst case) carried the plume over the short travel distance from the site center to the site boundary. Unlike WLDS, however, this was the case for both barge sizes. The smaller barge size was not small enough to sufficiently decrease the time needed for dilution. The percent volume of clumps and percent volume of free water used in the simulations were not significant in the ranges simulated. For CLDS, the model results suggest that dilution of contaminants below the prescribed 1/100th LC_{50} level for worst-case projects could potentially be achieved by adjusting the management approach—either by further limiting barge size, limiting operations to times other than during spring tide, positioning the release point according to the ambient currents, or expanding the site boundaries (EPA, 2004).

Impacts on sediment quality at CLDS are not likely to occur for the same reasons placement of dredged material would not likely impact the area at WLDS. Several metals do not appear to be in biologically available form; toxicity test data indicate that sediments are not toxic to amphipods. Bioaccumulation rates for clams, worms, finfish, and lobster were generally in the range of levels in other, non-placement areas of Long Island Sound. Advanced benthic recovery has been documented following dredged material placement. Continued placement of dredged material at CLDS could improve sediment quality at the site. These results show that the sediment quality within the sites is not significantly degraded and that irreversible or significant adverse impacts from the placement of dredged material at the sites have not occurred (EPA, 2004).

Air quality and noise impacts at CLDS (as at WLDS) would likely be short-term and minor, would comply with regulations, and would be within background levels for the area.

Infrastructure Impacts

The open-water placement of dredged material at CLDS would not impact most infrastructure resources (e.g., mooring areas, ports, coastal structures, cable/power/utility crossings, and aquaculture) because these are not present at the site. Navigation channels are present at CLDS. The temporary transit of barges from harbor regions to and from the alternative site would cause short-term impacts by displacing shipping vessels and recreational and commercial vessels at CLDS and/or the transit area. Alteration of bottom depths could also potentially impact navigation. However, management of dredged material placement at the site would ensure that adequate water depths were maintained to minimize impacts to navigation.

Cultural Impacts

No cultural resources (e.g., shipwrecks, archaeology sites, and historic districts) are known to exist at the CLDS. The Connecticut State Historic Preservation Office also determined that there are no known aboriginal artifacts at the CLDS (EPA, 2005). Two of the region's Indian tribes (the Eastern Pequot Indians of Connecticut and Narragansett Indian Tribe) participated as cooperating agencies during the development of the designation EIS (EPA, 2004), and neither of them identified any natural nor cultural features of historical significance at this site. Therefore, no impacts to cultural resources would occur at the CLDS. The only potential visual impacts would be of short duration as vessels and barges traveled to and from the alternative site.

Cornfield Shoals Disposal Site

Physical Impacts

The CSDS, located in the Eastern Basin south of the mouth of the Connecticut River, is the only site in a non-depositional area managed as a dispersive site (dredged material is allowed to be transported out of the site boundary). The CSDS is the deepest of the four open-water placement alternatives, with water depths ranging from 151 ft in the northeast corner to a maximum depth of 189 ft in the southwestern quadrant where there is a depression (ENSR, 2005a). The predominant topographic features are a smooth, sandy bottom and bedforms oriented in an east-west direction that gently slope from northeast to southwest. The sand deposits at the mouth of the Connecticut River form a shoal complex that is reworked by tidal currents (Knebel & Poppe, 2000). Because sediments have not been observed to substantially accumulate at the CSDS

(ENSR, 2005a), and because the water depth is greater than at other alternatives, no impacts to currents or waves are expected to occur from dredged material placement at CSDS.

CSDS has received dredged material primarily from the Connecticut River and harbors adjacent to the river. Connecticut River navigation channel sediments tend to consist of sand similar to CSDS sediments, while the harbors and marinas have finer sediments. Although there could be potential impacts to the site if dredged material had different grain size characteristics from the ambient sediments, CSDS is a site with active sediment transport; dredged materials placed there are not confined within the site and do not accumulate significant amounts within it. Any potential impacts from differences in sediment type would be short-term until the placed sediments were reworked. There could be potential impacts on sediment type to the west of the site due to the prevailing tidal transport mechanism.

The coarse particle size of sediments (sand and gravel) at the site is a result of high-energy physical processes from tidal currents, atmospheric storms, and the Connecticut River outflow in the area. CSDS is located in a narrow part of Long Island Sound, which constricts ocean tidal currents through the Eastern Basin, increasing flow rates. The high energy at the CSDS results in a westward sediment transport that also disperses placed dredged material to the west (ENSR (ENSR, 2005a); Wiley (1996)). Observations of clay nodules from glacial lake deposits also provide evidence of scouring at the site (SAIC, 1988). Sediment transport was not modeled for the CSDS site as part of the 2003 EPA study (EPA, 2004). Unlike WLDS and CLDS, it is expected that most of the dredged material would be transported from the site following discharge due to the greater depths and high-energy regime at CSDS.

During a current meter deployment at CSDS in the early 1990s, two major storms passed over the area (Wiley, 1996). On August 19, 1991, Hurricane Bob produced maximum wind speeds of 45 knots. During the hurricane, the data from the mid-water meter showed that the mid-day flood velocity was reduced by more than half and the succeeding flood tide current was normal. Then, at the end of October 1991, what became known as the “Perfect Storm” occurred, with sustained winds of 40 knots over October 30 and 31. The National Weather Service determined that storm to be a 100-year storm; therefore, the potential for erosion could have been high. During this "Halloween" storm, the current meters showed no change in current strength, yet the net near bottom drift shifted from a normal west-southwest direction to directly west. More recent current meter deployments and modeling (2013) identify the area of CSDS as one of the highest areas of bottom stress in eastern Long Island Sound during fair weather and storm conditions (O’Donnell, 2014b). The timing of storms and wind directions with respect to tidal cycles appears to be critical to result in bottom current impacts at this deep water site.

Environmental Impacts

Impacts to the benthic community at CSDS would be fewer than those at WLDS or CLDS, but they would occur over a greater area for two main reasons: the dredged material is expected to be dispersed much more by currents at the site, and management practices deliberately do not target a specific area for placement. In other words, the same size barge of dredged material would result in a small and thicker deposit at the other sites compared to a larger and thinner deposit at CSDS, and deposits would occur over a larger area; therefore, different burial impacts would result. Potential increased organic matter and reduced grain size temporarily available at the site could have a beneficial impact by serving as a food source for benthic organisms. The changes to the sediment could also potentially delay or cause changes to benthic recovery rates. Because the site experiences routine disturbance from tidal currents, impacts could be less than at other sites that do not experience routine disturbances. The amount of benthic data available at CSDS is less than at the other sites, which makes it more difficult to evaluate conditions over time. However, increased species richness could be expected because of the coarser sediments at the site and the east-west gradient of increasing species richness that has been observed throughout Long Island Sound. The richness of species occurrence is likely due to the larger potential species pool given connections to Block Island Sound, the Atlantic Ocean, and coastal areas. Increased richness could aid in the recovery times of benthic invertebrates.

Potential short-term impacts to shellfish from dredged material placement could include burial and temporary water quality impairments. These impacts would be similar to those at WLDS and CLDS; however, the burial impacts may be less likely and would occur over a larger area of the site due to dispersal by currents and the lack of mound formation or target areas for placement. Habitat mapping indicates that the American lobster, blue crab, blue mussel, horseshoe crab, and softshell clam could occur at CSDS (NOAA, 2014). Surveys in 2000 observed lobster at the site, though they were less abundant than at other sites (EPA (2004), Appendix H-7). Concerns have been raised about shellfish beds located about 1.2 mi north of CSDS on the north side of Long Sand Shoal. In response, studies on currents at the site and comparative bathymetric surveys over time have examined the potential for impacts. These studies have shown that sediment transport is predominantly westward and oriented in an east-west direction, aligned with the predominant tidal currents (ENSR, 2005a). Because CSDS lies to the south, impacts to these shellfish beds from dredged material sediment transport from CSDS would be unlikely.

Similar to WLDS and CLDS, short-term impacts to plankton could potentially occur from dredged material entrainment and sediment plumes in the water column at CSDS. A larger area of impact would be expected at CSDS compared to the other sites due to water column depth and the high tidal energy regime of the site.

The location of the CSDS Alternative in the Eastern Basin of Long Island Sound is in deep sand fish habitat near shallow sand and deep transitional habitats. Finfish trawl catch per unit effort data from 1984 to 2000 indicate that of the 24 areas in Long Island Sound sampled, CSDS had the second lowest finfish abundances (EPA, 2004). The depressed levels were not ascribed to placement activity at CSDS as placement was sporadic and species richness was comparable to other areas (EPA (2004), Appendix H-6). It was suggested that the proximity of CSDS to the Long Sand Shoal and Connecticut River outflow negated the habitat advantages of deeper waters (EPA (2004), Appendix H-6). A detailed analysis of direct and indirect impacts to finfish similar to those at WLDS and CLDS has not been conducted at this time.

Placement of dredged material at CSDS would not be expected to cause major alterations to the seafloor habitat over the long term due to dispersal at the site. Minor changes in topography and increased organic matter over the short term could improve demersal fish habitat by creating diversity in seafloor conditions and supporting prey populations.

All of Long Island Sound is mapped as EFH, and there are three listed endangered fish species that potentially could occur at CSDS. There are 10 Federally managed species according to the NOAA EFH square designations. Given that fish are less abundant overall and that fewer EFH species occur, impacts to fish would likely be less than at WLDS and CSDS, and placement at the site is not likely to adversely affect EFH. There could be a greater chance of impacts on the listed shortnose sturgeon and Atlantic sturgeon, as both use the Connecticut River for habitat, than at the other open-water placement alternatives.

About 20 species of marine mammals and reptiles have been identified as possibly occurring at CSDS, which includes five endangered or threatened species of both whales and sea turtles. Open-water placement could potentially impact marine mammals and reptiles, either directly by vessel strikes or indirectly by harassment during dredged material placement due to noise and sediment discharge. Temporary sediment plumes could also cause these creatures to avoid the local area. No habitat at or near CSDS is currently designated or proposed ‘critical habitat’ in accordance with provisions of the ESA. The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions have been found to be effective in reducing strikes to whales (Conn & Silber (2013); NOAA (2013)). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. The potential occurrence of endangered or threatened species would be greater at CSDS or NLDS due to proximity to the ocean than at WLDS or CLDS. Potential adverse impacts would be limited and of short duration.

Similar to the other open-water alternatives, there would be intermittent, short-term impacts to water quality from sediment plumes resulting from dredged material placement. At CSDS, water quality impacts would likely be less than those at the other open placement alternative sites due to the rapid mixing and dispersion of suspended sediments given the deeper water column and strong tidal currents. Modeling has indicated that suspended sediments would disperse over a wider area than at WLDS and CLDS. In contrast to the other open-water alternatives, resuspension of dredged material with ambient sediments is also expected to occur with ongoing westward sediment transport at CSDS after placement. This resuspension of sediment could increase short-term turbidity levels in localized bottom waters, however, this would not be significantly greater than ambient conditions in the area.

Long-term impacts on sediment quality would not be likely at CSDS because sediment is typically not confined at the site. Short-term impacts also would not be likely due to sediment testing protocols that do not allow placement of highly contaminated sediments and the generally lower contamination levels of sediments in the harbors and bays of eastern Long Island (Fredette, 2005).

Air quality and noise impacts would likely be short-term and minor, would comply with regulations, and would be within background levels for the area, similar to the other open-water placement alternatives.

Infrastructure Impacts

The open-water placement of dredged material at CSDS would not impact most infrastructure resources (e.g., mooring areas, ports, coastal structures, cable/power/utility crossings, and aquaculture) because these are not present at the site. The temporary transit of barges from harbor regions to and from the alternative site could potentially cause short-term impacts by displacing shipping vessels as well as recreational and commercial vessels at CSDS and/or the transit area. Alteration of bottom depths could also potentially impact navigation. However, navigational channels are not present at CSDS. Moreover, CSDS is a dispersive site, and the management of dredged material placement at the site would ensure that adequate water depths were maintained to minimize impacts to navigation.

Cultural Impacts

No cultural resources (e.g., shipwrecks, archaeology sites, and historic districts) exist at the CSDS Alternative site; therefore, no impacts to these resources would occur. The only potential visual impacts would be of short duration as vessels and barges traveled to and from the alternative site.

New London Disposal Site

Physical Impacts

The NLDS is located south of the mouth of the Thames River and west of Fishers Island. The overall topography of NLDS slopes from a depth of about 46 ft in the north toward the south where depths reach 79 ft (AECOM, 2009). NLDS has similar depths as CLDS but is slightly deeper. A broad trough, or depression, oriented northwest to southeast occurs in the southwest portion of NLDS. The central portion of the trough has been partially filled with dredged material, resulting in an irregular topography. Broad, flat dredged material mounds are a predominant feature at the site, which is managed to maintain a minimum water depth of 46 ft (AECOM, 2009). As long as this depth is maintained, dredged material placement at NLDS would not impact surface waves.

NLDS is located in a complex depositional area where the sediment particle grain size ranges from gravel to silt/clay, with silty fine sand, often with shell fragments dominating much of the seafloor (AECOM, 2009). The dredged material deposited at NLDS has varied from fine-grained sediment to sand, comparable to the range seen at reference areas. Given the predominance of historic dredged material at the site and variability in grain size of ambient sediments in the area, potential impacts to sediment from dredged material placement would be limited due to potential differences in grain size and TOC content (AECOM, 2009).

Diurnal tidal currents tend to be the dominant physical processes that affect sediment transport and deposition at NLDS (Waddell, et al., 2001). Average tidal current speeds are comparable to those seen at CLDS, although observed maximums were higher at NLDS. Recent modeling of circulation in eastern Long Island Sound indicates that NLDS is in an area with relatively low current velocities (O’Donnell, 2014b). The increased elevation of the dredged material mounds appears to compound the stress of the tidal currents, resulting in the winnowing of unconsolidated fine sediments (Waddell, et al., 2001). Field evidence indicates that over time, the remaining coarser material and shell fragments at the sediment-water interface result in both an “armoring” layer that protects the area from erosion and a stable deposit (Waddell, et al. (2001), AECOM (2009)).

The location of NLDS with respect to the seafloor topography and nearby land (to the north and northeast, as well as Fishers Island) serves to limit wind-driven waves from the north and east and oceanic swell (Waddell, et al. (2001), O'Donnell (2014b)). Although it is exposed to winds from the west or southwest, which blow across the main longitudinal axis of Long Island Sound and are predominant in the summer, these winds do not appear to be strong enough to affect bottom currents or sediments. Strong westerly winds could possibly occur on the backside of a cyclonic storm (hurricane). In recent model simulations of circulation induced by Superstorm Sandy winds, the bottom shear stresses at NLDS were below the threshold to mobilize sediments (O'Donnell, 2014b). Therefore, even though much of eastern Long Island Sound had levels above of the threshold and likely experienced sediment disturbance, the modeling indicated that dredged material at NLDS would have remained stable during the storm (O'Donnell, 2014b).

Environmental Impacts
Dredged material placement would have similar impacts to those at WLDS and CLDS, with short-term impacts occurring from burial and potential water quality impairment.

Short-term impacts to shellfish from dredged material placement could occur at NLDS. Habitat mapping indicates that the American lobster, blue crab, Atlantic surfclam, horseshoe crab, and softshell clam could occur at NLDS (NOAA, 2014). Surveys in 2000 observed lobster at the site (EPA (2004), Appendix H-7). Dense shell beds of mussels (*Mytilus edulis*) have been documented at both dredged material mounds and reference areas for NLDS, and shell lag is common in the area (AECOM, 2009). Temporary potential impacts include burial and water quality impairments as well as potential benefits from increased variation in topography.

Similar to WLDS and CLDS, t short-term impacts to plankton could potentially occur from dredged material entrainment and sediment plumes in the water column at NLDS.

The location of the NLDS Alternative in the Eastern Basin of Long Island Sound is in shallow transitional habitats influenced by Niantic Bay and deep transitional habitats. No trawlable stations are located near NLDS. Finfish trawl catch per unit effort data from 1984 to 2000 indicate that the nearshore shallow transitional area near NLDS had lower finfish abundances than WLDS and CLDS but greater abundances than CSDS (EPA, 2004). Large catches of scup and butterfish were noted. A detailed analysis of direct and indirect impacts to finfish similar to those at WLDS and CLDS has not been conducted to date. Similar types of impacts from potential burial and respiratory injury, aversion, or displacement due to water quality impairments would be likely.

Placement of dredged material at NLDS would not be expected to cause major alterations to the seafloor habitat. Minor changes in topography and increased organic matter could improve demersal fish habitat by creating diversity in seafloor conditions and supporting prey populations.

All of Long Island Sound is mapped as EFH, and there are three listed endangered fish species that potentially could occur at NLDS. There are 10 Federally managed species according to the NOAA EFH square designations. Given that fish are less abundant overall and that fewer EFH species occur, impacts would likely be fewer than at WLDS and CSDS, and placement at the site is not likely to adversely affect EFH.

About 20 species of marine mammals and reptiles have been identified as possibly occurring at NLDS, which includes five endangered or threatened species of both whales and sea turtles. Open-water placement could potentially impact marine mammals and reptiles, either directly by vessel strikes or indirectly by harassment during dredged material placement due to noise and sediment discharge. Temporary sediment plumes could also cause these creatures to avoid the local area. No habitat at or near NLDS is currently designated or proposed 'critical habitat' in accordance with provisions of the ESA. The potential for vessel strikes is limited by the slow speed of tugboat and barge operations. Recent ship speed reductions have been found to be effective in reducing strikes to whales (Conn & Silber (2013); NOAA (2013)). No strikes to endangered or threatened species or to dolphins and seals are known to have occurred in the history of the DAMOS program. The potential occurrence of endangered or threatened species would be greater at CSDS or NLDS due to proximity to the ocean than at WLDS or CSDS. Potential adverse impacts would be limited and of short duration.

Similar to WLDS and CLDS, there would be intermittent, short-term impacts to water quality at the NLDS Alternative from sediment plumes resulting from dredged material placement. At NLDS, impacts on sediment quality would not be likely for the same reasons dredged material placement would not likely impact the area at WLDS. Several metals do not appear to be in biologically available form, and toxicity test data indicate that sediments are not toxic to amphipods. Bioaccumulation rates for clams, worms, finfish, and lobster were generally in range of levels found in other, non-placement areas of Long Island Sound. Advanced benthic recovery has been documented following dredged material placement. Continued placement of dredged material at NLDS could improve sediment quality at the site.

Air quality and noise impacts would likely be short-term and minor, would comply with regulations, and would within background levels for the area, similar to the other open-water placement alternatives.

Infrastructure Impacts

The open-water placement of dredged material at NLDS would not impact most infrastructure resources (e.g., mooring areas, ports, coastal structures, cable/power/utility crossings, and aquaculture) because these are not present at the site. Navigation channels are present at NLDS. The temporary transit of barges from harbor regions to and from the alternative site would have short-term impacts by displacing shipping vessels as well as recreational and commercial vessels at NLDS and/or the transit area. Discharge of dredged material could also have short-term impacts on submarine transit; a corridor has been established within NLDS to exclude placement in this designated area to minimize potential impacts. Alteration of bottom depths could also potentially impact navigation. However, management of dredged material placement at the site would ensure that adequate water depths were maintained to minimize impacts to navigation.

Cultural Impacts
No cultural resources (e.g., shipwrecks, archaeology sites, and historic districts) exist at the alternative site; therefore, no impacts to these resources would occur. The only potential visual impacts would be of short duration as vessels and barges traveled to and from the alternative site.

Confined Open-Water Placement

Physical Impacts

At the confined open-water site (Sherwood Island Borrow Pit – Site E), the seafloor elevation would be restored to historic depths prior to dredging of the borrow pit. If the physical properties of the cap material were different from the native sediments, placement of material at the site could change the existing sediment grain size and TOC. For example, impacts to sediments would likely occur where native fine-grained sediments were replaced by more granular, sandy material. Placement activities could temporarily increase turbidity and sedimentation surrounding the site. There would likely be no impacts to littoral drift patterns/rates, currents, and waves because the existing depression would be filled to ambient sea floor elevation.

Environmental Impacts

Because a placement pit already exists at Sherwood Island Borrow Pit – Site E, there would be no impacts from construction. Operation (i.e., filling) of the confined open-water alternative would directly impact any bottom-dwelling resources living within the footprint area through direct destruction and/or burial. Resources in the adjacent areas (i.e., the surrounding environment) could potentially be indirectly affected through sedimentation and increased water column turbidity. These impacts would be greatest for sedentary/immobile resources (e.g., benthic infauna and shellfish). Species such as fish and lobster are typically mobile enough to avoid the descending material and could burrow out from beneath a modest thickness of deposited material. It is anticipated that the reduction in diversity and abundance of benthic infauna and shellfish populations within the site would be of short duration. Recovery to levels similar to pre-placement would likely occur within months to several years, as documented at other dredged material placement sites in Long Island Sound in the New England region (Fredette & French (2004), USACE (2012b)). Potential short-term impacts to plankton could occur near the site from entrainment during dredged material placement and temporary decreases in water quality.

The proposed Sherwood Island Borrow Pit – Site E alternative is located in designated EFH. Bottom-dwelling species could potentially occur at this site. Placement operations could potentially change the habitat permanently if sediment that differed from the native material were placed at the site. The placement of suitable dredged material at the site would limit bioaccumulation of any contaminants in the dredged material and would allow a stable benthic community to develop. Although placement of material at this site would cause the permanent loss of water column habitat and decrease habitat diversity, filling the depression to ambient depth could benefit certain fish, shellfish, and other organisms. For example, habitat enhancement for fish and shellfish could potentially occur through an increase in habitat diversity due to bathymetric variations and improved sediment quality.

Federally managed fish species and marine mammals were identified as potentially occurring in the Sherwood Island Borrow Pit – Site E area. These species could experience harassment during operations at the site (USACE, 2012c). There is also the potential for vessel strike impacts from transporting dredged material to the site. However, the same vessel traffic would also create noise and disturb these animals, which would likely deter them from entering the area.

Intermittent, short-term changes in water quality could potentially occur within the residual plumes during and following placement, with a greater potential for water quality impacts under worst-case conditions. Best management practices would limit increased turbidity and the potential for water quality and habitat impairment during placement. The hydrodynamic characteristics (i.e., limited wave action and wave-induced currents) at the site would need to be assessed to ensure that they did not enhance dispersion of dredged material during placement or capping.

Operation activities would create the potential for intermittent, short-term changes in air quality and noise levels, which are anticipated to return to ambient level once placement operations cease.

Infrastructure Impacts

During site operations, potential impacts to recreational resources (boating or swimming) could occur. Vessels and recreational users would be temporarily excluded from the area during operations. However, no designated recreational areas or navigational channels occur at the site. Particle settling during placement operations could potentially deposit sediment at resources adjacent to the CAD cell. Filling the existing depression to the ambient sea floor would have no undermining/erosion impacts to nearby infrastructure resources.

Cultural Impacts

No shipwrecks or other cultural resources occur within the footprint area of the site (USACE, 2012c). Two shipwrecks have been documented shoreward of the site within a half a mile to a mile. There could be a potential indirect impact from increased sedimentation to these resources during the filling of the depression, but this impact would likely be of short duration and would be limited to the immediate vicinity of the site. No historical districts or archeological sites were identified in the nearby area. Because the site would not rise from the seafloor surface, there would be no visual impacts associated with this alternative type.

5.3.2 In-Harbor CAD Cells

Site-specific impacts to the physical, environmental, infrastructure, and cultural resources associated with the in-harbor CAD cell alternative sites have been previously assessed (USACE, 2012c).

5.3.3 Confined Disposal Facilities

Site-specific impacts to the physical, environmental, infrastructure, and cultural resources associated with the CDF alternative sites have been previously assessed (USACE, 2012c).

5.3.4 Landfill Placement

Site-specific impacts to the physical, environmental, infrastructure, and cultural resources associated with the landfill placement alternative site have not been evaluated. General impacts for the placement of dredged material at a landfill site for containment are summarized in USACE (2015a).

5.3.5 Beneficial Use

Site-specific impacts to the physical, environmental, infrastructure, and cultural resources associated with the beach nourishment, landfill capping/cover, Brownfields, and habitat restoration, have not been evaluated. General impacts for the use of dredged material at these alternative sites are summarized in USACE (2015a).

Site-specific impacts associated with the nearshore berm alternative sites have been previously assessed (USACE, 2012d).

5.3.6 Innovative Treatment Technologies

No specific innovative treatment technology alternative sites have been identified for the Long Island Sound study area. If these technologies are to be utilized in the future, an assessment of the associated impacts would need to be conducted on a project-by-project basis.

5.4 CUMULATIVE IMPACTS

The CEQ regulations implementing the procedural provisions of NEPA require Federal agencies to consider the cumulative impacts of a proposal (40 CFR 1508.25(c)). A cumulative impact to the environment is the impact that results from the incremental impact of an 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). This type of an assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

Cumulative impacts of current and future actions are summarized to determine which alternatives afford the greatest impact or benefit and to allow alternatives to be prioritized for each project. As with the general impacts and benefits discussed in Section 5.1, cumulative impacts are discussed from a qualitative perspective, commensurate with the programmatic level of detail within which this document was developed.

Long Island Sound (LIS) has seen dramatic environmental changes since colonial times, with increased environmental degradation over the last ~200 years (the industrial period), intensifying over the last 50 years with a peak in pollution during the 1950s-1960s. While some improvement has been documented in pollutant loadings in recent years, cumulative impacts from non-dredging events (vessel traffic incidental discharges, particulate emissions, spillage, and accidents) and watershed-wide contaminant loading from agricultural, urban, and industrial sources continue to stress the Long Island Sound sediment environment, particularly in the Western Basin.

5.4.1 Identification of Cumulative Effects Issues

The first step in developing a cumulative impact analysis in this PEIS was to identify the significant cumulative effects issues associated with the various alternatives analyzed. The relevant NEPA guidance (CEQ, 1997) recommends focusing the analysis on each affected resource, ecosystem, and human community. Therefore, after a review of the generic and site-specific impacts in the Environmental Consequences chapter (Sections 6.1 and 6.3, respectively), cumulative impacts were analyzed for the following resources: physical resources (sediment/soils and waves/currents), environmental resources (benthic invertebrates, shellfish, SAV, MPAs, birds, marine mammals and reptiles, terrestrial and coastal threatened and endangered species, wetlands, air quality, and noise), infrastructure resources, and socioeconomic resources. These resources were identified as having impacts (Section 5.3) for at least one alternative. The remaining resources are not likely to have significant impacts and were therefore not included in the cumulative effects analysis.

Public scoping comments (see Chapter 7) identified the following issues/resources that should be considered in the cumulative impact analysis:

- Concern that most of the dredged material projected to be placed in the Sound for the next 20 years will originate from six Connecticut harbors that contain sediment laced with elevated heavy metals and PCB contamination.
- Concern that lack of dredging will negatively affect employment levels, cost of living, population levels, and quality of life (road congestion and environmental damage) in Connecticut.
- Air quality – increases from increased truck traffic when local ports cannot be used by deep-draft vessels to bring in commodities.
- Economic development – oil movement via barge versus truck, increased truck traffic, economic model used to justify dredging.
- Impacts to adjoining property owners of an upland placement site used for dredged material

5.4.2 Geographic and Temporal Scope of the Cumulative Effects Analysis

The geographic and temporal boundaries of the cumulative effects analysis were expanded to encompass additional effects on the resources, ecosystems, and human communities of concern. The boundaries of the geographic and temporal scopes are described below.

Geographic Scope

The geographic boundaries of the cumulative effects analysis were defined for each type of resource considered. These boundaries allowed for the inclusion of potential impacts from other actions on the resources analyzed. The study area for the cumulative effects for any open-water resources is the Long Island Sound estuary. The study area for the cumulative effects to nearshore and upland resources include the entire study area, which encompasses a portion of the state of New York, all of Connecticut, and a portion of Rhode Island. The cumulative effects study area for air quality impacts is the Long Island Air Basin, which includes the states of New York, Connecticut, and Rhode Island. The cumulative effects study area for the socioeconomic impacts include the entire study area, which encompasses a portion of the state of New York, all of Connecticut, and a portion of Rhode Island

Temporal Scope

For each resource that was considered in the cumulative impact assessment, the temporal boundaries were defined in order to identify past, present, and reasonably foreseeable future actions to be included in the analysis. As described in Chapter 2, since 1977, the USACE, EPA, and the states have evaluated and regulated placement of dredged material in Long Island Sound under the provisions of the CWA amendments to the Federal Water Pollution Control Act and MPRSA. Since 1972, Federal activities and activities of others carried out under Federal permit are subject to review by the states under their CZMA programs. Therefore, the past impacts that are included in the cumulative effects analysis are those that occurred within approximately the last 40 years (i.e., since 1972).

As described in Chapter 1, the planning period for the DMMP is 30 years from the initiation of the DMMP effort. Therefore, 30 years was used as the timeframe for the identification of other reasonably foreseeable future actions (i.e., 2045).

5.4.3 Past, Present, and Reasonably Foreseeable Future Actions

Table 5-3 presents past, present, and reasonably foreseeable future actions that relate to potential impacts to physical, environmental, infrastructure, and socioeconomic resources within the Long Island Sound study area. These actions are considered when determining cumulative actions.

5.4.4 Cumulative Impacts of the No Action Alternative

Under the No Action Alternative, the option of dredged material placement at a designated open-water placement site would no longer be available. The scenarios that would result from ‘No Action’ (described in Section 5.2) vary, from continued dredging and placement of materials at multiple selected open-water sites or nearshore/upland locations within the Long Island Sound area to no dredging at all. Cumulative impacts to physical, environmental, infrastructure, and socioeconomic resources from the various No Action scenarios are described below by resource.

Physical Resources

As described in Section 5.2, sedimentation and erosion could increase because sediment could be dispersed over a greater area within or outside of Long Island Sound under the No Action Alternative. Climate change resulting in sea level rise and increased storm activity could have a greater impact on beach loss and erosion, which could lead to increased damage to shoreline and nearshore alternative sites and increased sediment transport. Increased shoreline protection could occur in areas where nourishment or restoration alternatives are located. However, the volume of sediment being deposited in the Sound from the three large rivers that empty into the Sound (Connecticut, Thames, and Housatonic) is much larger than the volumes that would be placed in the Sound through dredging. Therefore, under some scenarios of the No Action Alternative, significant impacts on the physical resources in Long Island Sound would not be expected given the scale and magnitude of other regional events. If dredging were limited or did not occur, the accumulation of naturally deposited sediment could cause shoaling in rivers and harbors, resulting in decreased water depths and potential changes in nearshore hydrodynamics.

Environmental Resources

Under the No Action Alternative, future dredged material that passed quality standards for unconfined placement would be restricted to approved areas with a relatively small footprint, either inside or outside the Long Island Sound basin, so that sediment quality impacts could be limited. However, an increase in the number of selected placement sites could extend the overall placement footprint and increase impacts to sediment quality. Non-dredging events (vessel-related contamination) and watershed-wide contaminant loading from agricultural, urban, and industrial sources would continue to dominate the inventory of stressors. The potential cumulative Long Island Sound sediment quality effects resulting strictly from placing dredged material that meets quality standards in the Sound, at sites elsewhere, at additional selected sites, or in confined areas are considered to be minor compared to the other sources of contaminants around the Sound[4]. Decreased dredging, which could result under the No Action Alternative, coupled with contaminant loading from point and non-point sources, could potentially result in decreased sediment quality at harbor and river locations.

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[4] MPRSA requirements are only required for all Federal projects and for non-Federal projects involving more than 25,000 CY of material.

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis.

Resource	Past Actions	Present Actions	Future Anticipated Actions
Physical Resources			
Sediments (including sand)	It is estimated that more than 37 million CY of material may have been placed throughout Long Island Sound between 1941 and 2014. Runoff from CT rivers has brought silt, sediments, and sand to Long Island Sound since they first began flowing into the Sound. Sand has also been placed throughout various beach, shoreline, and open-ocean site locations. Large storms have moved sediment, sand, and silt throughout Long Island Sound.	Distinct placement mounds from current dredged material placement at designated unconfined open-ocean disposal sites have formed. Depending on the source type of material and the placement location, a change in grain size and TOC could occur. Runoff from CT rivers brings silt and sediments to Long Island Sound. Direct runoff from land to Long Island Sound occurs from storms (NY and CT). Large storms will continue to move sediments, soils, and sand around Long Island Sound.	Projects currently approved and funded for dredging and dredged material placement will continue. CT rivers will continue to deposit silt and sediment into Long Island Sound. Waves from strong storms will continue to move silt, sediment, and sand from land masses throughout Long Island Sound into the waters of the Sound. This movement could increase due to climate change and sea level rise.
Currents/ Waves/ Littoral Drift	Changes to coastal areas due to storms, currents, and waves; sea level changes; and man-made alterations of the coastline have influenced littoral drift in some areas.	Changes to coastal areas due to storms, currents, and waves; sea level changes; and man-made alterations of the coastline are influencing littoral drift in some areas.	Changes to coastal areas due to storms, currents, and waves; sea level changes; and authorized man-made alterations will influence littoral drift in some areas in the future.
Environmental Resources			
Sediment Quality	In the distant past, sediments with a range of potential contaminants moved down watershed rivers and into the Long Island Sound basin or were placed there without regulation. Since passage of the CWA and other environmental laws, contaminant loading to sediments has declined, contaminated sediment placement restrictions have been established, and the	All dredged material considered for placement in Long Island Sound is evaluated for quality following the criteria established by EPA (40 CFR 227 & 228). Dredged material that passes the criteria is placed either in unconfined locations or in nearshore or upland locations, while material that does not pass the criteria is placed in confined areas. Sediment quality has generally	Projects currently approved and funded for dredging and dredged material placement will continue. Designation of a dredged material disposal site is likely in eastern Long Island Sound. Watershed rivers will continue to deposit silt, sediment, and associated contaminants into Long Island Sound. In addition, some level of continued contaminant loading is anticipated from point

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
Sediment Quality (cont.)	quality of dredged sediments placed in Long Island Sound has improved. MPRSA Section 106(f) requires that all material considered for Long Island Sound placement meet quality criteria established by EPA (40 CFR 227 & 228). In the recent past, dredged material that passed the criteria was normally placed in unconfined locations, while material that did not pass the criteria was placed in confined areas.	improved due to stricter screening of dredged material for placement and due to general control of pollution in the watershed. However, watershed rivers and runoff continue to deposit silt, sediment, and associated contaminants into the Long Island Sound basin. Various local and regional programs that may reduce the volume of sediment carried by stormwater and runoff from the states within the watershed have been developed (Appendix E).	and non-point sources, including river and runoff sediment loads. Programs designed to reduce volumes of sediment entering into Long Island Sound will continue.
Bioaccumulation Potential	Trends in tissue concentrations have been monitored for many years through various local, regional, and national programs. Tissue concentrations have been found to be variable over the past 40 years, with some contaminants showing marked decreases in some organisms over time. Spatially, tissue concentrations have generally been found to be higher in the western portion of Long Island Sound compared to the eastern portion. Overall, direct correlation with sediment concentrations has been weak.	All dredged material considered for placement in Long Island Sound is evaluated for quality, including an assessment of bioaccumulation potential. Dredged material that passes the criteria is normally placed in unconfined locations, while material that does not pass the criteria is placed into confined sites. Tissue concentrations in various organisms continue to be monitored by existing local, regional, and national programs. Watershed rivers continue to deposit silt, sediment, and potential contaminants with bioaccumulation potential into the Long Island Sound basin.	Bioaccumulation potential from open-water placement will continue to be measured as a requirement for placement permits. Tissue concentrations in various organisms will continue to be monitored by existing local and national programs. Watershed rivers will continue to deposit silt, sediment, and associated contaminants into Long Island Sound and some level of continued contaminant loading and associated bioaccumulation potential is anticipated from point and non-point sources, including river sediment loads.

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
Water Quality	In the past, water quality was impacted by releases of various pesticides, chemicals, and untreated human waste into the environment. However, since the implementation and constant updating of environmental regulations, water quality has improved. In recent years, hypoxia has been an issue in Long Island Sound due to the excess nutrients carried by CT rivers into Long Island Sound. The amount of hypoxia experienced in Long Island Sound in a particular year varies.	Federal regulations control releases of chemicals and wastewaters into the environment. The TMDL for nitrogen in Long Island Sound was developed in 2000 as a management tool to decrease nutrient loading and improve DO concentrations in the sound (NYSDEC and CTDEP, 2000). Federal grants are being obtained to develop programs to decrease the level of excess nutrients that Long Island Sound receives. Localized sediment plumes occur during dredged material placement, resulting in short-term and localized increases in turbidity and the potential for a localized, short-lived source of nutrients and other anthropogenic compounds to the water column.	The nitrogen TMDL will lead to reduced levels of eutrophication in the Sound. Additional focus on non-point nutrient sources will further enhance the success of these water quality improvement measures. Climate change will lead to higher sea level, potentially more severe and frequent storms, and additional precipitation/runoff in the region. Climate change is also leading to an overall increase in acidity in the world’s oceans. Ocean acidification will likely exacerbate eutrophication in coastal waters by reducing pH even further, potentially impacting shellfisheries, benthos, phytoplankton, and other aspects of the ecosystem. It is unclear how these climate changes will impact the effectiveness of resource management actions to reduce nutrient inputs to Long Island Sound. Any impacts on water quality due to future population growth and development in the region should be mitigated by aspects of the TMDL and be limited.
Benthic Invertebrates	Natural and anthropogenic stressors on benthic habitats in Long Island Sound include physical (storms and dredged material placement) and chemical disturbances (anoxia, contamination, and acidification). Short-term reductions in abundance and diversity were observed at all dredged material placement sites; however, when sediment characteristics	Natural and anthropogenic stressors on benthic habitats in Long Island Sound include physical (storms and dredged material placement) and chemical disturbances (anoxia, contamination, and acidification). Short-term reductions in abundance and diversity occur at all dredged material placement sites, but when sediment characteristics are similar at both the	Short-term reductions in abundance and diversity from future dredged material placement in eastern Long Island Sound and existing open-water placement locations is expected. However, recovery to abundance and species diversity similar to pre-placement levels are expected, though possibly delayed or prevented when sediment characteristics at the placement location are different from the

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
	were similar at both the dredging location and the placement location, recovery to abundance and species diversity similar to pre-placement levels were documented. Changes in abundance and species diversity occurred where dredged sediment characteristics were different from native material at the placement site.	dredging location and the placement location, recovery to abundance and species diversity similar to pre-placement levels is expected. Changes in abundance and species diversity occur where dredged sediment characteristics are different from native material at the placement site.	dredging location. Future changes in benthic invertebrates due to sea level rise and climate change are possible based on changes in overall depth in various locations; the potential for changes in temperature; and increased storm activity, acidity of seawater, and runoff (sedimentation).
Shellfish (not including leased areas)	In the past, there have been decreases in shellfish populations attributed to disease, contamination, overfishing, and possibly loss of optimal habitat due to increased nearshore water temperatures.	Commercially important species of shellfish continue to be fished. Changes in ocean temperatures increase the likelihood of disease and habitat alteration. There has been a noted decrease in overall levels of contaminants in sediments and water, decreasing the potential for contaminants in shellfish.	Commercially important species of shellfish will continue to be fished. Changes in ocean temperatures and sea level rise will increase the potential for disease and habitat destruction. Decreases in overall levels of contaminants in sediments and water will decrease the potential for contaminants in shellfish. Future changes in shellfish due to sea level rise and climate change are possible based on changes in overall depth in various locations; the potential for changes in temperature; and increased storm activity, acidity of seawater, and runoff (sedimentation).
Federally Managed Species	Many environmental and man-made activities have caused a decrease in habitat and populations of some Federally managed species. Implementation of environmental regulations banning or limiting the use of contaminants in the environment has resulted in population increases for some Federally managed species. Being aware of migration patterns, mating/nesting areas, foraging areas, etc.,	Changes in populations of Federally managed species (increases and decreases) are occurring for a variety of reasons, including climate change, sea level rise, and habitat change. Currently, regulations are in place to prevent the dredging and placement of material when and where Federally managed species are present. Being aware of migration patterns, mating/nesting areas, foraging areas, etc., and creating dredging	Regulations will remain in place to prevent the disturbance of Federally managed species. Being aware of migration patterns, mating/nesting areas, foraging areas, etc., and creating dredging windows will continue to minimize impacts to Federally managed species. Climate change and sea level rise may cause changes to habitats.

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
	and creating dredging windows have collectively worked to minimize impacts to Federally managed species.	windows continues to minimize impacts to Federally managed species.	
SAV (eelgrass)	Fragmentation and overall decrease in SAV resources have occurred due to development, damage from fishing activities, disease, and reduction in coastal water quality. SAV conservation efforts within the study area have included improving coastal water quality, limiting development in SAV beds, and implementing replanting programs.	Development and impaired coastal water quality continues to adversely impact SAV beds in the study area. SAV conservation efforts include improving coastal water quality, limiting development in SAV beds, and implementing replanting programs.	Increase in sea level and ocean temperatures and continued coastal development provide the potential for additional impacts to SAV. Focused conservation efforts provide the potential for SAV restoration within the study area.
Marine Protected Areas	MPAs were established within the study area in the early 2000s to conserve marine resources, and locations were identified and protected.	At this time, additional protections being instituted in this area are unknown.	Additional MPAs could be identified and additional protections could be put in place, but none are currently known.
Birds	Coastal development and other environmental and human activities have caused a decrease in habitat and populations of some species of waterfowl, colonial waterbirds, and endangered and threatened species. Implementation of environmental regulations banning or limiting the use of contaminants in the environment has resulted in population increases for some endangered and threatened species	Changes in species populations of birds (increases and decreases) are occurring due to climate change, sea level rise, and habitat change. Currently, regulations are in place to prevent the dredging and placement of material when and where endangered and threatened birds are present.	Human activity and coastal development will continue. However, regulations will remain in place to prevent the disturbance of endangered and threatened species. Climate change and sea level rise may cause changes to habitat.
Marine Mammals & Reptiles	Coastal development, shipping, whaling, and other environmental and human activities have impacted marine mammals and reptiles and their habitats in the past.	Impacts to marine mammals and reptiles continue to occur. Current regulations are in place to prevent the dredging and placement of dredged material when and where marine mammals and reptiles are present during	Human activity and coastal development will continue; however, regulations will remain in place to prevent the disturbance of marine mammals and reptiles. Climate change and sea level rise may cause changes to habitat.

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
		specific life events (i.e., foraging areas, migration patterns, etc.).	
Wetlands	Fragmentation and overall decrease in wetland function has occurred due to development, decreased water quality, and introduction of invasive species. Wetland restoration has occurred in some portions of the study area.	Colonization of invasive species and impairments to water quality continue to impact wetland communities. Damage due to storms or environmental releases (i.e., water-based oil spills) is a threat to wetland resources. Conservation efforts are protecting and restoring wetlands within the study area.	Colonization of invasive species and changes in sea level, temperature, and water quality could result in impacts to wetland communities. Damage due to storms or environmental releases (i.e., water-based oil spills) could also result in changes to wetlands. Conservation and restoration efforts have the potential to increase wetland resources and functions.
Federal & State Listed Species (Terrestrial and Coastal)	Losses or changes in habitat, impaired water quality, and application of chemical pesticides have caused a decrease in the habitat and populations of some terrestrial species, leading to them being protected at the Federal or state level.	Habitat fragmentation and impaired water quality continue to impact threatened and endangered species. Protection under Federal and state programs reduces this impact, and some populations have stabilized.	Climate change may impact Federal and state-listed species. Regulations will remain in place to prevent further disturbance to the habitat of endangered and threatened species.
Air Quality/ Noise	Increased urbanization and development has resulted in increased noise in surrounding areas and adverse effects on regional air quality.	Noise and air pollution from urban settings will continue. As dredging projects are authorized, noise and air pollution increase due to the use of dredges and tugs. Where upland placement is used, noise and air pollution from land-based sources also increases.	Future dredging and dredged material placement activities will continue to have adverse noise and air quality impacts.
Infrastructure Resources			
All Infrastructure Within the Study Area	Coastal infrastructure (e.g., mooring areas, navigation channels, ports, coastal structures, cable/power/utility crossings, recreational areas, aquaculture, dredged material alternative sites) and upland infrastructure (e.g., roads, railways,	Current infrastructure is growing and constantly being updated to meet the growing demands of an urbanized area. Dredging continues to maintain critical navigation routes. However, recent storms and resulting flooding have caused significant damage to	Dredging to maintain critical infrastructure is expected to continue. Concern for climate change and sea level rise will prompt Federal, state, and local agencies and private parties to consider measures to protect and provide resiliency to coastal communities,

Table 5-3. Past, Present, and Reasonably Foreseeable Future Actions for the PEIS Cumulative Impact Analysis (continued).

Resource	Past Actions	Present Actions	Future Anticipated Actions
	bridges) have been generally well established during the previous 40 years. Dredging activities often supported maintenance of these structures and of areas such as navigational dredging and dredging of ports and harbors.	many existing structures and impacted much of the coastal infrastructure. In light of these recent events, guidance on rebuilding coastal infrastructure was recently published (NOAA and USACE, 2013).	with strategies to manage risk to vulnerable populations, property, ecosystems, and infrastructure (USACE, 2015b).
Socioeconomic Resources			
Socioeconomic Resources Within the Study Area	The shores of Long Island Sound have been transformed since the second half of the 20th century by widespread suburbanization, urban renewal, and commercial and corporate development.	Long Island Sound is located within the most vibrant economic region for commerce in the nation. The study area encompasses one of the most densely populated and industrialized regions in North America. There are over 15.2 million persons, over 430,000 businesses and 6.1 million employees, and nearly 400 identified ports within the Long Island Sound study area. Long Island Sound provides open-water access to commercial navigation, commercial and recreational fishing, strategic military operations, and tourism. The contribution of navigation-dependent activity to GSP within the Long Island Sound region is approximately $9.4 billion per year and represents 0.93% of the study area's overall GSP.	Based on historical trends, population growth in the Long Island Sound study area is projected to increase 0.2% between 2010 and 2030. Any expansion of economic activity reliant upon the resources available from Long Island Sound may add pressure for increased utilization. Designation of a dredged material placement site in eastern Long Island will provide a viable placement alternative for nearby dredging projects. Long Island Sound will continue to contribute to the diversity of the regional economy, but tradeoffs for resource use may be necessary to accommodate demand.

Water quality impacts associated with climate change—including increased severity and frequency of storms in the northeast, sea level rise, ocean acidification, and increased runoff—appear to be much more substantial compared to impacts associated with the various No Action Alternative scenarios. Increased placement at upland locations could impact terrestrial and riverine water quality.

Benthic invertebrates could experience increased impacts through climate change, sea level rise, and increased dispersion of dredged material if additional sites were selected within Long Island Sound. If dredged material were repeatedly placed at a given location, recovery of benthic invertebrates could be reduced or delayed. The recruitment of benthic invertebrates to a disturbed site could be negatively impacted if placement occurred at multiple sites within the same geographic area, including potential alteration of community as a result of changes to habitat type (grain size) and food resources. However, dredging-related impacts are not expected to be significant compared to impacts associated with climate change.

Shellfish could experience increased impacts through climate change, sea level rise, and increased dispersion of dredged material if additional sites were selected within Long Island Sound. Susceptibility could increase due to parasites and compromised immune systems because of environmental changes in water temperature. If dredged material were repeatedly placed at a given location, recovery of shellfish species present could be reduced or delayed. The recruitment of shellfish species to a disturbed site could be negatively impacted if placement occurred at multiple sites within the same geographic area, including potential alteration of community as a result of changes to habitat type (grain size) and food resources. Lobsters, in particular, have been susceptible to multiple stressors within the Long Island Sound ecosystem. The fundamental shifts in the ecosystem, together with the persistent freshening, warming, hypoxia, and ongoing pollution, all likely have and will continue to impact the lobster populations (Varekamp, et al., 2010). Relative to these ongoing stressors, dredging-related impacts are not expected to be significant.

Atlantic sturgeon and several species of turtles are the Federally managed species most likely to be found in Long Island Sound. Changes to food resources and habitat, either adverse or beneficial, could affect some Federally managed species during particular behaviors, such as migration, spawning, foraging, and schooling. If additional sites were designated or selected within Long Island Sound, dredged material placement activities could increase turbidity and impair water quality and habitat. Potential issues from vessel strikes and/or harassment due to noise could also deter species from entering the area. Federally managed species could also experience increased impacts through climate change and sea level rise, including potential alteration of community as a result of changes to habitat type (grain size) and food resources. However, dredging-related impacts are not expected to be significant compared to impacts associated with climate change.

SAV and wetlands could experience increased impacts through climate change, impaired water quality, and increased placement of dredged material at coastal sites in Long Island Sound. If dredged material were repeatedly placed at a given location, recovery of SAV resources could be reduced or delayed. If open-water placement is limited, additional nearshore and shoreline placement sites could be required in order to meet placement needs and could result in increased nearshore placement. Sea level rise could also alter habitat and impact SAV resources.

If open-water placement is limited, additional nearshore and shoreline placement sites could be required in order to meet placement needs. This could increase impacts to birds and other Federal and state-listed species and could increase impacts to existing or new MPAs. However, some nearshore placement could also create new habitat and provide benefits, including protection from wave energy, creation of bird feeding and nesting habitat, and enlargement of a coastal MPA. Bird species could also experience increased impacts through climate change, sea level rise, and increased dispersion of dredged material if additional sites were selected within Long Island Sound.

Cumulative impacts to marine mammals and reptiles could occur from climate change and sea level rise, which could result in potential alteration of community as a result of changes to habitat type (grain size) and food resources. If additional sites were selected within Long Island Sound, dredged material placement activities could alter habitat, increase turbidity, and impair water quality and habitat.

Present and future urbanization-related activities in upland areas and activities in Long Island Sound under No Action Alternative conditions would have cumulative and adverse effects on air emissions and noise. However, these cumulative effects are not likely to be significantly different from existing conditions.

Infrastructure

As seen from recent historic storms, impacts from climate change and sea level rise have caused significant damage to many existing structures and have affected much of the coastal infrastructure within Long Island Sound. These impacts are regional in scale and much larger in magnitude than anticipated impacts from dredging-related activities. Decreased dredging, in combination with increased runoff and sedimentation as a result of climate change and sea level rise, could result in increases in shoaling, which would have negative impacts to recreational and commercial vessels.

Socioeconomic Resources

Continued growth in the region is expected to result in an increased demand for goods and shipping-related needs. The cumulative impacts of delayed or abandoned dredging of Long Island Sound’s waterways would likely affect those regional economic enterprises (and the associated employment) that depend on Long Island Sound for reliable access to water resources and transportation. In the absence of a DMMP, local ports would compete for limited dredging funds at a higher unit cost while attempting to maintain economic viability. As time passed, with limited maintenance of existing channels, market forces would likely create alternatives to existing marine transportation activity and other uses of the Sound, with a projected decrease in Long Island Sound’s overall contribution to the regional economy.

5.4.5 Cumulative Impacts of the Placement Alternatives

This PEIS evaluates the following types of potential dredged material placement alternatives: unconfined open-water placement, confined open-water and nearshore placement, upland placement, and various beneficial use alternatives. Cumulative impacts would vary depending on the type of alternative chosen. Any cumulative adverse impact to Long Island Sound's physical, environmental, infrastructure, or socioeconomic resources could diminish its value for commercial and recreational uses; however, the short-term impacts observed to date under the alternatives considered (discussed in Section 5.3) have been shown to be temporary and have not resulted in significant unacceptable adverse impacts to Long Island Sound. Potential cumulative impacts covering the range of placement alternatives are described below by resource.

Physical Resources

The overlap of multiple open-water dredged material placement events would ultimately build discernible mounds, altering the topography of the area ranging from increases of several inches to several feet. Accumulations would be monitored at designated sites to limit mound heights to depths that would not restrict navigation. Minimal alterations of bottom currents could also occur; however, these are not known to interfere with regional circulation. Bottom currents and topography alterations at nearshore placements sites (i.e., berms) could have more localized impacts to both navigation and circulation. Any sedimentation impacts from dredged material plumes would likely occur close to placement sites and would be very small compared to the total sedimentation rate of Long Island Sound. Beneficial impacts of nearshore placements would include reducing shoreline erosion; stabilizing beaches and saltmarsh wetlands; and importing organic matter to (and covering historic dredged material at) deep-water designated sites. Impacts to currents, waves, or littoral drift would likely be localized and small relative to Long Island Sound and its hydrodynamics. CDFs typically change the shoreline and the nearshore sea floor elevation, thereby altering wave energy regimes; therefore, littoral drift patterns/rates, currents, waves, and sediment transport would be impacted as the CDFs are filled to elevations above mean sea level. There is the potential for increased tidal channelization in nearshore areas and changes to flow rates and wave action. Beneficial impacts would include reducing nearshore wave and current action and reducing shoreline erosion. Impacts from climate change and sea level rise need to be considered when siting alternative placement locations. Rising seas and increasing storms could have similar if not greater impacts on the physical conditions of nearshore and shoreline areas.

Environmental Resources

Cumulative impacts related to sediment quality and bioaccumulation from open water and nearshore placement would likely be minor and temporary. Potential CDF transfer losses with bioaccumulation potential are expected to be minimal; CDF designs/specifications would address effluent discharges and pre-treatment would be instituted as needed. Material placed at Brownfield or mine reclamation sites would be required to meet site-specific design and quality requirements and would be managed on a case-by-case basis. Non-dredging events (vessel-related contamination) and watershed-wide contaminant loading from agricultural, urban, and industrial sources would continue to dominate the inventory of stressors. The potential cumulative Long Island Sound sediment quality effects resulting strictly from placing dredged material that met quality standards in the Sound, at sites elsewhere, or in confined areas would likely be short-term and minor.

Impacts to water quality from dredged material placement at open-water and nearshore sites are generally short-term and localized. Impacts from runoff from confined placement alternatives, including landfills, are generally tightly regulated and can be treated if required to limit water quality impacts. Water quality impacts from other regional sources, including agricultural, industrial and urban runoff, and from the effects of climate change and sea level rise, would likely be more significant, far-reaching, and long term.

Impacts to benthic and shellfish communities and habitats from dredged material placement would likely be localized and temporary (months to several years). However, if dredged material were repeatedly placed at a given location, the habitat characteristics could change and recovery of these organisms could be reduced or delayed. If placement occurred at multiple sites within the same geographic area, the recruitment of benthic invertebrates and shellfish to a disturbed site could be negatively impacted. The estimated annual average dry weight of dredged material placed in Long Island Sound is less than half of the annual sedimentation rate from rivers to the Sound (SAIC, 1994). Also, the surface area of open-water and nearshore alternative sites is small compared to the overall area of Long Island Sound. The cumulative impacts to benthos and shellfish are likely to be caused by natural factors (such as susceptibility to parasites and compromised immune systems because of environmental changes in water temperature due to climate change) as well as man-made stressors, including watershed-wide contaminant loading from agricultural, urban, and industrial sources. Lobsters, in particular, have been susceptible to multiple stressors within the Long Island Sound ecosystem. The fundamental shifts in the ecosystem, together with the persistent freshening, warming, hypoxia, and ongoing pollution, all likely have and will continue to impact the lobster populations (Varekamp, et al., 2010). Relative to these ongoing stressors, dredging-related impacts are not expected to be significant.

Atlantic sturgeon and several species of turtles are the Federally managed species most likely to be found in Long Island Sound. Dredged material placement activities could increase turbidity, and therefore change (impair or enhance) these species' food resources and habitat. These changes could also affect some Federally managed species and other marine mammals during particular behaviors, such as migration, spawning, foraging, and schooling. There could be potential issues from vessel strikes and/or harassment due to noise, which could also deter species from entering the area. Impacts related to climate change and sea level rise could occur as well.

Impacts to SAV beds and wetlands from dredged material placement would likely be localized and temporary. However, if dredged material were repeatedly placed at a given location, recovery of the resource could be reduced or delayed. The surface area of coastal and upland alternative sites is small compared to the overall study area, and many of these sites were selected in part due to the degraded condition of the site and lack of sensitive resources. Therefore, it is likely that impacts from climate change, sea level rise, and invasive species would be more widespread and permanent than impacts from dredged material placement.

Impacts to existing or new MPAs over time are possible. However, some nearshore placement could also create new habitat and provide benefits, including protection from wave energy, creation of bird feeding and nesting habitat, and enlargement of a coastal MPA. Cumulative impacts could occur from climate change, sea level rise, and impaired coastal water quality.

Impacts to birds from dredged material placement would likely be localized and temporary. However, if dredged material were repeatedly placed at a given location, historic avian nesting locations could be abandoned. Changes (increases and decreases) in species populations of birds are occurring for a variety of reasons other than dredging and dredged material placement, including climate change, sea level rise, and habitat change due to both environmental and man-made influences.

Impacts to threatened and endangered species from dredged material upland placement would likely be localized and temporary. However, if dredged material were repeatedly placed at a given location, recovery of the resource could be reduced or delayed. The surface area of upland alternative sites is very small compared to the overall study area, and many of these sites were selected in part due to the degraded condition of the site and lack of sensitive resources. Therefore, it is likely that impacts from climate change and habitat fragmentation would be more widespread and permanent than impacts from dredged material placement.

Continued urbanization within the affected environment of the Long Island Sound study area, especially in nearshore and upland areas, is likely and could cumulatively contribute to the effects on air quality and noise from the proposed placement alternatives, particularly for upland placement options. The degree of additive impacts resulting from the proposed alternatives would likely be low, in part because the sources of air emissions and noise under the placement alternatives are not likely concentrated or located in close proximity to sensitive land areas or receptors; therefore, the alternatives would not be likely to violate ambient air quality standards or result in significant noise impacts.

Infrastructure

As seen from recent historic storms, impacts from climate change and sea level rise have caused significant damage to many existing structures and have affected much of the coastal infrastructure within Long Island Sound. These impacts are regional in scale and much larger in magnitude than anticipated impacts from dredging-related activities.

Socioeconomic Resources

Under the proposed placement alternatives, the cumulative impact on socioeconomic resources would be continued reliability of the Long Island Sound waterway system to provide for resource utilization and reliable waterway transportation. Marine transportation, recreational boating, and the Naval Submarine Base account for the majority of the impact of navigation-dependent activities on regional output, GSP, employment, and tax revenue within the Long Island Sound study area (USACE, 2010). By focusing on water placement in designated, well-defined areas within the Sound as well as utilizing other placement alternatives, impacts to environmental resources would be minimized and the use of Long Island Sound for commercial and recreational consumption would be preserved. Beach creation/nourishment from berm placement could contribute to long-term recreational benefit to the region.

Summary

Overall, urbanization, climate change, and sea level rise would likely impact the various resources in Long Island Sound on a much larger scale and with greater magnitude than would dredged material placement activities. Cumulative impacts for each project-specific alternative would need to be analyzed in the future as part of the planning and permitting activities for specific dredging projects.

5.5 MITIGATION

Mitigation needs must be considered as part of an EIS. With regard to this PEIS, mitigation can be addressed only in general terms because the details of most of the actual dredging projects have not been developed at this time. When those projects are developed, specific mitigation strategies and practices will be addressed as part of the permitting process.

Mitigation is defined in CEQ regulation 40 CFR 1508.20 (a-e) as:

> (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
> (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
> (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
> (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
> (e) Compensating for the impact by replacing or providing substitute resources or environments.

Generally accepted mitigation strategies related to the various resources potentially impacted by the alternatives considered in this PEIS are described below.

Impacts from the creation of mounds due to offshore placement and/or berm creation can be avoided or mitigated through notices to mariners and through other site management practices.

Many potential environmental impacts from dredged material placement in water can be avoided by limiting dredging and placement to specific times of the year when disturbance to species migration or spawning may be avoided. In addition, material placement can be ‘sequenced’ to ensure that the type of material (e.g., grain size) placed at the surface closely resembles ambient material contiguous to the site; this practice can support natural recovery and ensure that communities are minimally impacted. While there may be minimal short-term impacts to fish and benthos (principally the burial of limited portions of in-water placement sites), these impacts can sometimes be limited by the infrequent, temporary and seasonally restricted nature of the placement operations. Short-term impacts to benthos from burial can be mitigated by recolonization and the targeted creation of placement mounds. Water quality impacts from offshore placement can be modeled and generally show very localized and short-term occurrences. These can also be mitigated through site management practices.

A number of management techniques can eliminate or minimize adverse direct physical and environmental impacts resulting from construction of CDFs (EPA and USACE, 2004). These techniques include dewatering dredged material to reduce volume; treating effluent; removing material from the CDF for some beneficial use, thereby restoring the capacity of the CDF and reducing the need for larger or additional sites; creating alternative habitat; and improving site aesthetics by landscaping and/or installing screens when warranted.

Various construction techniques can mitigate and minimize impacts from CAD cells. The thickness of the sediment cap (where necessary), the equipment and dredging techniques selected, and the placement schedule with respect to tidal currents can minimize water quality impacts under the CAD cell alternative. Environmental monitoring during placement can also mitigate impacts under this alternative.

Impacts to nearshore and upland water quality from confined placement and landfill placement can generally be avoided through strict regulatory monitoring of effluent and runoff to meet water quality standards.

In general, impacts to infrastructure resources (e.g., mooring areas, navigation channels, ports, coastal structures, cable/power/utility crossings, recreational areas, aquaculture, and dredged material alternative sites) from offshore or nearshore placement, including CDFs, are not anticipated because the selected sites for these alternatives would avoid coastal areas where ports or other marine structures are present.

Under the No Action Alternative, adaptive behavior will likely occur to mitigate impacts to markets if dredging in the Sound’s waterways is reduced. As time passes with limited maintenance of existing channels, market forces will rely on alternatives to existing marine transportation activity and other uses of Long Island Sound, with a projected decrease in the Sound’s overall contribution to the region’s economy.

To mitigate socioeconomic impacts from open-water placement, lobstermen and other fishermen can be notified prior to dredging operations, and barges and scows can use short tow lines to minimize dragging, which can damage lobster pots in the project area. To mitigate socioeconomic impacts to other fishery-related resources, dredging and placement activities can be deferred during key life-cycle events for these species, and dredged material placement sites can be situated at locations where sensitive spawning grounds or habitats are not present.

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6 ALTERNATIVE SELECTION

The purpose of this chapter is to describe the screening process used to evaluate and rank a wide range of dredged material placement alternatives (Chapter 3) identified during the preparation of the LIS DMMP for each of the USACE Navigation Projects within the Long Island Sound study area. This screening does not identify or select the “preferred” alternative for any of the projects; rather, it is a guide to assist the USACE in identifying the most feasible and cost-effective alternatives within the universe of potential alternatives. Screening was also performed for other Federal agency (non-USACE) projects, which are presented with the USACE Navigation Projects by dredging center. This ranking of alternatives, combined with the procedures and standards recommended in the DMMP (Section 7 of the DMMP), support the identification and use of practicable alternatives to open-water disposal

Actual decisions on the final plan for dredged material placement for Federal projects would be made as projects are funded and investigated in the future. These projects would each need to conduct investigations on sediment suitability and placement site acceptability, prepare any NEPA and decision documents, provide for adequate public involvement and review, secure any necessary Federal and state agency regulatory approvals, and secure Federal and sponsor funds for implementation.

A listing of potential alternatives for use by non-Federal projects is provided in the screening data appendix (Appendix G) for informational purposes only; non-Federal projects are not analyzed or discussed in this chapter.

6.1 TECHNICAL APPROACH

As recommended by the Long Island Sound DMMP Working Group, the USACE developed a formal, quantitative screening process using Multi-Criteria Decision Analysis (MCDA) to evaluate and rank placement alternatives for each of the USACE Navigation Projects in Long Island Sound (Linkov, et al., 2013). In addition to the physical, logistical, and economic factors that were used to score and rank placement alternatives (Section 6.1.3), the evaluation hierarchy and relative priorities expressed by the Working Group were used to guide the development of the impacts/benefits portion of the screening process. The following sections describe the technical approach used to develop and perform the alternative screening analysis.

6.1.1 Data Collection

Background information and data provided by USACE, as well as information compiled during the Long Island Sound DMMP study efforts and information from the EIS for the designation of dredged material placement sites in central and western Long Island Sound (EPA, 2004), were used to describe and characterize each of the USACE Navigation Projects and potential placement alternatives. These data included the following sources:

- **List of USACE Navigation Projects (Chapter 2).** The list of USACE Navigation Projects was derived from the list of projects included in the Dredging Needs Study (USACE, 2009a). The list was further refined using input and information from USACE during the preparation of this PEIS. For example, some dredging projects have distinct areas with varying sediment types within the dredging footprint that would generate different types of dredged material (e.g., sandy material from an outer harbor and silty material from an inner harbor); these projects were split into sub-projects to be evaluated separately. Projects from the Connecticut River that historically have been placed in-river (bar or island placement) were not included in the screening. Projects that are no longer authorized Federal channels have also been removed from the screening.
- **Dredged material characterization data for USACE Navigation Projects.** These data were received from USACE (Appendix C) and included the year in which a sediment was last tested or dredged, the chemical and physical properties of the sediment based on previous testing, and the most recent placement sites used for each project (USACE, 2014). The dredged material characterizations for USACE and other Federal agency projects were updated in the dredging center write-ups in the Long Island Sound DMMP (Chapter 5). These characterizations are based on historical results and may not reflect future results.
- **Projected 30-year dredged material volumes for each USACE Navigation Project (DMMP Chapter 5).** These data were available from the 2009 Long Island Sound Dredging Needs Report (USACE, 2009a). The report data were then updated by the USACE in 2014-2015 during preparation of the draft DMMP, because it was recognized that (1) a significant volume of dredging work had occurred in the Long Island Sound region since 2009 including the work done in the wake of Hurricane Sandy, (2) that the 2009 report had not differentiated the types of dredged material in developing its dredging needs timeline, (3) that a number of USACE Navigation Projects, including many from NAN, and up-river/up-harbor segments of larger projects, did not have specific data on historical or projected dredging, and (4) that some USACE Navigation Projects with maintenance frequencies of less than 30 years did not have future projections that included recurring dredging actions. For these reasons the information gathered from the analysis of FNPs and the non-Corps facility survey was updated. Information for the FNPs was revised to reflect recent activities and currently proposed efforts. This mainly involved eliminating dredging completed from the projections, adding newly projected work to later years of the extended DMMP timeframe, and adjusting volume estimates as described below. For the non-Corps dredging work, large projects completed since 2009 were removed from the projections, and dredging center-wide projections of demand were shifted over the revised 30-year period, as was recurring maintenance at those facilities reporting such needs in 2009. These revised data were compiled for individual USACE Navigation Projects and for other Federal agency projects (U.S. Navy, U.S. Coast Guard) and used in the alternative screening. Data for non-Federal dredging projects were also gathered but were aggregated by

dredging center (as defined in the Dredging Needs Report (USACE, 2009a) rather than by individual project.

- **Alternative site characteristics (location, capacity, and target sediment type).** These data were available from the Long Island Sound DMMP study reports (USACE (2009b); USACE (2010); USACE (2011); USACE (2012a); USACE, (2012b)) and the EIS for the designation of dredged material placement sites in central and western Long Island Sound (EPA, 2004). They contain an initial level of screening used to identify potentially feasible alternative sites for use by Federal dredging projects and to exclude those sites that are not likely feasible due to location, capacity, engineering guidelines (e.g., site bathymetry/elevation, existing substrate, hydrodynamics, type and volume of material to be placed, placement or construction methods, etc.), or other criteria (e.g., availability, ability to accept dredged material, etc.).
- **Dewatering site characteristics.** Upland alternative sites would require the use of a sediment dewatering or rehandling facility to dry and consolidate the dredged material prior to transport and placement. A series of study reports was prepared that identified, characterized, and screened potential dewatering sites for use by USACE Navigation Projects (USACE (2009b); USACE (2010)). In addition to the "feasible" and "potentially feasible" dewatering sites identified in the Phase 2 upland and dewatering site report ((USACE, 2010), the USACE provided a list of "local" dewatering sites that have been used in the past for dredged material from specific harbors. This list of dewatering sites was used to evaluate the feasibility of the upland alternatives sites.
- **Distance data (Appendix G).** Distances between alternative placement sites, USACE and other Federal dredging projects, and dewatering sites were calculated using ArcView GIS software. Each site was mapped, and straight-line distances between each location pair were calculated. For non-Federal projects, distances between dredging centers and the various alternative sites and dewatering sites were calculated using the same method.
- **Additional alternative site data.** In instances where the USACE was aware of historical placement sites that had not been identified in the alternative site inventory described above, the USACE provided additional documentation on the location, capacity, and target material for these locations for screening purposes.

The data collected for the USACE Navigation Projects, alternative placement sites, and dewatering sites (including distance data) were entered into Excel spreadsheets. These spreadsheets were then loaded into an MS Access Database for analysis (Section 6.1.2).

6.1.2 Screening Database

An MS Access database was created to store, organize, query, and export the screening data and results. Database queries were used to compile the data into new data tables, check for blank or orphan records, perform data calculations, and assign scoring values. Linked views in MS Access were used to summarize and compile scores for each of the evaluation factors described below (Section 6.1.3) and to calculate a total score for each

USACE Navigation Project and alternative site pair (project–alternative pair) (Section 6.1.4).

A unique screening ID was assigned to each alternative site in the database, consisting of the alternative site type and Site ID (see Chapter 3). This screening ID was the identifier used to link data and evaluation scores for each alternative site among multiple database tables and views.

The full suite of alternative sites described in Chapter 3 of this PEIS was screened against each USACE Navigation Project and other Federal agency projects (Chapter 2). The alternatives were carried through the entire screening process, except in cases where a project's dredged material characteristics were incompatible with use at a given alternative site type (for example, silty dredged material would be incompatible for beach nourishment alternatives that require coarse sand). In these cases, the incompatible alternative was flagged (i.e. scored as -1) and was not scored for the remaining evaluation factors for that project (Section 6.1.3).

6.1.3 Evaluation Factors and Metrics

Alternative sites that were identified in the DMMP background studies were screened against each USACE Navigation Project using a series of evaluation factors to identify those alternatives that would most likely be feasible for each project. Screening was conducted using four evaluation factors:

- Suitability/compatibility of project material for placement at a variety of alternative site types
- Available alternative site capacity to receive project material
- Distance between dredging project and alternative site
- Impacts (physical, environmental, cultural, infrastructure, and socioeconomic).

Metrics were developed for the four evaluation factors above to quantitatively score each alternative site by project. Three scoring categories were developed for each factor (Green, Yellow, and Red). The "Green" category indicated a favorable or compatible ranking, and the "Red" category indicated an unfavorable or incompatible ranking. The "Yellow" category indicated either a moderate ranking or a lack of data to assign a clear ranking. Metrics were not developed for the dredging and placement costs; instead, estimated costs were included with the screening results for comparison purposes but were not included in the quantitative screening scores.

The following sections describe the rationale and approach for applying the metrics to each of the evaluation factors listed above.

Suitability Evaluation Factor

The suitability factor was used to evaluate the suitability of dredged material generated by USACE Navigation Projects for placement at a variety of alternative site types. This evaluation was performed for classes of alternatives, rather than specific alternative sites, because suitability criteria are based on the use of dredged material by alternative type, rather than specific alternative sites. It is also understood that this assessment of suitability would need to be confirmed in the future based on new testing before any proposed project was implemented. The types of alternatives considered included:

- Open-Water Placement
- Confined Placement
- Beneficial Use

Suitability for Open-Water Placement

The evaluation of anticipated suitability of project material for unconfined, open-water placement was based on existing chemistry data and previous placement history for each USACE Navigation Project. These data were used to classify the dredged material for each project into one of three categories using the metrics presented in Table 6-1. For those USACE Navigation Projects with no available testing results, sediment testing data from nearby non-Federal private dredging permit applications were used to anticipate material types at the USACE Navigation Projects. The open-water placement alternatives were then scored based on their feasibility to receive dredged material from each USACE Navigation Project. For many of the projects, recent sediment chemistry data were unavailable. In these cases, previous open-water placement of a project's material was assumed to mean that the project's current material would be suitable for open-water placement. For these projects, the open-water placement alternatives were assigned to the "Green" category and given a scoring value of 100. In the past, when a project's dredged material was placed at an upland facility or CDF, it was assumed that the project's current material would likely not be suitable for unconfined, open-water placement, unless recent sediment chemistry data indicated otherwise. For these projects, the open-water placement alternatives were assigned to the "Red" category and received a score of -1. For those projects for which a suitability determination could not be made based on lack of recent sediment chemistry data or placement history, the open-water placement alternatives were assigned to the "Yellow" category and assigned a score of 50. Suitability scores are presented in Appendix G.

Table 6-1. Open-Water Placement Evaluation Factor Metrics.

Category	Metric	Scoring Value
Green	Likely suitable; previous open-water placement	100
Yellow	Unknown; additional testing required	50
Red	Likely unsuitable; previous upland placement	-1

Suitability/Compatibility for Confined Placement

The confined placement alternative types that were screened against the USACE Navigation Projects included:

- Confined Open-Water Placement
- In-Harbor CAD Cells
- CDFs

The evaluation of anticipated suitability of project material for confined placement was based on the existing chemistry and physical data for each USACE Navigation Project. Dredged material characterized as primarily sand was assumed to be clean fill. Dredged material characterized as silt and clay was assumed to be clean fill unless the available chemistry data indicated otherwise.

The confined placement alternatives (confined open-water placement, CAD cells, and CDFs) may receive two types of material: suitable (clean, sandy) material for the cap and unsuitable (contaminated) material for the base. Therefore, a "cap" option and a "base" option were created for each containment alternative type (confined open-water placement, CAD cells, and CDFs). The "cap" and "base" options for a given alternative were mutually exclusive, so if a project had compatible material for a CAD cap, then it was assumed to not have compatible material for a CAD base. The confined alternatives were scored based on their feasibility to receive dredged material from each of the USACE Navigation Projects. For projects that had compatible material, the confined placement alternatives were assigned to the "Green" category and given a scoring value of 100 for that alternative type (Table 6-2). For projects with incompatible material, the confined placement alternatives were assigned to the "Red" category and received a score of -1. A suitability score of -1 removed an alternative type from further consideration for a given project, and this alternative was not evaluated using the remaining factors. For those projects for which a determination of compatibility could not be made based on lack of recent sediment grain size data or chemistry data, the confined placement alternatives were assigned to the "Yellow" category and assigned a score of 50. Suitability/compatibility scores are presented in Appendix G.

Table 6-2. Confined Placement Suitability Evaluation Factor Metrics.

Category	Metric		Scoring Value
	Cap Material	Base Material	
Green	Primarily sand (<40% fines)	Sand with >40% fines, or primarily silt and clay	100
Yellow	Unknown	Unknown	50
Red	Sand with >40% fines, or primarily silt and clay	Primarily sand (<40% fines)	-1

Suitability/Compatibility for Beneficial Use

The evaluation of anticipated suitability of project material for beneficial use was based on existing physical data and, in some cases, on existing chemical data, for each USACE Navigation Project. Dredged material characterized as primarily sand was assumed to be clean fill. Dredged material characterized as silt and clay was assumed to be clean fill unless the available chemistry data indicated otherwise. These data were used to classify the dredged material for each USACE Navigaton Project against various beneficial use alternatives and assign each project to one of three categories using the metrics presented in Table 6-3. Compatible material was specific to each alternative type:

- Beaches – Coarse to medium sand (up to 15% – 20% fines)
- Berms – Coarse to silty sand (up to 30% – 40% fines)
- Landfill cover/capping – Clean fill, silty sand or fine material (silt/clay)
- Brownfields and Mines/Quarries – Clean fill, fines acceptable
- All other beneficial use alternatives[1] – Clean fill

Table 6-3. Beneficial Use Suitability Evaluation Factor Metrics.

Category	**Metric**				**Scoring Value**
	Beach Material	**Berm Material**	**Landfill Cover/Capping**	**Other Beneficial Use**	
Green	Primarily sand (<20% fines)	Primarily sand (<40% fines)	Silty sand (>40% fines) or primarily silt/clay	Clean fill, fines acceptable	100
Yellow	Unknown	Unknown	Unknown	Unknown	50
Red	Sand with >20% fines or primarily silt/clay	Sand with > 40% fines or primarily silt/clay	Primarily sand (<40% fines)	Not compatible	-1

Beneficial use alternatives were scored based on their feasibility to receive dredged material from each USACE Navigation Project. For projects with compatible material for a given alternative type, the compatible alternatives were assigned to the "Green" category and received a score of 100. For projects with material that was likely incompatible with a given alternative type, the incompatible alternatives were assigned to the "Red" category and received a score of -1. A suitability score of -1 removed an alternative type from further consideration for a given project, and this alternative was not evaluated using the remaining factors. For those projects for which it was unknown if the material was compatible for a given alternative, the alternatives were assigned to the

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[1] Concrete/asphalt plants were not evaluated as a beneficial use alternative for use by Federal Navigation Projects. The rationale for removing them was based on the fact that concrete/asphalt plants do not utilize silty material, and the sandy material that the plants would use would be more appropriate for beach nourishment. Concrete/asphalt plants were evaluated for non-Federal projects only.

"Yellow" category and received a score of 50. Suitability/compatibility scores are presented in Appendix G.

Capacity Evaluation Factor

The capacity evaluation of each specific alternative site was based on the percentage of project material that each alternative site could accept. Alternative site capacity data were derived from the DMMP background reports for each alternative type (USACE (2010); USACE (2012a); USACE (2012b)). Capacity information for the open-water sites was provided by USACE during the preparation of this PEIS.

To determine the volume of cap material that could be accepted at each confined placement alternative site, a cap depth of 3 ft was assumed and multiplied by the area of the site. The volume of base material was then calculated by subtracting the cap volume from the total site capacity found in the containment site study report (USACE, 2012b). For most alternative sites, the capacity percentage was calculated as the available alternative site capacity (in cubic yards) divided by the projected 30-year dredging volume at each project (in cubic yards). For beaches and feeder berms, material placed at the site would likely be transported away from the site over time, making additional capacity available. For these alternatives, the capacity percentage was calculated using the average volume of material per placement event (in cubic yards), rather than the 30-year dredging volume at each project.

Alternative sites were scored based on their percent capacity to receive a project's dredged material (e.g., an alternative site with 25% capacity for a given project received a score of 25) (Table 6-4). Any site with >100% capacity was assigned a score of 100. Capacity scores are presented in Appendix G.

Table 6-4. Capacity Evaluation Factor Metrics.

Category	Metric	Scoring Value
Green	≥100% available capacity	100
Yellow	1% – 99% available capacity	1 – 99, based on percentage
Red	0% available capacity	0

Distance Evaluation Factor

For the evaluation of distance, the specific alternative sites were organized into two groups based on anticipated methods for transport and placement of dredged material from the USACE Navigation Projects to the alternative sites:

- Alternatives with direct placement of material (open water, CAD cells, CDFs, beaches, and berms)
- Alternatives that require sediment dewatering/rehandling before placement (landfill placement and cover/capping, Brownfields, habitat restoration)

Distances for the direct placement alternatives reflect the distance between each USACE Navigation Project and each direct placement alternative site. Metrics for each alternative type were assigned based on reasonable haul or pump distances based on USACE staff experience and industry practices. An example is an 8-hour work day for water transport distances (20 mi) or a maximum pumping distance (2 mi) for beaches and berms (Table 6-5). Alternative sites located within these distances were assigned to the "Green" category and received score of 100. Alternative sites that are farther away, but could still be logistically feasible, were assigned to the "Yellow" category and received a score of 50. Alternative sites that were not feasible based on their distance from USACE Navigation Projects were assigned to the "Red" category and received a score of 0. Distance scores are presented in Appendix G.

Table 6-5. Distance Evaluation Factor for Direct Placement Alternative Sites.

Category	**Metric**			**Scoring Value**
	Water Transport	**Berms**	**Beaches**	
Green	< 20 mi	< 2 mi	< 2 mi	100
Yellow	20 – 30 mi	2 – 10 mi	2 – 5 mi	50
Red	> 30 mi	> 10 mi	>5 mi	0[a]

[a] Beaches located greater than 5 mi from a USACE Navigation Project were scored as -1, because material cannot be pumped beyond 5 mi. Therefore, beaches greater than 5 mi away were excluded from the analysis.

Distances for the upland alternative sites were derived using a two-step process:

1) Distances between the USACE Navigation Projects and all dewatering sites (feasible, potential, local) were calculated, and an Access query was run to identify the closest dewatering site to each USACE Navigation Project.
2) Using the closest dewatering site for each project, the distance from that dewatering site to each alternative site was calculated and scored.

Metrics for upland distances are consistent with USACE cost calculations (10, 25, >25 mi) (Table 6-6). Distance scores are presented in Appendix G.

Table 6-6. Distance Evaluation Factor for Upland Alternative Sites.

Category	**Metric**	**Scoring Value**
Green	<10 mi	100
Yellow	10 – 25 mi	50
Red	> 25 mi	0

Site Impacts Evaluation Factor

The impacts evaluation was based on anticipated adverse impacts and benefits to four categories of resources within the study area:

- Physical resources (waves, currents, littoral drift, and sediment type)
- Environmental resources (biological resources, water, sediment, and air quality)
- Cultural resources (historic districts and buildings, archaeological sites, and shipwrecks), and
- Infrastructure (moorings, ports, utilities, recreational areas, etc.).

These categories were developed in the Long Island Sound DMMP background reports that described the Confined Open Water, In-Harbor CAD Cell, Island CDF, Nearshore CDF, and Nearshore Bar/Berm Alternative sites (USACE (2012a); USACE (2012b)). These reports assessed site-specific impacts for these alternative sites based on the resource data gathered and presented in the reports. The types of impacts assessed for each resource are summarized in Appendix G. However, impacts for the entire suite of resources presented in the Affected Environment section of this PEIS were not part of the previous impact assessment. Therefore, impacts for resources not included in the USACE reports (i.e., plankton, benthic invertebrates, water quality, sediment quality, bioaccumulation potential, air quality/noise) were assessed to create a complete impact assessment for screening of these alternative site types.

For the remaining alternative site types for which site-specific impacts were not previously developed (i.e., unconfined open water, beach nourishment, habitat restoration, Brownfield restoration, landfill placement and capping), anticipated impacts were developed using site-specific resource information from the Affected Environment chapter of this PEIS, as well as other existing NEPA documents (e.g., the designation EIS for WLDS and CLDS (EPA, 2004)). In cases where site-specific information was lacking for a particular resource, generic impacts were developed using best professional judgment, assuming that the resource could be present at a particular site. The lack of site-specific resource information had a minimal impact on the overall screening results because of the scoring method used for impacts (described below) and the multiple evaluation criteria used in the screening process. In addition, the screening provided a relative ranking of alternatives and did not identify a “preferred” alternative.

Socioeconomic impacts were assessed for all alternative site types according to Section 122 of the River and Harbor Act and Flood Control Act of 1970, P.L. 91-611. Socioeconomic parameters for which adverse impacts were assessed included:

- Destruction/disruption of man-made and natural resources
- Aesthetic values
- Community cohesion
- Availability of public facilities and services
- Employment effects
- Tax and property value losses
- Injurious displacement of people, businesses, and farms
- Disruption of desirable community and regional growth

Once impacts had been developed for all alternative sites and resources, adverse impacts were then assigned scores using the metrics described in Table 6-7. For resources with multiple types of impacts (Appendix G), each impact type was scored using the following scale:

- Where placement of dredged material was anticipated to result in no or an unlikely adverse impact, the impact was assigned a score of 100.
- Where placement of dredged material was anticipated to result in a potential adverse impact, the impact was assigned a score of 50.
- Where placement of dredged material was anticipated to result in an adverse impact, the impact was assigned a score of 0.

The impact scores were then averaged across types of impacts (Appendix G) for a given resource to generate an impact score per resource. These resource-specific scores were then averaged across resources to generate a single impact score for each alternative site. This score is based on the anticipated impacts resulting from the placement of dredged material at a specific alternative site and is not influenced by the dredging project generating the material. Therefore, this impact score was applied to its respective alternative site across all USACE Navigation Projects. Impact scores are presented in Appendix G.

Table 6-7. Impact Evaluation Factor Metrics.

Category	Metric	Scoring Value
Green	No/Unlikely Adverse Impact	100
Yellow	Potential Adverse Impact	50
Red	Likely Adverse Impact	0

In addition to adverse impacts, positive impacts (or benefits) resulting from the placement of dredged material at each potential alternative site were also assessed. Site benefits were not quantified in the screening, but are described in the database. The presence of benefits (environmental and socioeconomic) is indicated in separate columns in the screening results. A response of “Yes” in the benefits column indicates that there is a potential benefit to at least one of the resources evaluated. In most cases, potential benefits would depend on the final site design. Benefits data are presented in Appendix G.

Cost Information

Dredging and placement cost information were developed by USACE (Appendix D) and take into account dredging methods, alternative types, dredging volumes, and haul distances. The Excel cost spreadsheet generated by USACE was formatted into a normalized table and loaded into the Access database. A description of how these data and variables were used to develop an estimated cost for each project–alternative pair is provided below. Estimated costs were included with the screening results (as $/CY) for comparison purposes but were not included in the quantitative screening scores.

Dredging Methods: Where costs for two different dredging methods for a given volume, alternative type, and distance were provided, the lower of the two costs was used for the cost calculations and screening, and the associated method was noted in the Access database. For example, 1,000 CY of material transported to an ocean placement site 10 mi away would have an estimated cost of $615,323 if a bucket dredge were used and of $750,363 if a hopper dredged were used (Appendix D). The lower cost ($615,323) and associated method (bucket dredge) were retained in the normalized data table and loaded into the Access database for cost calculations.

Alternative Types: Costs for each alternative type were associated in the database with specific alternative sites within the same category. For example, the cost category titled "Containment Island Placement" was used to estimate costs for all of the island and nearshore CDF alternative sites (Appendix D).

Dredging Volumes: USACE developed cost estimates based on discrete dredging volumes (i.e., 1,000 CY, 2,000 CY, 5,000 CY, 10,000 CY, etc.). Because some projects will be dredged multiple times over the 30-year project period, an average volume (in CY) per dredging event was developed for each USACE Navigation Project. Because these dredging volumes often did not correspond exactly to the discrete dredging volumes used to develop costs, the cost for each project–alternative pair was interpolated using the costs associated with the two discrete dredging volumes that bracketed the project's estimated average dredging volume per event. These two volumes (x1 and x2) and their associated costs (y1 and y2) were used to produce a line with slope:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

The y-intercept was calculated as:

$$b = y1 - m * x$$

Finally, the project's estimated average dredging volume (x) was inserted into the equation of a line to solve for the cost associated with the project volume:

$$y = mx + b$$

A few project–alternative pairs resulted in a combination of capacity-distance for which no cost was provided by the USACE (e.g., a project with less than 1,000 CY that uses an alternative site located 60 mi away from the project). These costs were not estimated for the screening and were flagged with the qualifier "cost not estimated."

For projects with estimated average per-event dredging volumes greater than the greatest dredging volume for which costs were developed, the greatest estimated volume was used and the associated costs were flagged with the qualifier “highest estimated volume.”

For projects with an estimated average per-event dredging volume that occurred between volumes for which the least costly method differed, the method for the higher capacity was selected and flagged with the qualifier “methods differ by volume.”

Haul Distances: For direct placement alternatives (beaches, berms, open water, CADs, and CDFs), the distance used to identify the cost was the straight-line distance from the project to the alternative site (i.e., the same distance used for the distance evaluation factor screening above). For the upland alternatives (landfill placement, landfill cover/capping, habitat restoration, and Brownfields), the distance used to identify the cost was the sum of 1) the straight-line distance between the project and the nearest dewatering facility, and 2) the straight-line distance between that dewatering facility and the upland alternative site.

The resulting cost estimate for each project–alternative pair was then divided by the average per-event dredging volume to obtain a cost per cubic yard ($/CY). It is important to note that these unit costs are not included as a quantitative screen (i.e., they were not included in the screening score) but are listed in the screening results for the purpose of comparison among alternatives. Estimated costs for each project–alternative pair are presented in Appendix G.

6.1.4 Scoring

Linked views in MS Access were used to compile the scores from each evaluation factor (suitability, capacity, distance, impacts) into a summary score for each of the alternative sites by USACE Navigation Project. If any of the alternative sites received a score of “-1” because the project’s dredged material characteristics were incompatible with that alternative site type, that alternative was not scored for the remaining evaluation factors, and it retained a final score of -1.

The summary score allows alternative sites to be ranked by USACE Navigation Project to identify the most feasible alternatives based on the four evaluation factors used. The summary scores for each project–alternative pair are presented in Appendix G. Benefits and cost information, which were not included in the total screening score, are included as separate columns in the summary table of results.

6.2 RESULTS

The screening process provides a relative ranking of all potential alternative sites for each USACE and other Federal agency project; it does not identify or select a “preferred” alternative for any of the projects. It is a guide to assist the USACE in identifying the most likely feasible and cost-effective alternatives within the universe of potential alternatives. The screening results for the individual evaluation factors for each project–alternative pair are presented in Appendix G. The alternative sites associated with the

10 highest total scores for each of the USACE and other Federal agency projects are presented in Table 6-8 through Table 6-69. The screening results for the entire list of alternative sites evaluated for each of the USACE and other Federal agency projects are presented in Appendix G.

The screening result tables identify alternatives using a Screening ID, which is a unique identifier assigned to each alternative site in the database and consists of the alternative site type and Site ID. The following codes were used to identify alternative site type:

- UOW – unconfined open water
- COW – confined open water
- CAD – CAD cell
- IslandCDF – island CDF
- ShoreCDF – shoreline CDF
- Beach – beach nourishment
- Berm – nearshore berm
- LFPlace – landfill placement
- LFCap – landfill cap/cover
- Habitat – habitat restoration
- BF - Brownfield

As described earlier in this chapter, the confined placement alternatives (confined open-water placement, CAD cells, and CDFs) may receive two types of material: suitable (clean, sandy) material for the cap and unsuitable (contaminated) material for the base. Therefore, a "cap" option and a "base" option were created for each containment alternative type (confined open-water placement, CAD cells, and CDFs). These options are identified in the screening results with the suffix "-cap" or "-bse".

When reviewing the screening results, the following assumptions should be considered:

- **Suitability/Compatibility:** Suitability of material was determined based on the most recent sediment testing results and/or most recent placement site used for each USACE and other Federal agency project. In some cases, the most recent testing occurred decades ago and may not reflect current conditions. All project material would be tested to determine suitability for placement before any future dredging occurred.
- **Capacity:** Alternative site capacity was calculated using either the 30-year projected dredging volume or the average per-event volume (for beaches and feeder berms) for each project, and did not consider that multiple placements of smaller volumes could occur over the project lifetime. Therefore, the available capacity used to score each alternative site assumes that all project material would be placed at that one alternative site. The scoring also did not take into consideration that an alternative site could be used by multiple projects over the 30-year period of the DMMP, or that a single project could use multiple alternative sites during a dredging event.

- **Distances:** Distances between project–alternative pairs are straight-line distances and do not reflect actual haul distances that equipment would use to transport material from dredging projects to alternative sites.
- **Impacts:** Impacts are based on resource data (where available) and reflect potential or anticipated impacts. Project-specific NEPA documents would need to be prepared that describe in greater detail the current conditions and anticipated impacts associated with placement of dredged material at each alternative site considered for each dredging project. The potential for environmental or socioeconomic benefits that were identified for a particular alternative are indicated in the table by either "Yes" or "No". Potential benefits were not quantified in the screening process but are included for informational purposes only.
- **Cost:** As described earlier in this chapter, estimated costs were included with the screening results for comparison purposes but were not included in the quantitative screening scores.

6.2.1 Block Island Area Dredging Center

The Block Island Dredging Center encompasses the harbors of Block Island, Rhode Island, incorporated as the Town of New Shoreham. There are two harbors, each of which has a USACE Navigation Project: Block Island Harbor of Refuge and Great Salt Pond.

Block Island Harbor of Refuge

Dredged material from the Block Island Harbor of Refuge project, including the entrance channel, the majority of the anchorage, and inner basin, has been shown to be clean sand ranging from 0.1% to 12% fines. A small amount (2,000 CY) of silty material could be present in the southwest area of the anchorage or the corners of the inner basin. Therefore, these two material types were screened separately. The top 10 ranked alternatives for each project sub-area are presented in Table 6-8.

Great Salt Pond

Material to be dredged from the USACE Navigation Project at Great Salt Pond has been shown to be predominantly sand. The top 10 ranked alternatives for this project are presented in Table 6-9.

Table 6-8. Screening Results for Top Ten Ranked Alternative Sites for Block Island Harbor of Refuge.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Block Island Harbor of Refuge - Entrance Channel, Inner Basin, and Anchorage										
Berm-600	Crescent Beach (Block Island)	100	92	100	82.66	375.10	Yes	Yes	$35.02	
Beach-600	Crescent Beach (Block Island)	100	100	100	70.67	370.67	Yes	Yes	$35.02	
Berm-610	Sachem's Pond West Beach	100	93	50	81.25	324.76	Yes	Yes	$69.31	
UOW-NLDS	NLDS	100	100	50	72.31	322.31	No	Yes	$59.77	
IslandCDF-R_cap	Groton Black Ledge	100	100	50	67.53	317.53	Yes	Yes	$145.92	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$147.54	
Berm-177	Shadmoor State Park	100	100	0	84.64	284.64	Yes	Yes	$102.46	
Berm-384	Misquamicut State Beach	100	100	0	84.56	284.56	Yes	Yes	$87.16	
Berm-63	Asharoken Beach	100	100	0	83.57	283.57	Yes	Yes	$102.46	
Berm-327/333/330	Bradley Point Park, Savin Rock & Oak Street Beach	100	100	0	83.23	283.23	Yes	Yes	$102.46	
Block Island Harbor of Refuge - Anchorage SW Area and Inner Basin Corners										
UOW-NLDS	NLDS	100	100	50	72.31	322.31	No	Yes	$378.76	
IslandCDF-R_bse	Groton Black Ledge	100	100	50	67.53	317.53	Yes	Yes	$473.09	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$471.81	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$471.81	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$373.50	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$365.60	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$373.50	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$373.50	
UOW-CLDS	Central Long Island Sound D.S.	100	100	0	75.43	275.43	No	Yes	$471.81	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$471.81	

Table 6-9. Screening Results for Top Ten Ranked Alternative Sites for Great Salt Pond.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Berm-610	Sachem's Pond West Beach	100	100	100	81.25	381.25	Yes	Yes	$70.18	
Beach-610	Sachem's Pond West Beach	100	100	100	70.67	370.67	Yes	Yes	$70.18	
Berm-600	Crescent Beach (Block Island)	100	100	50	82.66	332.66	Yes	Yes	$103.18	
UOW-NLDS	NLDS	100	100	50	72.31	322.31	No	Yes	$93.02	
IslandCDF-Q_cap	Twotree Island	100	100	50	71.51	321.51	Yes	Yes	$182.62	
IslandCDF-R_cap	Groton Black Ledge	100	100	50	67.53	317.53	Yes	Yes	$182.62	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$155.52	
CAD-M_cap	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$121.48	
Berm-177	Shadmoor State Park	100	100	0	84.64	284.64	Yes	Yes	$162.46	
Berm-384	Misquamicut State Beach	100	100	0	84.56	284.56	Yes	Yes	$132.91	

6.2.2 Fishers Island Dredging Center

The Fishers Island New York Dredging Center encompasses the harbors of Fishers Island, New York, part of the Town of Southold. The single USACE Navigation Project in this dredging center is Hay (West) Harbor.

Hay (West) Harbor

There are no sediment sampling and testing data on record for this project. Testing results for a non-Federal dredging application in Hay (West) Harbor showed a range of 39% to 92% fines, with a portion of the material determined suitable for placement at the CLDS. The shoal material in the Hay (West) Harbor project is expected to be slightly coarser, but still classified as silty sand, not suited to direct beach placement but likely suitable for unconfined open-water placement. The top 10 ranked alternatives for this project are presented in Table 6-10.

6.2.3 Fishers Island Sound/Little Narragansett Bay Area Dredging Center

The northern (mainland) shore of Fishers Island Sound includes the Towns of Westerly, Rhode Island, and Stonington and Groton, Connecticut, and constitutes the Fishers Island Sound/Little Narragansett Bay Dredging Center. The dredging center includes the USACE Navigation Projects for the 1) Pawcatuck River, Little Narragansett Bay, and Watch Hill Cove, 2) Stonington Harbor, and 3) Mystic Harbor. The dredging center stretches from Watch Hill, Rhode Island, in the east to Mumford Point, Connecticut, in the west.

Pawcatuck River, Little Narragansett Bay, and Watch Hill Cove

Pawcatuck River

The only USACE sediment sampling and testing data on record (1971) for this project segment show a range of about 3% to 95% fines, with a mean of 43%. Future maintenance of this segment of the project is expected to yield suitable fine-grained material. The top 10 ranked alternatives for this project segment are presented in Table 6-11.

Little Narragansett Bay

The entrance channel of the Little Narragansett Bay project yields clean sand (less than 2% fines – June 2003 sampling and testing) suitable for beach nourishment. The inner bay channel reaches yield silty material not suitable for beach placement. Therefore, the two material types for this project were screened separately. The top 10 ranked alternatives for the two sub-areas of this project segment are presented in Table 6-12.

Table 6-10. Screening Results for Top Ten Ranked Alternative Sites for Hay (West) Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$76.97	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$83.78	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$165.65	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$165.65	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$195.96	
ShoreCDF-O_bse	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$195.96	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$155.91	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$155.91	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$149.71	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$129.87	

Table 6-11. Screening Results for Top Ten Ranked Alternative Sites for Pawcatuck River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$31.06	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$122.50	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$122.50	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$36.61	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$97.36	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$97.36	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$130.49	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$65.50	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$130.49	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$130.49	

Table 6-12. Screening Results for Top Ten Ranked Alternative Sites for Little Narragansett Bay.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Little Narragansett Bay - Entrance Channel										
Berm-381/382	Watch Hill & Napatree Point Beaches	100	100	100	82.47	382.47	Yes	Yes	$51.53	
Beach-620	Sandy Point Beach (Westerly)	100	100	100	75.00	375.00	No	Yes	$43.54	
Beach-381	Watch Hill Beach	100	100	100	72.66	372.66	Yes	Yes	$51.53	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$56.81	
Beach-382	Napatree Point Beach	100	100	100	72.27	372.27	Yes	Yes	$51.53	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$154.47	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$134.14	
Berm-620	Sandy Point Beach (Westerly)	100	72.33	100	75.00	347.33	No	Yes	$43.54	
Berm-384	Misquamicut State Beach	100	100	50	84.56	334.56	Yes	Yes	$69.11	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$71.60	
Little Narragansett Bay - Inner Bay Channel										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$31.06	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$122.50	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$112.23	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$36.61	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$97.36	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$97.36	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$130.49	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$65.50	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$130.49	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$130.49	

Watch Hill Cove

It is expected that any material dredged from the USACE Navigation Project at Watch Hill Cove in the future would generate clean sand, suitable for beach nourishment, as in the past, or for nearshore placement. The top 10 ranked alternatives for this project segment are presented in Table 6-13.

Stonington Harbor

There are no USACE sediment test results on record for the Stonington Harbor project. Sediment test results for a non-Federal suitability determination (2010) indicated silty materials found suitable for open-water placement at the CLDS, with some materials suitable for placement at the NLDS. Future maintenance of the Stonington Harbor project is expected to yield shoal sediments classified generally as mixed coarse to fine-grained material likely suitable for open-water placement. The top 10 ranked alternatives for this project are presented in Table 6-14.

Mystic Harbor

Sediment test results from 2014 indicate a range of suitable fine-grained material (28% to 90% fines) from the Mystic Harbor project. In addition to maintenance dredging anticipated to occur at the Mystic Harbor project, a large improvement project (450,000 CY) may occur within the next 30 years. It is assumed that the proposed channel and anchorage improvements would not increase the current maintenance dredging frequency or volume. Therefore, the maintenance and improvement projects for Mystic Harbor were screened separately. The top 10 ranked alternatives for this project are presented in Table 6-15.

6.2.4 New London Area Dredging Center

The New London Area Dredging Center stretches from Mumford Point in Groton, Connecticut, in the east to Goshen Point in the west. The dredging center also extends northerly upriver to Norwich, Connecticut, and includes several navigable coves tributary to the river. The dredging center consists of the cities of New London and Groton on the coast, and the municipalities along the Thames River to the head of navigation, including Waterford, Ledyard, Montville, Preston, and Norwich, Connecticut. The USACE Navigation Projects located within this dredging center include New London Harbor and the Thames River. For planning purposes, the Thames River is divided into two segments, above and below Cow Point at the upstream end of the U.S. Naval submarine base in Groton. The U.S. Navy and U.S. Coast Guard have major facilities at New London and Groton that require periodic maintenance and occasional improvement dredging.

Table 6-13. Screening Results for Top Ten Ranked Alternative Sites for Watch Hill Cove.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Berm-381/382	Watch Hill & Napatree Point Beaches	100	100	100	82.47	382.47	Yes	Yes	$68.53	
Berm-620	Sandy Point Beach (Westerly)	100	100	100	75.00	375.00	No	Yes	$79.20	
Beach-620	Sandy Point Beach (Westerly)	100	100	100	75.00	375.00	No	Yes	$79.20	
Beach-381	Watch Hill Beach	100	100	100	72.66	372.66	Yes	Yes	$68.53	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$82.74	
Beach-382	Napatree Point Beach	100	100	100	72.27	372.27	Yes	Yes	$68.53	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$176.50	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$176.50	
Berm-384	Misquamicut State Beach	100	100	50	84.56	334.56	Yes	Yes	$101.45	
Berm-368	Bluff Point State Park	100	100	50	81.61	331.61	Yes	Yes	$113.85	

Table 6-14. Screening Results for Top Ten Ranked Alternative Sites for Stonington Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$120.38	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$237.22	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$207.95	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$152.81	
COW-E_bse	Sherwood Island Borrow Pit	100	100	00	85.57	285.57	Yes	Yes	$198.12	
COW-E_cap	Sherwood Island Borrow Pit	100	100	00	85.57	285.57	Yes	Yes	$198.12	
LFPlace-59	110 Sand Company	100	100	00	85.27	285.27	Yes	Yes	$224.23	
CAD-M_bse	Morris Cove	100	100	00	85.16	285.16	Yes	Yes	$172.56	
LFCap-61	Town of Brookhaven Landfill	100	100	00	77.41	277.41	Yes	Yes	$224.23	
LFCap-251	Manchester Landfill	100	100	00	77.41	277.41	Yes	Yes	$224.23	

Table 6-15. Screening Results for Top Ten Ranked Alternative Sites for Mystic Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Mystic Harbor – Maintenance										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$27.57	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$114.18	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$114.18	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$130.16	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$39.18	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$103.89	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$103.89	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$114.30	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$72.49	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$114.30	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$114.30	
Mystic Harbor - Improvement										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$18.47	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$111.16	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$111.16	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$125.58	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$37.98	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$79.63	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$119.21	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$66.72	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$119.21	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$119.21	

New London Harbor

Material from the New London Harbor main and waterfront channels is expected to be suitable fine-grained material as in the past. There is the possibility that Shaws Cove shoal materials would be found unsuitable for unconfined open-water placement with future testing. Therefore, Shaws Cove was screened separately from the rest of New London Harbor and was treated as having unsuitable fine-grained materials. The top 10 ranked alternatives for these project segments are presented in Table 6-16.

Thames River

In the future, material from the lower Thames River channel between the railroad bridge at New London and Cow Point in Groton above the submarine base is expected to yield shoal material similar to what was encountered in this area prior to the Navy's deepening projects (i.e., fine-grained sediment suitable for open-water placement). The sediments in the 25-ft upper Thames River channel above Cow Point (above the area improved by the U.S. Navy) are expected to be largely silty material, suitable for open-water placement. The top 10 ranked alternatives for these project segments are presented in Table 6-17.

Naval Submarine Base, New London

The U.S. Navy maintains and occasionally improves its dredged access and berth areas at the Navy base in Groton. In the past, these efforts have yielded both suitable and unsuitable fine-grained materials. The U.S. Navy's berth dredging activities are expected to continue to generate these types of material in the future, and the U.S. Navy has indicated it will likely continue its improvement dredging program as well. Therefore, three types of material were screened for this project: suitable maintenance (60%), unsuitable maintenance (40%), and suitable improvement material. The top 10 ranked alternatives for these project materials are presented in Table 6-18.

U.S. Coast Guard Station, New London

The New London Station is located on the west shore of the harbor just north of Fort Trumbull. For the purposes of the DMMP, the Coast Guard's maintenance materials will be assumed to be suitable for open-water placement or any other use for fine-grained suitable materials. The top 10 ranked alternatives for this project are presented in Table 6-19.

U.S. Coast Guard Academy

The U.S. Coast Guard Academy is located on the west shore of the Thames River a short distance above the bridges and below the U.S. Navy base. For the purposes of the DMMP, the Coast Guard's maintenance materials will be assumed to be suitable for open-water placement or any other use for fine-grained suitable materials. The top 10 ranked alternatives for this project are presented in Table 6-20.

Table 6-16. Screening Results for Top Ten Ranked Alternative Sites for New London Harbor.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
New London Harbor – Main Channel and Anchorage, 23-Foot Channel										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$13.06	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$27.28	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$108.84	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$88.05	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$123.78	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$126.58	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$126.58	
UOW-CLDS	CLDS	100	100	0	75.43	275.43	No	Yes	$48.34	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$64.59	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$141.14	
New London Harbor – 15-Foot Shaws Cove										
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$123.99	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$111.96	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$144.76	
ShoreCDF-O_bse	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$144.76	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$93.98	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$174.79	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	0	71.25	271.25	Yes	Yes	$174.79	
IslandCDF-L_bse	New Haven Breakwaters	100	100	0	70.94	270.94	Yes	Yes	$174.79	
ShoreCDF-D_bse	Norwalk Outer Harbor Islands - Containment	100	100	0	70.36	270.36	Yes	Yes	$174.79	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	0	68.28	268.28	Yes	Yes	$174.79	

Table 6-17. Screening Results for Top Ten Ranked Alternative Sites for Thames River.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
Thames River – Lower Channels, Navy Base to Harbor										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$17.36	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$26.46	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$107.17	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$107.17	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$122.49	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$124.84	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$124.84	
UOW-CLDS	CLDS	100	100	0	75.43	275.43	No	Yes	$46.55	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$63.45	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$139.34	
Thames River – Upper Channel, to Norwich										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$22.97	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$100.19	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$100.19	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$59.11	
UOW-CLDS	CLDS	100	100	0	75.43	275.43	No	Yes	$59.11	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$133.22	
UOW-CSDS	CSDS	100	100	0	72.31	272.31	No	Yes	$40.67	
IslandCDF-L_bse	New Haven Breakwaters	100	100	0	70.94	270.94	Yes	Yes	$133.22	
IslandCDF-P_bse	Duck Island Roads	100	47	50	72.76	270.17	Yes	Yes	$120.87	
ShoreCDF-J_bse	Stratford Point	100	100	0	66.72	266.72	Yes	Yes	$133.22	

Table 6-18. Screening Results for Top Ten Ranked Alternative Sites for Naval Submarine Base, New London.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Naval Submarine Base, New London - Suitable										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$30.95	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$38.30	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$117.18	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$117.18	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$133.97	
ShoreCDF-O_bse	Clinton Harbor	100	80	50	69.95	299.75	Yes	Yes	$133.97	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$110.97	
COW-E_bse	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$110.97	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$103.73	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$80.96	
Naval Submarine Base, New London - Unsuitable										
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$120.85	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$120.85	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$138.68	
ShoreCDF-O_bse	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$138.68	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$82.71	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$167.12	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	0	71.25	271.25	Yes	Yes	$167.12	
IslandCDF-L_bse	New Haven Breakwaters	100	100	0	70.94	270.94	Yes	Yes	$167.12	
ShoreCDF-D_bse	Norwalk Outer Harbor Islands - Containment	100	100	0	70.36	270.36	Yes	Yes	$167.12	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	0	68.28	268.28	Yes	Yes	$167.12	

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Naval Submarine Base, New London - Improvement										
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$26.43	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$32.10	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$113.24	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$113.24	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$128.94	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$101.49	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$123.21	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$68.84	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$123.21	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$123.21	

Table 6-19. Screening Results for Top Ten Ranked Alternative Sites for U.S. Coast Guard Station, New London.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$262.10	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$262.10	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$320.20	
UOW-NLDS	NLDS	50	100	100	72.31	322.31	No	Yes	$174.87	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$192.41	
ShoreCDF-O_bse	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$320.20	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$300.67	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$234.25	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$300.67	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$300.67	

Table 6-20. Screening Results for Top Ten Ranked Alternative Sites for U.S. Coast Guard Academy.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$119.85	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$119.85	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$137.39	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$42.20	
UOW-NLDS	NLDS	50	100	100	72.31	322.31	No	Yes	$34.19	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$108.55	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$82.23	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$108.55	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$108.55	
ShoreCDF-O_bse	Clinton Harbor	100	54.41	50	69.95	274.36	Yes	Yes	$137.39	

6.2.5 Niantic Area Dredging Center

The Niantic Dredging Center encompasses the coastal areas of the towns of Waterford, East Lyme, and Old Lyme, Connecticut, from Goshen Point west to Hatchet Point. The area includes the USACE Navigation Project for Niantic Bay and Harbor.

Niantic Bay and Harbor

The only sediment testing on record for the Federal channel shoal materials (1977) showed that material in the 8-ft entrance channel and the lowest reach of the 6-ft upper channel in the harbor is sand (4% to 10% fines). Materials in the 6-foot channel further upstream were 16% to 71% fines. Therefore, the materials from the entrance and upper channels were screened separately (the entrance channel material as sand and the upper channel material as fine-grained). The top 10 ranked alternatives for these project materials are presented in Table 6-21.

6.2.6 Connecticut River Dredging Center

The Connecticut River Area Dredging Center consists of all of the Connecticut towns along the river from Long Island Sound up to Hartford: Old Saybrook, Old Lyme, Lyme, Essex, Deep River, Chester, East Haddam, Haddam, East Hampton, Middletown, Portland, Cromwell, Glastonbury, Rocky Hill, Wethersfield, East Hartford, and Hartford, Connecticut. This dredging center includes the USACE Navigation Projects for the Connecticut River Below Hartford, and its tributary sub-projects, including North Cove (Old Saybrook), Essex Cove Harbor (Essex), Eightmile River and Hamburg Cove (Lyme), Salmon River Cove (Haddam and East Haddam), and Wethersfield Cove (Wethersfield). However, USACE Navigation Projects that use in-river placement of material (such as Salmon River Cove and Wethersfield Cove) are not included in the alternatives screening.

North Cove

Past testing (1975, 1980, 1988, 1999, 2001, and 2008) of material from North Cove has indicated the presence of suitable silt and clay (76% to 100% fines). In the future, the North Cove project is expected to yield suitable fine-grained material of a similar nature. The top 10 ranked alternatives for this project are presented in Table 6-22.

Essex Cove Harbor

Based on past testing results from 1974, future material dredged from the Essex Cove Harbor USACE Navigation Project is expected to be largely fine-grained along the waterfront, becoming sandier to the east in the anchorage. These materials are all expected to remain suitable for unconfined open-water placement or upland placement. The top 10 ranked alternatives for this project are presented in Table 6-23.

Table 6-21. Screening Results for Top Ten Ranked Alternative Sites for Niantic Bay and Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Niantic Bay and Harbor – Entrance Channel										
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$193.24	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$99.37	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$96.10	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$183.34	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$193.24	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$183.34	
Berm-367	Rocky Neck State Park	100	100	50	83.31	333.31	Yes	Yes	$122.78	
Berm-368	Bluff Point State Park	100	100	50	81.61	331.61	Yes	Yes	$135.56	
IslandCDF-N_cap	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$217.49	
Berm-441	Cove Island Beach	100	100	0	87.76	287.76	Yes	Yes	$219.57	
Niantic Bay and Harbor – Upper Channel										
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$205.01	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$189.93	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$205.01	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$189.93	
IslandCDF-N_bse	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$226.03	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$106.03	
UOW-NLDS	NLDS	50	100	100	72.31	322.31	No	Yes	$102.60	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$183.26	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$151.90	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$183.26	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$183.26	

Table 6-22. Screening Results for Top Ten Ranked Alternative Sites for North Cove.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$121.88	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$111.96	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$30.12	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$23.17	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$121.88	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$121.88	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$36.95	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$127.08	
CAD-M_bse	Morris Cove	100	53	50	85.16	288.57	Yes	Yes	$65.80	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$127.72	

Table 6-23. Screening Results for Top Ten Ranked Alternative Sites for Essex Cove.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$149.22	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$126.92	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$149.22	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$126.92	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$149.22	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$100.59	
UOW-NLDS	NLDS	50	100	100	72.31	322.31	No	Yes	$50.63	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$48.07	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$149.41	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$117.95	

Eightmile River

Maintenance dredging material from the Eightmile River project is expected to be fine-grained based on sediment testing conducted in 1977. Future testing of these materials is expected to find them suitable for unconfined open-water placement or upland placement. The top 10 ranked alternatives for this project are presented in Table 6-24.

Connecticut River Below Hartford

In the past, materials in the main river channels have largely been placed upland in areas adjacent to the river, except for those channel reaches from Chester downstream to the river mouth which have on occasion been placed in open water in Long Island Sound. In general, main channel sediments below the lower-most bridges at Old Saybrook and Old Lyme are silty sands, likely due to reduced current velocities as the river estuary opens up before meeting the Sound. Upstream of the lower bridges, the river is largely confined to its channel and deposits more sandy materials in its bed. Two segments of the Connecticut River Below Hartford project were screened for alternatives in this PEIS: 1) River Entrance Bars (At Saybrook) – Saybrook Outer Bar, Saybrook Shoals and Railroad Reach, and 2) Lower River Bars (Above Saybrook to Essex) – Calves Island, Essex Shoal, and Brockway Bars. The top 10 ranked alternatives for these project segments are presented in Table 6-25.

6.2.7 Clinton/Westbrook Area Dredging Center

The Clinton/Westbrook Area Dredging Center consists of the towns of Westbrook and Clinton, and the western shore of the town of Old Saybrook, Connecticut. It includes the USACE Navigation Projects for Patchogue River, Duck Island Harbor of Refuge, and Clinton Harbor. The dredging center stretches from Cornfield Point in the east to Hammonasset Point in the west.

Patchogue River

The latest sampling and testing for the Patchogue River project (2004) showed materials from the entrance channel to be sands and silty sands ranging from zero to 38% fines (average 18%). Sediments from the inner harbor were suitable silts and clays ranging from 68% to 94% fines (average 86%). Therefore, these segments of the project were screened separately. The top 10 ranked alternatives for these project segments are presented in Table 6-26.

Duck Island Harbor of Refuge

There are no current sediment test results for the shoal material at the Duck Island anchorage. The annual report for the 1938 maintenance dredging described the material as “mud and sand.” Local sources report that the shoal material in the refuge anchorage is principally sand. As the entrance channels of nearby harbors yield suitable sandy material, it is expected that Duck Island Harbor dredged materials would be similar. The top 10 ranked alternatives for this project are presented in Table 6-27.

Table 6-24. Screening Results for Top Ten Ranked Alternative Sites for Eightmile River.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$135.33	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$135.33	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$135.33	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$135.33	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$135.33	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$84.64	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$44.33	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$111.09	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$111.09	
LFCap-61	Town of Brookhaven Landfill	100	100	0	77.41	277.41	Yes	Yes	$111.09	

Table 6-25. Screening Results for Top Ten Ranked Alternative Sites for Connecticut River Below Hartford.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Connecticut River Below Hartford – Entrance Bars										
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$120.07	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$111.19	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$27.39	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$14.11	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$111.19	
IslandCDF-R_bse	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$120.07	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$37.93	
CAD-M_bse	Morris Cove	100	53	50	85.16	288.25	Yes	Yes	$66.68	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$119.60	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$119.60	
Connecticut River Below Hartford – Lower Bars										
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$122.07	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$19.14	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$30.41	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$112.05	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$112.05	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$122.07	
IslandCDF-P_cap	Duck Island Roads	100	83	100	72.76	355.99	Yes	Yes	$112.05	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$36.84	
CAD-M_cap	Morris Cove	100	51	50	85.16	286.37	Yes	Yes	$65.70	
COW-E_cap	Sherwood Island Borrow Pit	100	100	0	85.57	285.57	Yes	Yes	$54.55	

Table 6-26. Screening Results for Top Ten Ranked Alternative Sites for Patchogue River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Patchogue River – Entrance Channel										
Beach-345	West Beach	100	100	100	74.14	374.14	Yes	Yes	$59.65	
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$168.68	
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$153.67	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$70.65	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$168.68	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$153.67	
Berm-Grove Beach	Grove Beach	100	73.21	100	75.00	348.21	No	Yes	$59.65	
CAD-M_cap	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$120.81	
Berm-365	Hammonasset State Park	100	100	50	81.28	331.28	Yes	Yes	$89.96	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$92.09	
Patchogue River – Inner Harbor										
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$180.24	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$169.57	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$84.07	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$180.24	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$169.57	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$132.83	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$108.77	
UOW-NLDS	NLDS	100	100	50	72.31	322.31	No	Yes	$108.77	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$200.67	
IslandCDF-R_bse	Groton Black Ledge	100	100	50	67.53	317.53	Yes	Yes	$200.67	

Table 6-27. Screening Results for Top Ten Ranked Alternative Sites for Duck Island Harbor of Refuge.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$14.96	
IslandCDF-N_cap	Falkner Island	100	60.05	100	73.28	333.33	Yes	Yes	$100.63	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$34.41	
UOW-NLDS	NLDS	100	100	50	72.31	322.31	No	Yes	$34.41	
IslandCDF-L_cap	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$120.99	
ShoreCDF-O_cap	Clinton Harbor	100	32.86	100	69.95	302.81	Yes	Yes	$100.63	
IslandCDF-Q_cap	Twotree Island	100	22.27	100	71.51	293.78	Yes	Yes	$116.12	
Berm-Grove Beach	Grove Beach	100	3.22	100	75.00	278.22	No	Yes	$3.71	
Beach-345	West Beach	100	2.93	100	74.14	277.07	Yes	Yes	$4.53	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$40.91	

Clinton Harbor

Maintenance materials dredged from the Clinton Harbor channel at and seaward of Cedar Point are clean sands suitable for direct beach or nearshore bar placement or other uses as determined by sediment testing conducted in 2001 and 2003 (including biological testing). Materials from inner channel reaches are finer sandy material potentially suitable for nearshore bar placement. This determination was based on state sampling and testing of inner channel shoal materials in 2012. Materials from the anchorage, however, are predominantly silt and clay but are suitable for open-water placement in Long Island Sound. The top 10 ranked alternatives for these project materials are presented in Table 6-28.

6.2.8 Guilford/Branford Area Dredging Center

The Guilford-Branford Area Dredging Center consists of the towns of Madison, Guilford, and Branford, Connecticut, and includes the USACE Navigation Project for Guilford Harbor, Stony Creek, and Branford Harbor. The dredging center stretches from Hammonasset Point west to the Farm River on the border between Branford and East Haven.

Guilford Harbor

All materials at the entrance channel and inner harbor are considered fine-grained and suitable for open-water placement based on sediment sampling test results from 2013. The channel bend area (middle segment) materials are typically sand suitable for beach or nearshore bar placement. The top 10 ranked alternatives for these project materials are presented in Table 6-29.

Stony Creek Harbor

All past testing (1975 and 1992) has shown Stony Creek shoal materials to be largely silt and clay(87% to 97% fines) and suitable for open-water placement. The top 10 ranked alternatives for this project are presented in Table 6-30.

Branford Harbor

Past sediment testing (1987) found the material at Branford Harbor to be 87% to 97% fine-grained silt and suitable for open-water placement at the CLDS in Long Island Sound. The top 10 ranked alternatives for this project are presented in Table 6-31.

Table 6-28. Screening Results for Top Ten Ranked Alternative Sites for Clinton Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
Clinton Harbor – Entrance Channel										
CAD-M_cap	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$105.14	
Berm-365	Hammonasset State Park	100	100	100	81.28	381.28	Yes	Yes	$50.43	
Beach-365	Hammonasset State Park	100	100	100	73.83	373.83	Yes	Yes	$50.43	
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$132.93	
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$123.02	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$53.14	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$153.59	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$123.02	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$70.33	
Beach-345	West Beach	100	100	50	74.14	324.14	Yes	Yes	$67.82	
Clinton Harbor – Inner Harbor										
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$109.12	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$138.21	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$128.64	
IslandCDF-Q_bse	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$157.43	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$128.64	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$57.60	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$162.98	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$162.98	
IslandCDF-R_bse	Groton Black Ledge	100	100	50	67.53	317.53	Yes	Yes	$162.98	
LFPlace-59	110 Sand Company	100	100	0	85.27	285.27	Yes	Yes	$127.21	

Table 6-29. Screening Results for Top Ten Ranked Alternative Sites for Guilford Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Guilford Harbor - Middle										
CAD-M_cap	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$81.75	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$40.74	
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$118.85	
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$118.85	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$40.74	
IslandCDF-L_cap	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$128.62	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$118.85	
Berm-365	Hammonasset State Park	100	100	50	81.28	331.28	Yes	Yes	$56.73	
IslandCDF-Q_cap	Twotree Island	100	100	50	71.51	321.51	Yes	Yes	$136.11	
ShoreCDF-J_cap	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$136.11	
Guilford Harbor – Entrance and Inner										
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$169.84	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$121.86	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$205.58	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$205.58	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$121.86	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$232.98	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$205.58	
IslandCDF-Q_bse	Twotree Island	100	100	50	71.51	321.51	Yes	Yes	$246.31	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$246.31	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$246.31	

Table 6-30. Screening Results for Top Ten Ranked Alternative Sites for Stony Creek Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$81.50	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$39.95	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$118.31	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$127.26	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$118.31	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$127.26	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$127.26	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$44.97	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$135.42	
ShoreCDF-O_bse	Clinton Harbor	100	45	100	69.95	315.05	Yes	Yes	$127.26	

Table 6-31. Screening Results for Top Ten Ranked Alternative Sites for Branford Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$71.29	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$27.20	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$113.87	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$124.73	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$113.87	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$124.73	
ShoreCDF-K_bse	Milford Harbor	100	76	100	67.68	343.44	Yes	Yes	$124.73	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	68	100	71.25	339.68	Yes	Yes	$124.73	
COW-E_cap	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$38.72	
COW-E_bse	Sherwood Island Borrow Pit	100	92	50	85.57	327.55	Yes	Yes	$38.72	

6.2.9 New Haven Area Dredging Center

The New Haven Dredging Center consists of the city of New Haven and the Towns of East Haven and West Haven, Connecticut, and encompasses a single USACE Navigation Project – New Haven Harbor. New Haven is Connecticut's largest port, with a full mix of navigation and marine trades from commercial/industrial shipping to fishing and recreational boating. The dredged features of the New Haven Harbor project can be divided into four sub-projects: the main deep-draft channels and upper harbor anchorage and maneuvering area, and the Mill River, Quinnipiac River, and West River tributaries. The harbor also includes the U.S. Coast Guard Sector Long Island Sound.

New Haven Harbor

New Haven Harbor is one of the most extensively tested harbors in New England, with sediment sampling and testing undertaken 10 times since 1970, with the most recent testing completed in 2010. Overall, dredged materials from the maintenance of the main deep-draft project features of the New Haven Harbor project are fine-grained (silty) materials, suitable for open-water placement at the CLDS. The material is expected to be similar for both maintenance and improvement dredging activities, which were screened separately. The top 10 ranked alternatives for this project are presented in Table 6-32.

West River

The latest testing (1986) for proposed maintenance dredging showed that the shoal material consisted of predominantly silt and clay, averaging 89% fines, and was deemed suitable for placement at the CLDS. The top 10 ranked alternatives for this project are presented in Table 6-33.

Mill River

Based on sediment testing in 1980, any future dredging of the Mill River project would likely encounter silty material. Further chemical and biological testing would need to be conducted at that time to determine suitability for various placement alternatives. There is some risk that Mill River shoal materials, if subjected to today's testing protocols and evaluation procedures, would be found unsuitable for unconfined open-water placement. These materials will therefore be treated as unsuitable fine-grained materials for DMMP purposes. The top 10 ranked alternatives for this project are presented in Table 6-34.

Quinnipiac River

Any future dredging of the Quinnipiac River project features would likely encounter silty material (sediment testing conducted in 1980). Further chemical and biological testing would need to be conducted at that time to determine suitability for various placement alternatives. There is some risk that Quinnipiac River shoal materials, if subjected to today's testing protocols and evaluation procedures, would be found unsuitable for unconfined open-water placement. These materials will therefore be treated as unsuitable fine-grained materials for DMMP purposes. The top 10 ranked alternatives for this project are presented in Table 6-35.

Table 6-32. Screening Results for Top Ten Ranked Alternative Sites for New Haven Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
New Haven Harbor - Maintenance										
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$16.86	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$117.38	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$87.94	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$117.38	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$117.38	
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$34.92	
CAD-M_bse	Morris Cove	100	18	100	85.16	302.82	Yes	Yes	$64.28	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	8	100	71.25	278.75	Yes	Yes	$117.38	
ShoreCDF-K_bse	Milford Harbor	100	8	100	67.68	275.98	Yes	Yes	$105.65	
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$44.92	
New Haven Harbor - Improvement										
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$11.33	1
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$90.89	1
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$65.61	1
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$90.89	1
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$90.89	1
UOW-CSDS	CSDS	100	100	50	72.31	322.31	No	Yes	$26.75	1
CAD-M_bse	Morris Cove	100	9	100	85.16	294.30	Yes	Yes	$49.19	1
UOW-WLDS	WLDS	100	100	0	75.43	275.43	No	Yes	$31.80	1
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	4	100	71.25	275.13	Yes	Yes	$90.89	1
UOW-NLDS	NLDS	100	100	0	72.31	272.31	No	Yes	$31.80	1

1 = The dredging volume for this project exceeded the volumes used in the USACE cost matrix (Appendix D). Therefore, the largest volume available in the cost matrix was used to estimate costs for this project.

Table 6-33. Screening Results for Top Ten Ranked Alternative Sites for West River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$75.02	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$28.36	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$125.97	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$114.84	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$125.97	
ShoreCDF-K_bse	Milford Harbor	100	96.39	100	67.68	364.07	Yes	Yes	$114.84	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$125.97	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	87.07	100	71.25	358.32	Yes	Yes	$125.97	
COW-E_bse	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$40.15	
COW-E_cap	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$40.15	

Table 6-34. Screening Results for Top Ten Ranked Alternative Sites for Mill River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$66.59	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$120.24	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$111.27	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	98.21	100	71.25	369.46	Yes	Yes	$120.24	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$111.27	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$120.24	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$125.79	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$125.79	
ShoreCDF-O_bse	Clinton Harbor	100	29.70	100	69.95	299.65	Yes	Yes	$120.24	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$145.71	

Table 6-35. Screening Results for Top Ten Ranked Alternative Sites for Quinnipiac River.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$66.59	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$120.24	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$111.27	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$120.24	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$120.24	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	91.16	100	71.25	362.41	Yes	Yes	$120.24	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$125.79	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$125.79	
ShoreCDF-O_bse	Clinton Harbor	100	27.57	100	69.95	297.52	Yes	Yes	$120.24	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$145.71	

U.S. Coast Guard Sector Long Island Sound

Sediment sampling and testing (1998) showed the materials to be sand to sandy silts ranging from 5% to 62% fines (40% on average). Previously dredged material has been fine-grained material, largely suitable for the same potential placement and uses as material from the New Haven Harbor project. The top 10 ranked alternatives for this project are presented in Table 6-36.

6.2.10 Housatonic River/Milford Area Dredging Center

The Housatonic River/Milford Area Dredging Center consists of the town of Milford, a portion of the town of Stratford, and the Housatonic River from Long Island Sound through the towns of Orange and Shelton to the head of navigation at Derby, Connecticut. The dredging center includes the USACE Navigation Project for Milford Harbor, in the town of Milford, and the Housatonic River. The dredging center stretches from Pond Point in Milford in the east to Stratford Point in the west.

Milford Harbor

Based on past sediment testing results, with 2003 being the most recent time Milford Harbor was sampled, it is expected that future dredged material from the entrance channel will be sand suitable for beach or nearshore bar placement and that material from the inner harbor will be more silty. The top 10 ranked alternatives for this project are presented in Table 6-37.

Housatonic River

The project for the Housatonic River consists of two segments: an 18-ft MLLW lower channel from Long Island Sound upriver to a point just below Popes Island in Stratford, and a 7-ft MLLW channel from that point up to Derby just below the Connecticut Route 8 bridge. Each of these segments was screened separately in this PEIS.

Housatonic River downstream of Popes Island

Past sediment testing (1999) found material from throughout the 18-ft channel to be sand ranging from <1% to 21% fines. It is expected that future testing will show sand suitable for beach or nearshore bar placement in the entire 18-ft lower channel, with perhaps all but the uppermost reach materials along lower Popes Island suitable for direct beach placement. The top 10 ranked alternatives for this project segment are presented in Table 6-38.

Housatonic River upstream of Popes Island

There are no sediment test results on file for the 7-ft Federal channel above Popes Island. Sections of the river between Popes Island and Naugatuck/Shelton have been mined in the past for sand and gravel. It is expected that shoal material in the upper river bars will be mixed sand and silty sand, similar to the material found at the head of the 18-ft channel at Popes Island, and may vary by bar. The top 10 ranked alternatives for this project segment are presented in Table 6-38.

Table 6-36. Screening Results for Top Ten Ranked Alternative Sites for U.S. Coast Guard Sector Long Island Sound.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$107.58	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$155.72	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$155.72	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$135.86	
ShoreCDF-O_bse	Clinton Harbor	100	99.75	100	69.95	369.70	Yes	Yes	$155.72	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$135.86	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$155.72	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$155.72	
UOW-CLDS	CLDS	50	100	100	75.43	325.43	No	Yes	$55.61	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$160.15	

Table 6-37. Screening Results for Top Ten Ranked Alternative Sites for Milford Harbor.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Milford Harbor – Entrance Channel and Outer Anchorage										
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$54.80	
CAD-M_cap	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$104.27	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$52.18	
Beach-364	Silver Sands State Park (FSPP)	100	100	100	73.83	373.83	Yes	Yes	$49.39	
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$152.76	
ShoreCDF-I_cap	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$131.80	
IslandCDF-L_cap	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$131.80	
ShoreCDF-J_cap	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$131.80	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$152.76	
ShoreCDF-K_cap	Milford Harbor	100	76.79	100	67.68	344.47	Yes	Yes	$121.81	
Milford Harbor – Inner Channels and Anchorages										
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$44.46	
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$44.46	
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$85.01	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$36.97	
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$135.64	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$121.49	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$121.49	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$106.80	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$121.49	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$135.64	

Table 6-38. Screening Results for Top Ten Ranked Alternative Sites for Housatonic River.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
Housatonic River downstream of Popes Island										
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$27.77	
IslandCDF-L_cap	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$111.30	
ShoreCDF-J_cap	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$111.30	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$111.30	
UOW-WLDS	WLDS	100	100	50	75.43	325.43	No	Yes	$37.79	
COW-E_cap	Sherwood Island Borrow Pit	100	39	100	85.57	324.70	Yes	Yes	$27.77	
IslandCDF-N_cap	Falkner Island	100	95	50	73.28	317.84	Yes	Yes	$125.85	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	30	100	66.90	297.30	Yes	Yes	$120.32	
CAD-M_cap	Morris Cove	100	12	100	85.16	296.79	Yes	Yes	$66.56	
Beach-450	Short Beach	100	18	100	74.14	292.07	Yes	Yes	$18.68	
Housatonic River upstream of Popes Island										
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$31.80	
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$31.80	
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$67.20	
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$31.80	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$112.81	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$123.37	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	97	100	71.25	368.31	Yes	Yes	$112.81	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$112.81	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$123.37	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$112.81	

6.2.11 Bridgeport Area Dredging Center

The Bridgeport Area Dredging Center consists of the towns of Stratford (western part), Bridgeport, and Fairfield, Connecticut, and includes the USACE Navigation Projects for Bridgeport Harbor, Black Rock Harbor, and Southport Harbor. The dredging center stretches from Stratford Point, west to Sasco Brook (the Fairfield/Westport boundary).

Bridgeport Harbor

The USACE Navigation Project for Bridgeport Harbor consists of the following sub-projects:

- Bridgeport Main Harbor
- Pequonnock River
- Yellow Mill Channel
- Johnsons River

The Bridgeport Harbor project and associated sub-projects of Pequonnock River and Yellow Mill Channel are the subject of a separate DMMP currently being finalized by the USACE, which will be summarized in the regional DMMP (USACE, 2012c). The base plan for these projects has already been defined, and they were not included as part of the alternative site screening for the Long Island Sound PEIS.

Johnsons Creek

The last sediment sampling (1973) found sediments to be primarily gray or black organic silt (64% to 93% fines) and to contain moderately high to high concentrations of metals and volatile solids. The top 10 ranked alternatives for this project are presented in Table 6-39.

Black Rock Harbor

Sediment sampling and testing conducted prior to 1980 indicated that sediments at Black Rock Harbor are fine-grained silts, which is the material type likely to be found in the future. Its suitability for open-water or other placement options will need to be demonstrated by further sampling and testing. For the purposes of this PEIS, it is assumed that the bulk of that material will be found suitable for open-water placement, although capping in conformance with the State of Connecticut's CWA protocols would likely be required. The top 10 ranked alternatives for this project are presented in Table 6-40.

Southport Harbor

In 1997 and 1998, entrance channel materials were shown to average about 7% fines (range of 2% to 14%), while materials from the inner harbor averaged 59% fines (range of 4% to 95%). Material from both project areas was suitable for open-water placement. The top 10 ranked alternatives for these project materials are presented in Table 6-41.

Table 6-39. Screening Results for Top Ten Ranked Alternative Sites for Johnsons Creek.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
CAD-M_bse	Morris Cove	100	100	100	85.16	385.16	Yes	Yes	$78.92	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$98.60	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$125.83	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$125.83	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$116.17	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$125.83	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$98.60	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$116.17	
IslandCDF-N_bse	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$132.71	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	50	68.28	318.28	Yes	Yes	$132.71	

Table 6-40. Screening Results for Top Ten Ranked Alternative Sites for Black Rock Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
UOW-CLDS	CLDS	100	100	100	75.43	375.43	No	Yes	$27.44	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$27.44	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$119.09	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$110.55	
COW-E_cap	Sherwood Island Borrow Pit	100	78	100	85.57	363.70	Yes	Yes	$18.05	
CAD-M_bse	Morris Cove	100	75	100	85.16	360.40	Yes	Yes	$66.60	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$88.29	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	89	100	66.90	356.32	Yes	Yes	$119.09	
COW-E_bse	Sherwood Island Borrow Pit	100	43	100	85.57	328.51	Yes	Yes	$18.05	
IslandCDF-N_bse	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$125.04	

Table 6-41. Screening Results for Top Ten Ranked Alternative Sites for Southport Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
Southport Harbor – Entrance Channel										
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$61.37	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$66.11	
Beach-433	Southport Beach (FSPP)	100	100	100	74.14	374.14	Yes	Yes	$52.51	
ShoreCDF-I_cap	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$145.01	
IslandCDF-L_cap	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$162.38	
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$145.01	
ShoreCDF-K_cap	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$162.38	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$145.01	
ShoreCDF-J_cap	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$145.01	
Berm-433	Southport Beach	100	78	100	82.92	360.46	Yes	Yes	$52.51	
Southport Harbor – Inner Harbor										
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$51.38	
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$51.38	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$54.80	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$131.80	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$152.76	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$131.80	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$152.76	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$131.80	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$131.80	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$131.80	

6.2.12 Norwalk Area Dredging Center

The Norwalk Area Dredging Center consists of the towns of Westport, Norwalk, and part of the Town of Darien, Connecticut, and includes the USACE Navigation Projects for Westport Harbor and Saugatuck River, Norwalk Harbor, Wilsons Point Harbor, and Fivemile River. The dredging center stretches from the Fairfield/Westport boundary in the east to Long Neck Point in Darien in the west.

Westport Harbor

Previous sediment sampling and testing (2003/2004) indicated suitable material that ranged from 16% to 84% fines with an average of 37%. The top 10 ranked alternatives for this project are presented in Table 6-42.

Norwalk Harbor

The long history of sediment analysis (1972, 1975, 1978, 1979, 1998, and 2000) for the Norwalk Harbor project has found nearly all materials suitable for open-water placement in Long Island Sound, with some management (capping) required by CTDEEP under its CWA authority. A small area of the West Branch Channel immediately upstream and downstream of the Interstate 95 Bridge has been found unsuitable for unconfined open-water placement; this material was screened separately in this PEIS. The top 10 ranked alternatives for these project materials are presented in Table 6-43.

Wilsons Point

Wilson Point Harbor has not been dredged since its initial improvement in 1889 to 1892. Material encountered in the 1892 work was described as mud and sand. No sediment sampling and testing has been done since that time. A 2013 suitability determination for a non-Federal dredging applicant found the sediments suitable for unconfined open-water placement. Therefore, the Wilsons Point material is expected to be silty/clayey material and likely suitable for unconfined open-water placement in Long Island Sound. The top 10 ranked alternatives for this project are presented in Table 6-44.

Fivemile River

Testing of sediment at Fivemile River conducted in 1995 indicated that the material from the Federal channel and anchorage was predominantly silt and clay ranging from 36% to 96% fines. Maintenance materials dredged from the project in the future are most likely to be fine-grained shoal materials suitable for unconfined open-water placement in Long Island Sound. The top 10 ranked alternatives for this project are presented in Table 6-45.

Table 6-42. Screening Results for Top Ten Ranked Alternative Sites for Westport Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$30.76	
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$30.76	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$43.44	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$133.27	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$120.70	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$133.27	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$133.27	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$120.70	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$133.27	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$120.70	

Table 6-43. Screening Results for Top Ten Ranked Alternative Sites for Norwalk Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Norwalk Harbor - Suitable										
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$25.84	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$123.29	
COW-E_cap	Sherwood Island Borrow Pit	100	77	100	85.57	362.76	Yes	Yes	$21.37	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$112.75	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	88	100	66.90	355.26	Yes	Yes	$93.58	
IslandCDF-B_bse	Greenwich Captain Harbor	100	79	100	68.28	347.73	Yes	Yes	$123.29	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$76.57	
COW-E_bse	Sherwood Island Borrow Pit	100	42	100	85.57	327.99	Yes	Yes	$21.37	
UOW-CLDS	CLDS	100	100	50	75.43	325.43	No	Yes	$37.08	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$128.31	
Norwalk Harbor – West Branch I-95 Area - Unsuitable										
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$155.72	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$126.13	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$155.72	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$126.13	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$155.72	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$135.86	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$107.35	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$160.15	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$160.15	
ShoreCDF-A_bse	Hempstead Harbor	100	100	50	67.58	317.58	Yes	Yes	$160.15	

Table 6-44. Screening Results for Top Ten Ranked Alternative Sites for Wilsons Point.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$119.09	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$119.09	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$119.09	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	90	100	66.90	356.41	Yes	Yes	$88.29	
IslandCDF-B_bse	Greenwich Captain Harbor	100	80	100	68.28	348.77	Yes	Yes	$119.09	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$98.68	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$18.05	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$125.04	
COW-E_cap	Sherwood Island Borrow Pit	50	78	100	85.57	313.77	Yes	Yes	$18.05	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	39	100	70.36	309.55	Yes	Yes	$88.29	

Table 6-45. Screening Results for Top Ten Ranked Alternative Sites for Fivemile River.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$34.10	
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$34.10	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$34.10	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$130.95	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$119.78	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$130.95	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$130.95	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$104.09	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$130.95	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$130.95	

6.2.13 Stamford Area Dredging Center

The Stamford Area Dredging Center consists of the cities of Stamford and portions of the towns of Darien and Greenwich, Connecticut. The dredging center includes the USACE Navigation Projects for Westcott Cove and Stamford Harbor, both in the City of Stamford. The dredging center stretches from Long Point in Darien in the east to Greenwich Point in the west.

Westcott Cove

Westcott Cove has produced, and will likely continue to produce, shoal materials of both silty and sandy materials. This determination is based off of sediment testing from 1975 and 1977, as well as the placement history of Westcott Cove's dredged material. Whether material will be located within the channel so as to enable separate dredging and placement methods during a particular maintenance operation will only be determined during the planning for that action. The top 10 ranked alternatives for this project are presented in Table 6-46.

Stamford Harbor

The three segments of the Stanford Harbor project are characterized individually for planning purposes: the 18-ft MLW Entrance Channel and outer anchorage, the 15-ft Main and West Branch Channels, and the 12-ft East Branch Channel. Considering past sediment testing (1975 and 1976) and the placement history of dredged material from Stamford Harbor, future maintenance of the harbor is expected to generate fine-grained materials largely suitable for unconfined open-water placement. However, the most recent sediment testing results (1971) for the East Branch Channel above the hurricane barrier indicated abnormally high values for all chemical parameters tested. Therefore, future chemical and biological testing would need to be conducted to determine the suitability of this material for various placement alternatives. The sediment from the East Branch Channel was treated as unsuitable fine-grained materials for the purposes of this screening and was screened separately from the material from the 18-ft and 15-ft channels. The top 10 ranked alternatives for these project materials are presented in Table 6-47.

6.2.14 Greenwich Area Dredging Center

The Greenwich Area Dredging Center consists of most of the shore areas of the town of Greenwich, Connecticut, and includes the USACE Navigation Projects for the Mianus River and Greenwich Harbor. The dredging center stretches from Greenwich Point in the east westward to Byram Point on the east side of the entrance to Port Chester Harbor and the Byram River, the boundary between Connecticut and New York.

Mianus River

The Mianus River sediments have been consistently fine-grained (average >78% fines) and were found to be suitable for unconfined open-water placement in 2005. The top 10 ranked alternatives for this project are presented in Table 6-48.

Table 6-46. Screening Results for Top Ten Ranked Alternative Sites for Westcott Cove.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Westcott Cove - Sand										
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$46.53	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$38.73	
Beach-442	Cummings Park Beaches	100	100	100	74.53	374.53	Yes	Yes	$32.88	
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$123.18	
Berm-441	Cove Island Beach	100	82.20	100	87.76	369.96	Yes	Yes	$38.49	
IslandCDF-B_cap	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$123.18	
ShoreCDF-A_cap	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$140.87	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$123.18	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$140.87	
Beach-441	Cove Island Beach	100	79.01	100	74.14	353.15	Yes	Yes	$38.49	
Westcott Cove - Fines										
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$123.16	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$123.16	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$140.81	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$123.16	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$140.81	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$46.51	
COW-E_bse	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$46.51	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$78.64	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$38.66	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$143.14	

Table 6-47. Screening Results for Top Ten Ranked Alternative Sites for Stamford Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
Stamford Harbor – Outer 18-Foot Channel & Anchorage and 15-Foot Upper Main & West Channel										
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$111.05	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$119.72	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$111.05	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$119.72	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$92.19	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.16	Yes	Yes	$26.87	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$13.25	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	50	100	70.36	320.27	Yes	Yes	$111.05	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$125.38	
COW-E_bse	Sherwood Island Borrow Pit	50	55	100	85.57	290.30	Yes	Yes	$26.87	
Stamford Harbor – 12-Foot East Branch Channel										
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$113.87	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$113.87	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$124.72	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$113.87	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$124.72	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$129.75	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$129.75	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$129.75	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$71.27	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$160.64	

Table 6-48. Screening Results for Top Ten Ranked Alternative Sites for Mianus River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$39.24	
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$39.24	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$31.73	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$117.82	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$117.82	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$126.02	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$117.82	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$126.02	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$104.88	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$134.79	

Greenwich Harbor

Past sediment testing results show that harbor sediment consisted mainly of silt and clay overlain by slightly sandy (fine to medium sand) and organic material. A 2014 suitability determination found that all shoal sediments in the inner harbor, and from all but the lower reach of the entrance channel, are unsuitable for unconfined open-water placement in Long Island Sound. The shoal sediments from the outer harbor end of the channel are suitable for unconfined open-water placement. For the purposes of the DMMP, it is assumed that the split between suitable and unsuitable materials in the channel is 50/50. The top 10 ranked alternatives for these project materials are presented in Table 6-49.

6.2.15 Port Chester-Rye Area Dredging Center

The Port Chester-Rye Area Dredging Center consists of most of the shore areas of the municipalities of Port Chester and Rye, New York, from Byram Point on the Connecticut state line to Hen Island east of Mamaroneck Harbor. The area includes the USACE Navigation Projects for Port Chester Harbor and Byram River, and Milton Harbor.

Port Chester Harbor

Sediment samples taken in 1994 from Port Chester Harbor ranged from sand and gravel in the lower project reaches to silty material in the upper areas. Current testing indicates that the majority of the material from this USACE Navigation Project is unsuitable for unconfined open-water placement in Long Island Sound. Testing prior to each dredging operation would be needed to confirm suitability for alternative placement. The top 10 ranked alternatives for this project are presented in Table 6-50.

Milton Harbor

The most recent testing of Milton Harbor’s sediments (1992) revealed that the majority of the material was silt (average 66.1%) with some clay (23.5%) and sand (10.4%). The material from Milton Harbor has been found in the past to be suitable for unconfined open-water placement. Testing prior to each dredging operation would be needed to confirm suitability for alternative placement. The top 10 ranked alternatives for this project are presented in Table 6-51.

6.2.16 Mamaroneck-New Rochelle Area Dredging Center

The Mamaroneck-New Rochelle Area Dredging Center consists of most of the shore areas of the municipalities of Mamaroneck, Larchmont, New Rochelle, and Pelham Manor, New York (all in Westchester County), and the Pelham Bay shore area of Bronx County southwest to the City Island causeway bridge. The area includes the USACE Navigation Projects for Mamaroneck Harbor, Larchmont Harbor, Echo Bay, and New Rochelle. The project for Larchmont Harbor consists solely of a rubblestone breakwater and does not include any dredged features.

Table 6-49. Screening Results for Top Ten Ranked Alternative Sites for Greenwich Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Greenwich Harbor – Entrance Channel - Suitable										
COW-E_bse	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$44.36	
COW-E_cap	Sherwood Island Borrow Pit	100	100	100	85.57	385.57	Yes	Yes	$44.36	
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$36.78	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$135.40	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$106.65	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$135.40	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$135.40	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$76.41	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$139.77	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$139.77	
Greenwich Harbor – Entrance Channel, Inner Channel and Anchorages										
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$94.37	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$124.07	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$124.07	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	72	100	70.36	342.36	Yes	Yes	$124.07	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$129.10	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$129.10	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$69.32	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	59	50	71.25	279.99	Yes	Yes	$129.10	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$159.25	
IslandCDF-P_bse	Duck Island Roads	100	100	0	72.76	272.76	Yes	Yes	$159.25	

Table 6-50. Screening Results for Top Ten Ranked Alternative Sites for Port Chester Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socio-economic	Unit Cost ($/CY)	Qualifier
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$94.04	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$123.74	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$123.74	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	66	100	70.36	336.64	Yes	Yes	$123.74	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$128.77	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$128.77	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$68.33	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	54	50	71.25	275.32	Yes	Yes	$128.77	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$158.55	
IslandCDF-P_bse	Duck Island Roads	100	100	0	72.76	272.76	Yes	Yes	$158.55	

Table 6-51. Screening Results for Top Ten Ranked Alternative Sites for Milton Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socio-economic	Unit Cost ($/CY)	Qualifier
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$125.68	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$117.68	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$117.68	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$125.68	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$86.75	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$39.04	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$134.62	
COW-E_cap	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$44.05	
COW-E_bse	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$44.05	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$81.20	

Mamaroneck Harbor

Sediment samples most recently taken from the Mamaroneck Harbor (1998) were mostly silt and clay, ranging from 36% to 53% silt and from 30% to 53% clay (overall range of 43% to 94% fines). Dredged material from this harbor is expected to be suitable fine-grained material in the future. The top 10 ranked alternatives for this project are presented in Table 6-52.

Echo Bay

Sediment testing conducted in 2008 showed the material in Echo Bay to be silty sand and clay with about 40% fines. Testing for one non-Federal permit project found that material suitable for unconfined open-water placement in Long Island Sound. Dredged material from this harbor is expected to be suitable fine-grained material in the future. The top 10 ranked alternatives for this project are presented in Table 6-53.

New Rochelle Harbor

USACE NAE dredging permit records show that material from three non-Federal dredging projects carried out in New Rochelle Harbor was placed at either CLDS or WLDS. Dredged material from this harbor is expected to be suitable fine-grained material in the future. The top 10 ranked alternatives for this project are presented in Table 6-54.

6.2.17 Eastchester Bay Area Dredging Center

The Eastchester Bay Area Dredging Center consists of most of the shore areas of the Bronx Borough of New York City (Bronx County) east of the Throgs Neck Bridge to the east side of City Island. It also includes all of the islands within Bronx County in Long Island Sound. The area includes the USACE Navigation Project for Eastchester Creek.

Eastchester Creek

Sediment samples analyzed in 2009 showed that the majority of sediments in Eastchester Creek were silt (12% to 74%) and clay (4.3% to 34%). Isolated areas of predominantly gravel samples were collected (3.6% to 84.8%) as well. This material was deemed unsuitable for placement at HARS in 2009. Unsuitable material is expected from future maintenance activities at least in the near term. For the purposes of the DMMP, it will be assumed that the next maintenance operation will yield unsuitable material, and that subsequent operations in future years will yield suitable fine material. The top 10 ranked alternatives for these project materials are presented in Table 6-55.

Table 6-52. Screening Results for Top Ten Ranked Alternative Sites for Mamaroneck Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$125.73	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$117.70	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$117.70	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$125.73	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$86.69	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$39.06	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$134.64	
COW-E_cap	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$44.08	
COW-E_bse	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$44.08	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$81.21	

Table 6-53. Screening Results for Top Ten Ranked Alternative Sites for Echo Bay.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$119.14	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$119.14	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$41.17	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	50	70.36	320.36	Yes	Yes	$136.48	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	50	66.90	316.90	Yes	Yes	$136.48	
BF-422/423	Flushing Airport Wetlands/Flushing Airport Uplands	50	100	100	62.03	312.03	Yes	Yes	$79.20	
COW-E_bse	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$46.19	
COW-E_cap	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$46.19	
LFPlace-59	110 Sand Company	50	100	50	85.27	285.27	Yes	Yes	$81.66	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$81.89	

Table 6-54. Screening Results for Top Ten Ranked Alternative Sites for New Rochelle Harbor.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$36.62	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$125.30	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$116.55	
COW-E_cap	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$42.50	
COW-E_bse	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$42.50	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$88.05	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	50	70.36	320.36	Yes	Yes	$133.19	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	50	66.90	316.90	Yes	Yes	$133.19	
BF-422/423	Flushing Airport Wetlands/Uplands	50	100	100	62.03	312.03	Yes	Yes	$76.33	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$79.69	

Table 6-55. Screening Results for Top Ten Ranked Alternative Sites for Eastchester Creek.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Eastchester Creek - Suitable										
UOW-WLDS	WLDS	100	100	100	75.43	375.43	No	Yes	$33.34	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$126.10	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$114.94	
BF-422/423	Flushing Airport Wetlands/Uplands	100	100	100	62.03	362.03	Yes	Yes	$73.85	
COW-E_bse	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$40.30	
COW-E_cap	Sherwood Island Borrow Pit	100	100	50	85.57	335.57	Yes	Yes	$40.30	
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$85.15	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	50	70.36	320.36	Yes	Yes	$131.14	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	50	66.90	316.90	Yes	Yes	$131.14	
Habitat-429	Jamaica Bay Marsh Islands	100	100	50	61.33	311.33	Yes	Yes	$85.15	
Eastchester Creek - Unsuitable										
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$121.97	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$112.00	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	50	66.90	316.90	Yes	Yes	$127.15	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	84.73	50	70.36	305.09	Yes	Yes	$127.15	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$65.75	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$153.07	
IslandCDF-P_bse	Duck Island Roads	100	100	0	72.76	272.76	Yes	Yes	$153.07	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$153.07	
IslandCDF-L_bse	New Haven Breakwaters	100	100	0	70.94	270.94	Yes	Yes	$153.07	
IslandCDF-R_bse	Groton Black Ledge	100	100	0	67.53	267.53	Yes	Yes	$153.07	

6.2.18 Manhasset and Little Necks Bays Area Dredging Center

The Manhasset and Little Neck Bays Area Dredging Center consists of most of the shore areas of the Queens Borough of New York City (Queens County) east of the Throgs Neck Bridge, and the shore of Western Nassau County east to Sands Point on Manhasset Neck. In Nassau County, the dredging center includes all or portions of the township of Hempstead and the villages of Kings Point, Great Neck, Manhasset, Plandome, Port Washington, Manorhaven, and Sands Point. The area includes the USACE Navigation Project for Little Neck Bay. Another USACE Navigation Project for Manhasset Bay was never constructed and later deauthorized. The dredging center also includes the U.S. Merchant Marine Academy on Kings Point.

Little Neck Bay

Sediment type and chemistry information is not available for the USACE Navigation Project at Little Neck Bay. However, records of recent permitting actions from non-Federal dredging projects proximal to the Little Neck Bay project have demonstrated suitability for upland placement. The assumption for the purposes of the DMMP is that maintenance of the Little Neck Bay project is expected to yield a mixed sandy and fine-grained dredged material. The material is expected to be suitable for open-water placement. The top 10 ranked alternatives for this project are presented in Table 6-56.

Yocum Sailing Center, U.S. Merchant Marine Academy

There are no sediment testing data available for the U.S. Merchant Marine Academy, so the sediment suitability for this project was screened as “unknown” for all alternative types. The top 10 ranked alternatives for this project are presented in Table 6-57.

6.2.19 Hempstead Harbor Area Dredging Center

The Hempstead Harbor Area Dredging Center consists of the Long Island shoreline in the Townships of North Hempstead and Oyster Bay in Nassau County, from Sands Point on Manhasset Neck in the west, to Matinecock Point (East Island) in the east. It includes the east shores of the villages of Sands Point and Port Washington, as well as the shore areas of Roslyn, Roslyn Harbor, Glenwood, Sea Cliff, and Glen Cove. The area includes the USACE Navigation Projects for Hempstead Harbor, Glen Cove Harbor (breakwater only – no dredged features), and Glen Cove Creek.

Hempstead Harbor

There is no recent shoal sediment test data available for this project. Grain size analysis from 1982 showed that harbor sediments were mostly sand (78.6%) with silt (16.7%) and clay (5.1%). Sediment suitability for this project was screened as a mixture of sandy and fine-grained dredged material, with unknown suitability for unconfined open-water placement. The top 10 ranked alternatives for this project are presented in Table 6-58.

Table 6-56. Screening Results for Top Ten Ranked Alternative Sites for Little Neck Bay.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$110.77	
LFPlace-59	110 Sand Company	100	89.73	50	85.27	325.00	Yes	Yes	$79.54	
IslandCDF-B_bse	Greenwich Captain Harbor	100	44.70	100	68.28	312.98	Yes	Yes	$119.34	
LFCap-251	Manchester Landfill	100	100	0	77.41	277.41	Yes	Yes	$120.84	
UOW-WLDS	WLDS	50	100	50	75.43	275.43	No	Yes	$38.25	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$142.97	
IslandCDF-P_bse	Duck Island Roads	100	100	0	72.76	272.76	Yes	Yes	$142.97	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$142.97	
IslandCDF-L_bse	New Haven Breakwaters	100	100	0	70.94	270.94	Yes	Yes	$142.97	
IslandCDF-R_bse	Groton Black Ledge	100	100	0	67.53	267.53	Yes	Yes	$142.97	

Table 6-57. Screening Results for Top Ten Ranked Alternative Sites for U.S. Merchant Marine Academy.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$46.84	
IslandCDF-B_cap	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$141.63	
IslandCDF-B_bse	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$141.63	
ShoreCDF-A_bse	Hempstead Harbor	50	100	100	67.58	317.58	Yes	Yes	$123.42	
ShoreCDF-A_cap	Hempstead Harbor	50	100	100	67.58	317.58	Yes	Yes	$123.42	
BF-422/423	Flushing Airport Wetlands/Uplands	50	100	100	62.03	312.03	Yes	Yes	$74.55	
COW-E_bse	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$56.31	
COW-E_cap	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$56.31	
LFPlace-59	110 Sand Company	50	100	50	85.27	285.27	Yes	Yes	$74.55	
Beach-181	Orchard Beach	50	100	50	74.14	274.14	Yes	Yes	$54.38	

Table 6-58. Screening Results for Top Ten Ranked Alternative Sites for Hempstead Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
LFPlace-59	110 Sand Company	100	100	50	85.27	335.27	Yes	Yes	$66.91	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$31.97	
IslandCDF-B_bse	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$123.67	
IslandCDF-B_cap	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$123.67	
ShoreCDF-A_cap	Hempstead Harbor	50	100	100	67.58	317.58	Yes	Yes	$93.96	
ShoreCDF-A_bse	Hempstead Harbor	50	100	100	67.58	317.58	Yes	Yes	$93.96	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	50	100	100	66.90	316.90	Yes	Yes	$123.67	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	50	100	100	66.90	316.90	Yes	Yes	$123.67	
COW-E_bse	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$37.51	
COW-E_cap	Sherwood Island Borrow Pit	50	100	50	85.57	285.57	Yes	Yes	$37.51	

Glen Cove Creek

Sediment samples analyzed in 1996 showed that Glen Cove Creek consisted mainly of silt and clay (4% to 99% fines) with a few core samples that showed a higher sand content (2% to 88% sand). In 2002, significant thorium contamination was determined to be present in the creek sediments. The work site was immediately secured by the USACE and EPA and converted to a Superfund cleanup site. The cleanup project was completed in March 2007 with the removal of an estimated 28,800 CY of dredged material from the creek. Future material from this project is not anticipated to be found suitable for unconfined open-water placement or beneficial use. The top 10 ranked alternatives for this project are presented in Table 6-59.

6.2.20 Oyster Bay-Cold Spring Harbor Area Dredging Center

The Oyster Bay-Cold Spring Harbor Area Dredging Center consists of the Long Island shoreline in the Townships of Oyster Bay (Nassau County) and Huntington (Suffolk County). The dredging center area extends from Matinecock Point in the west to Lloyd Point in the east. It includes rivers and harbors in the communities of Lattingtown, Bayville, Center Island, Mill Neck, Oyster Bay, Cove Neck, Oyster Bay Cove, Laurel Hollow, Cold Spring Harbor, and Lloyd Harbor. There are no USACE or other Federal agency projects located in this dredging center.

6.2.21 Huntington and Northport Bay Area Dredging Center

The Huntington and Northport Bay Area Dredging Center consists of the Long Island shoreline areas of Huntington Township from Lloyd Point in the west to Eatons Neck Point in the east. The area includes Huntington and Northport Bays and their tributaries and the USACE Navigation Projects for Huntington Harbor and Northport Harbor. The area includes the communities of Lloyd Harbor, Huntington, Centerport, Northport, Asharoken, and Eatons Neck. The dredging center also includes the U.S. Coast Guard facility at Eatons Neck.

Huntington Harbor

The available data on sediment characterization are inconclusive with regard to the type of material that might be expected in the future at Huntington Harbor, other than that it would likely be suitable for open-water placement. Therefore, the projected dredging volume for purposes of the screening was evenly split between sand and suitable fine-grained material. The top 10 ranked alternatives for these project materials are presented in Table 6-60.

Table 6-59. Screening Results for Top Ten Ranked Alternative Sites for Glen Cove Creek.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$159.74	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$141.38	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$141.38	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$159.74	
ShoreCDF-F_bse	Penfield Reef	100	100	50	59.43	309.43	Yes	Yes	$166.79	
CAD-M_bse	Morris Cove	100	100	0	85.16	285.16	Yes	Yes	$111.52	
IslandCDF-N_bse	Falkner Island	100	100	0	73.28	273.28	Yes	Yes	$201.49	
IslandCDF-P_bse	Duck Island Roads	100	100	0	72.76	272.76	Yes	Yes	$201.49	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$201.49	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	0	71.25	271.25	Yes	Yes	$201.49	

Table 6-60. Screening Results for Top Ten Ranked Alternative Sites for Huntington Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Huntington Harbor - Sand										
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$169.99	
IslandCDF-B_cap	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$169.99	
ShoreCDF-A_cap	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$169.99	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$169.99	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$169.99	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$75.07	
Berm-63	Asharoken Beach	100	100	50	83.57	333.57	Yes	Yes	$91.88	
Berm-170	Sunken Meadow State Park	100	100	50	82.37	332.37	Yes	Yes	$104.16	
Berm-456	Bayville	100	100	50	80.39	330.39	Yes	Yes	$104.16	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$72.17	
Huntington Harbor - Silt										
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$169.99	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$169.99	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$169.99	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$169.99	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$169.99	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$75.07	
COW-E_bse	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$75.07	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$72.17	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$183.72	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$183.72	

Northport Harbor

The available data on sediment characterization are inconclusive with regard to the type of material that might be expected in the future at Northport Harbor, other than that it would likely be suitable for open-water placement. Therefore, the projected dredging volume for purposes of the screening was evenly split between sand and suitable fine-grained material. The top 10 ranked alternatives for these project materials are presented in Table 6-61.

U.S. Coast Guard Station, Eatons Neck

There is no sediment testing data available for the U.S. Coast Guard Station, Eatons Neck, so the sediment suitability for this project was screened as "unknown" (with a value of 50) for all alternative types. Therefore, suitability was not a distinguishing factor for the screening for this project. The top 10 ranked alternatives for this project are presented in Table 6-62.

6.2.22 Smithtown Bay and Stony Brook Area Dredging Center

The Smithtown Bay and Stony Brook Harbor Area Dredging Center consists of the Long Island shoreline in the Townships of Huntington, Smithtown, and Brookhaven, from Eatons Neck Point in the west to Old Field Point in the east. It includes rivers and harbors in the communities of Fort Salonga, Kings Park, Nissequogue, Smithtown, Head of the Harbor, Stony Brook, and Old Field, and the Long Island Sound beaches of Asharoken. There are no USACE or other Federal agency projects in this dredging center.

6.2.23 Port Jefferson-Mount Sinai Area Dredging Center

The Port Jefferson-Mount Sinai Dredging Center consists of the western Long Island Sound coastal areas of the township of Brookhaven, and the communities of Old Field, Setauket and East Setauket, Poquott, Port Jefferson, Belle Terre, and Mount Sinai. The dredging center extends from Old Field Point in the west eastward to the east end of Cedar Beach in Mount Sinai. The area includes the USACE Navigation Project for Port Jefferson Harbor, which is locally maintained.

Port Jefferson Harbor

There is no projected Federal dredging activity projected during the DMMP planning timeframe for Port Jefferson Harbor, as non-Federal interests maintain the project to a depth greater than authorized for Federal maintenance. However, to provide a list of likely placement alternatives should maintenance of the USACE Navigation Project at Port Jefferson be required, the screening tool was run for both and sand and fine-grained material, for a minimal 5,000-CY volume. The top 10 ranked alternatives for this example project are presented in Table 6-63.

Table 6-61. Screening Results for Top Ten Ranked Alternative Sites for Northport Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Northport Harbor - Sand										
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$148.81	
IslandCDF-B_cap	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$148.81	
ShoreCDF-A_cap	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$148.81	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$148.81	
ShoreCDF-J_cap	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$148.81	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$148.81	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$50.14	
Berm-63	Asharoken Beach	100	100	50	83.57	333.57	Yes	Yes	$60.80	
Berm-170	Sunken Meadow State Park	100	100	50	82.37	332.37	Yes	Yes	$72.69	
Berm-456	Bayville	100	100	50	80.39	330.39	Yes	Yes	$72.69	
Northport Harbor - Silt										
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$148.81	
IslandCDF-B_bse	Greenwich Captain Harbor	100	100	100	68.28	368.28	Yes	Yes	$148.81	
ShoreCDF-A_bse	Hempstead Harbor	100	100	100	67.58	367.58	Yes	Yes	$148.81	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$148.81	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$148.81	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$148.81	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$50.14	
COW-E_bse	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$50.14	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$47.59	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	50	71.25	321.25	Yes	Yes	$148.73	

Table 6-62. Screening Results for Top Ten Ranked Alternative Sites for U.S. Coast Guard Station, Eatons Neck.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$109.99	
COW-E_bse	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$109.99	
UOW-WLDS	WLDS	50	100	100	75.43	325.43	No	Yes	$106.46	
Beach-64	Hobart Beach	50	100	100	73.20	323.20	Yes	Yes	$111.07	
ShoreCDF-I_cap	Bridgeport Yellow Mill Channel	50	100	100	71.25	321.25	Yes	Yes	$212.01	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	50	100	100	71.25	321.25	Yes	Yes	$212.01	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	50	100	100	70.36	320.36	Yes	Yes	$193.84	
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	50	100	100	70.36	320.36	Yes	Yes	$193.84	
IslandCDF-B_cap	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$212.01	
IslandCDF-B_bse	Greenwich Captain Harbor	50	100	100	68.28	318.28	Yes	Yes	$212.01	

Table 6-63. Screening Results for Top Ten Ranked Alternative Sites for Port Jefferson Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
Port Jefferson Harbor - Sand										
ShoreCDF-I_cap	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$283.33	
IslandCDF-L_cap	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$283.33	
ShoreCDF-D_cap	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$283.33	
ShoreCDF-K_cap	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$283.33	
ShoreCDF-C_cap	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$283.33	
ShoreCDF-J_cap	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$283.33	
ShoreCDF-F_cap	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$283.33	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$150.35	
CAD-M_cap	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$202.14	
Berm-170	Sunken Meadow State Park	100	100	50	82.37	332.37	Yes	Yes	$212.66	
Port Jefferson Harbor - Silt										
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	100	71.25	371.25	Yes	Yes	$283.33	
IslandCDF-L_bse	New Haven Breakwaters	100	100	100	70.94	370.94	Yes	Yes	$283.33	
ShoreCDF-D_bse	Norwalk Outer Harbor Containment	100	100	100	70.36	370.36	Yes	Yes	$283.33	
ShoreCDF-K_bse	Milford Harbor	100	100	100	67.68	367.68	Yes	Yes	$283.33	
ShoreCDF-C_bse	Norwalk Outer Harbor Marsh	100	100	100	66.90	366.90	Yes	Yes	$283.33	
ShoreCDF-J_bse	Stratford Point	100	100	100	66.72	366.72	Yes	Yes	$283.33	
ShoreCDF-F_bse	Penfield Reef	100	100	100	59.43	359.43	Yes	Yes	$283.33	
COW-E_cap	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$150.35	
COW-E_bse	Sherwood Island Borrow Pit	50	100	100	85.57	335.57	Yes	Yes	$150.35	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$202.14	

6.2.24 Suffolk County Northeast Shore Dredging Center

The Suffolk County Northeast Shore Area Dredging Center consists of the Long Island Sound shoreline areas of Brookhaven, Riverhead, and Southold Townships from the East end of Cedar Beach in Mount Sinai in the west to Orient Point, Plum Island, and the Gull Islands in the east. The USACE Navigation Project for Mattituck Harbor is located in this area. The area includes the communities (from west to east) of Miller Place, Sound Beach, Rocky Point, Shoreham, East Shoreham, Wading River, Wildwood, Baiting Hollow, Riverhead (Long Island Sound shore), Northville, Mattituck, Peconic, Southold, Greenport, East Marion, and Orient.

Mattituck Harbor and Inlet

Based on past sediment testing results (2003) and the harbor's placement history, any future maintenance of the project at Mattituck Harbor is expected to yield suitable, sandy dredged material. However, there is the potential for silty material to be encountered in the upper project reaches. Therefore, the alternatives screening was also run for a minor amount (7,000 CY) of fine-grained material to see which placement alternatives could be available if this type of material were encountered. The top 10 ranked alternatives for these project materials are presented in Table 6-64.

6.2.25 Great and Little Peconic Bays Area Dredging Center

The Great and Little Peconic Bays Dredging Center is the largest dredging center in the study area in terms of number of dredging actions. The two bays lie between the North and Sound Forks of outer Long Island. The dredging center consists of all areas west of a line from Cedar Beach Point on Great Hog Neck in Southold across to Jessup Neck in Southampton, including the Peconic River west up to the head of navigation at Riverhead. The area includes the communities (counter-clockwise from the northeast) of Southold, Cutchogue, New Suffolk, Mattituck, Laurel, Jamesport, Aquebogue, Riverhead, Riverside, Flanders, Hampton Bays, Tuckahoe, North Sea, and Noyack. The area includes the USACE Navigation Project for the Peconic River.

Peconic River

For the purposes of the DMMP, it was inferred from the limited Federal and county data that material to be dredged from the Peconic River project in the future will be mainly fine-grained dredged materials. However, sandy material could be encountered in the outer project reaches in the bay. Therefore, the alternatives screening was also run for a minor amount (7,000 CY) of sandy material to determine which placement alternatives could be available if that type of material were encountered. The top 10 ranked alternatives for these project materials are presented in Table 6-65.

Table 6-64. Screening Results for Top Ten Ranked Alternative Sites for Mattituck Harbor and Inlet.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suitability**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environmental**	**Socioeconomic**	**Unit Cost ($/CY)**	**Qualifier**
Mattituck Harbor and Inlet										
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$130.42	
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$130.42	
Beach-455/82	Mattituck Harbor 111/Bailie's Beach	100	100	100	70.43	370.43	Yes	Yes	$28.05	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$130.42	
CAD-M_cap	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$82.09	
Berm-454A	Hashamomuck Cove - County Rd 48	100	100	50	83.72	333.72	Yes	Yes	$57.70	
Berm-445	Jamesport State Park	100	100	50	81.98	331.98	Yes	Yes	$45.90	
UOW-CLDS	CLDS	50	100	100	75.43	325.43	No	Yes	$41.79	
Beach-445	Jamesport State Park	100	100	50	73.20	323.20	Yes	Yes	$45.90	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$41.79	
Mattituck Harbor and Inlet – Silt										
IslandCDF-N_bse	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$228.99	
IslandCDF-P_bse	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$228.99	
ShoreCDF-O_bse	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$228.99	
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$167.28	
UOW-CLDS	CLDS	50	100	100	75.43	325.43	No	Yes	$119.60	
UOW-CSDS	CSDS	50	100	100	72.31	322.31	No	Yes	$119.60	
IslandCDF-Q_bse	Twotree Island	100	100	50	71.51	321.51	Yes	Yes	$243.41	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$243.41	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$243.41	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	0	71.25	271.25	Yes	Yes	$293.83	

Table 6-65. Screening Results for Top Ten Ranked Alternative Sites for Peconic River.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suitability	Capacity	Distance	Impacts	Total	Environmental	Socioeconomic	Unit Cost ($/CY)	Qualifier
Peconic River										
CAD-M_bse	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$124.36	
IslandCDF-N_bse	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$187.21	
IslandCDF-P_bse	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$187.21	
IslandCDF-L_bse	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$187.21	
ShoreCDF-O_bse	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$187.21	
ShoreCDF-K_bse	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$187.21	
ShoreCDF-J_bse	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$187.21	
LFCap-61	Town of Brookhaven Landfill	50	100	50	77.41	277.41	Yes	Yes	$122.28	
IslandCDF-Q_bse	Twotree Island	100	100	0	71.51	271.51	Yes	Yes	$226.07	
ShoreCDF-I_bse	Bridgeport Yellow Mill Channel	100	100	0	71.25	271.25	Yes	Yes	$226.07	
Peconic River – Sand										
CAD-M_cap	Morris Cove	100	100	50	85.16	335.16	Yes	Yes	$167.28	
Berm-455/82	Mattituck Harbor & Bailie's Beach	100	100	50	83.93	333.93	Yes	Yes	$166.15	
Berm-171	Wildwood State Park	100	100	50	82.68	332.68	Yes	Yes	$166.15	
Berm-445	Jamesport State Park	100	100	50	81.98	331.98	Yes	Yes	$166.15	
IslandCDF-N_cap	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$243.41	
IslandCDF-P_cap	Duck Island Roads	100	100	50	72.76	322.76	Yes	Yes	$243.41	
IslandCDF-L_cap	New Haven Breakwaters	100	100	50	70.94	320.94	Yes	Yes	$243.41	
ShoreCDF-O_cap	Clinton Harbor	100	100	50	69.95	319.95	Yes	Yes	$243.41	
ShoreCDF-K_cap	Milford Harbor	100	100	50	67.68	317.68	Yes	Yes	$243.41	
ShoreCDF-J_cap	Stratford Point	100	100	50	66.72	316.72	Yes	Yes	$243.41	

6.2.26 Shelter Island and Gardiners Bay Area Dredging Center

The Shelter Island Sound and Gardiners Bay Dredging Center is the second largest dredging center in this study in terms of the number of harbors and waterways included in its area. The dredging center consists of all shores and waters east of a line from Cedar Beach Point on Great Hog Neck in Southold across to Jessup Neck in Southampton, including all of Shelter Island, Noyack Bay, Shelter Island Sound, the southerly and easterly shores of the North Fork east of Cedar Beach Point, and the northerly and easterly shores of South Hampton and East Hampton between Jessup Neck in the west and Lion Head Rock in the east. Also included are Plum Island and the Gull Islands, which separate Long Island Sound from Block Island Sound. The area includes the communities (counter-clockwise from the northeast) of Orient, East Marion, Greenport, Southold, Shelter Island, Noyack, North Haven, Sag Harbor, Northwest Harbor, and Springs. The dredging center includes the USACE Navigation Projects for Greenport Harbor and Sag Harbor (which has been deauthorized, making the future maintenance a non-Federal responsibility). The dredging center also includes the Department of Homeland Security's waterfront facilities at Orient Point and Plum Island.

Greenport Harbor

Sediment testing results for Greenport Harbor are limited (1971). However, any future maintenance of the Greenport Harbor project (Sterling Basin) is expected to yield suitable, sandy dredged material based on Suffolk County records of county dredging events. The top 10 ranked alternatives for this project are presented in Table 6-66.

U.S. Department of Homeland Security – Plum Gut Harbor and Orient Point

Future maintenance of the U.S. Department of Homeland Security facilities at Plum Gut Harbor on Plum Island and at Orient Point on Long Island will depend on the final closure and redevelopment of the island and its access facilities. For the purposes of the DMMP, it was assumed that the two facilities would continue to be maintained to provide access to the island. These facilities are expected to yield only clean sandy material in the future over the DMMP planning timeframe. The top 10 ranked alternatives for this project are presented in Table 6-67.

6.2.27 Montauk Area Dredging Center

The Montauk Area Dredging Center consists of all shores and waters along the Gardiners Bay shoreline of the South Fork of Long Island from Lions Head Rock east to Montauk Point. The area includes the New York communities (west to east) of Springs, Amagansett, Napeague, and Montauk, all in the East Hampton township. The dredging center includes the USACE Navigation Project for Lake Montauk Harbor and a U.S. Coast Guard station. The dredging center also includes Gardiners Island, a large privately owned island with its own landing.

Table 6-66. Screening Results for Top Ten Ranked Alternative Sites for Greenport Harbor.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
IslandCDF-N_cap	Falkner Island	100	100	100	73.28	373.28	Yes	Yes	$388.16	
Beach-79	Gull Pond Beach (Norman Klipp Park)	100	100	100	73.20	373.20	Yes	Yes	$225.18	
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$388.16	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$388.16	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$388.16	
Berm-454A	Hashamomuck Cove-County Rd 48	100	100	50	83.72	333.72	Yes	Yes	$287.56	
Berm-454B	Hashamomuck Cove-Kenney's Beach	100	100	50	83.23	333.23	Yes	Yes	$303.33	
Berm-180	Orient Beach State Park	100	100	50	78.31	328.31	Yes	Yes	$303.33	
Beach-76	Town Beach	100	100	50	74.14	324.14	Yes	Yes	$287.56	
Beach-111	Crescent Beach (Shelter Island)	100	100	50	73.20	323.20	Yes	Yes	$287.56	

Table 6-67. Screening Results for Top Ten Ranked Alternative Sites for U.S. Department of Homeland Security.

Screening ID	Alternative Site Name	Screening Scores					Benefits		Cost	
		Suita-bility	Capacity	Distance	Impacts	Total	Environ-mental	Socio-economic	Unit Cost ($/CY)	Qualifier
IslandCDF-P_cap	Duck Island Roads	100	100	100	72.76	372.76	Yes	Yes	$188.23	
UOW-CSDS	CSDS	100	100	100	72.31	372.31	No	Yes	$93.33	
UOW-NLDS	NLDS	100	100	100	72.31	372.31	No	Yes	$93.33	
Beach-437	Plum Island	100	100	100	72.27	372.27	Yes	Yes	$81.82	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$180.54	
ShoreCDF-O_cap	Clinton Harbor	100	100	100	69.95	369.95	Yes	Yes	$188.23	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$188.23	
Berm-367	Rocky Neck State Park	100	100	50	83.31	333.31	Yes	Yes	$131.28	
Berm-180	Orient Beach State Park	100	100	50	78.31	328.31	Yes	Yes	$118.66	
IslandCDF-N_cap	Falkner Island	100	100	50	73.28	323.28	Yes	Yes	$213.86	

Lake Montauk Harbor

Sediment sampling in the Lake Montauk Harbor project (2005) characterized the materials as predominantly sand, with medium-grained sand the dominant grain size found in most samples. Future maintenance of the Lake Montauk Harbor project will yield mainly suitable, sandy dredged materials. The top 10 ranked alternatives for this project are presented in Table 6-68.

U.S. Coast Guard Station

During the 2009 dredging needs survey, the U.S. Coast Guard indicated that it did not anticipate the need for any maintenance dredging at its station over the next 30 years (USACE, 2009a). An anticipated dredging volume of 0 CY was retained for this project in the updated dredging volumes (DMMP Chapter 5). However, the screening tool was run for this project to see which placement alternatives could be available if dredging is needed in the future. No sediment testing results were available for this project, so the suitability of the material was screened as “unknown” for all alternative types. The unit cost of $0 reflects a projected dredging volume of 0 CY. The top 10 ranked alternatives for this project are presented in Table 6-69.

Table 6-68. Screening Results for Top Ten Ranked Alternative Sites for Lake Montauk Harbor.

		Screening Scores					**Benefits**		**Cost**	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Berm-121/446	Theodore Roosevelt County Park & Gin Beach	100	100	100	84.45	384.45	Yes	Yes	$33.61	
Beach-453	Lake Montauk Harbor	100	100	100	73.20	373.20	Yes	Yes	$33.61	
Beach-446	Theodore Roosevelt County Park	100	100	100	72.89	372.89	Yes	Yes	$39.55	
IslandCDF-Q_cap	Twotree Island	100	100	100	71.51	371.51	Yes	Yes	$142.37	
IslandCDF-R_cap	Groton Black Ledge	100	100	100	67.53	367.53	Yes	Yes	$142.37	
Berm-453	Lake Montauk Harbor	100	54	100	84.53	338.95	Yes	Yes	$33.61	
Berm-177	Shadmoor State Park	100	100	50	84.64	334.64	Yes	Yes	$55.01	
Berm-173	Hither Hills State Park	100	100	50	83.20	333.20	Yes	Yes	$66.85	
Berm-178	Camp Hero State Park	100	100	50	82.14	332.14	Yes	Yes	$55.01	
Beach-178	Camp Hero State Park	100	100	50	72.89	322.89	Yes	Yes	$55.01	
Beach-179*	Montauk Point State Park*	100	100	50	72.89	322.89	Yes	Yes	$55.01	

*Because the top 10 and 11 ranked alternatives have the same total score, the top 11 ranked alternatives are presented for this project.

Table 6-69. Screening Results for Top Ten Ranked Alternative Sites for U.S. Coast Guard Station.

		Screening Scores					Benefits		Cost	
Screening ID	**Alternative Site Name**	**Suita-bility**	**Capacity**	**Distance**	**Impacts**	**Total**	**Environ-mental**	**Socio-economic**	**Unit Cost ($/CY)**	**Qualifier**
Berm-453	Lake Montauk Harbor	50	100	100	84.53	334.53	Yes	Yes	$0	
Berm-121/446	Theo. Roosevelt County Park/& Gin Beach	50	100	100	84.45	334.45	Yes	Yes	$0	
Beach-121	Gin Beach	50	100	100	73.20	323.20	Yes	Yes	$0	
Beach-453	Lake Montauk Harbor	50	100	100	73.20	323.20	Yes	Yes	$0	
Beach-446	Theodore Roosevelt County Park	50	100	100	72.89	322.89	Yes	Yes	$0	
UOW-NLDS	NLDS	50	100	100	72.31	322.31	No	Yes	$0	
IslandCDF-Q_cap	Twotree Island	50	100	100	71.51	321.51	Yes	Yes	$0	
IslandCDF-Q_bse	Twotree Island	50	100	100	71.51	321.51	Yes	Yes	$0	
IslandCDF-R_bse	Groton Black Ledge	50	100	100	67.53	317.53	Yes	Yes	$0	
IslandCDF-R_cap	Groton Black Ledge	50	100	100	67.53	317.53	Yes	Yes	$0	

6.3 REFERENCES

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7 PUBLIC INVOLVEMENT

As stated in Chapter 1, this PEIS is being prepared consistent with the requirements of NEPA and USACE's policy on NEPA compliance (Procedures for Implementing NEPA (USACE, 1988)). Section 102 of NEPA (42 USC § 4332) states:

> "Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, *shall be made available* to the President, the Council on Environmental Quality and *to the public* as provided by Section 552 of Title 5, United States Code, and shall accompany the proposal through the existing agency review processes."

Federal regulations that guide compliance with NEPA by the USACE (33 CFR Part 230) and the CEQ (40 CFR 1500 et seq.) are more explicit in their requirements for public involvement throughout the PEIS process.

This PEIS also addresses requirements of the MPRSA and the CWA, both of which include provisions for public involvement, and other Federal agency policies and agreements established over the history of dredged material management in Long Island Sound.

The Long Island Sound region has a long and rich history of public involvement and participation in environmental decision-making. In keeping with this tradition, and to satisfy the numerous statutory and regulatory requirements to which this proposed action is subject, USACE has conducted an extensive public involvement program throughout the development of the DMMP. The agency established a "Working Group" comprising representatives from Federal, state, regional, and local agencies and from various stakeholder organizations which have an interest in the management of dredged material in Long Island Sound. Public meetings and workshops were held to provide the public with information on the DMMP process and the results of studies conducted in support of the DMMP. All of the final studies conducted as part of the DMMP effort have been posted to the USACE webpage for public review or downloading. In addition, the public was given ample opportunity to provide input on the process and substance of the DMMP document. The following sections describe in detail the elements of the USACE public involvement program. Supporting documents are provided in the Public Involvement Appendix (Appendix A).

7.1 MAJOR PUBLIC INVOLVEMENT ACTIVITIES

7.1.1 Notice of Intent and Public Announcement

On August 31, 2007, USACE published a Notice of Intent to prepare a draft PEIS to analyze a Long Island Sound DMMP (Appendix A). The Notice of Intent outlined the project, listed the agencies involved, provided contact information for further information, and gave notification of the dates when upcoming public scoping meetings would be held.

7.1.2 Public Scoping Meetings

Scoping is the process through which Federal agencies responsible for the development of an PEIS determine the scope of the project, including the range of alternative actions that may meet the purpose of and need for the proposed action; the extent of the projected area and range of potential impacts resulting from the proposed and alternative actions; and the studies necessary to determine the extent of potential impacts resulting from these actions.

Six public scoping meetings were held to inform the public about the project, present progress on planning for the Long Island Sound DMMP, solicit feedback on these efforts, and gain public input on future direction (Table 7-1). The public notice was sent to the 2,538 individuals on the Long Island Sound DMMP mailing list that was previously assembled as part of the Long Island Sound Designation EIS (EPA, 2004) and Final Rule Making (70 Fed Reg. 32498). The list was updated to incorporate 1) new stakeholders expressing an interest since publication of the Final Rule, 2) changes in government officials, and 3) corrections and additions. Approximately 118 people attended the six public scoping meetings. Details of the meetings, including notarized transcripts and meeting materials, are presented in the scoping meeting report (EPA, 2008) (Appendix A).

A DMMP project website[1] was created for access by the public. Meeting materials, including presentations and handouts, were posted on the website following the scoping meetings.

Table 7-1. Long Island Sound DMMP Public Scoping Meetings.

Date/Time	Location
November 26, 2007 7 – 10 pm	Radisson New Rochelle (Empire Ballroom) One Radisson Plaza New Rochelle, New York 10801
November 27, 2007 1 – 4 pm	Danfords on the Sound (Diplomatic Ballroom) 25 East Broadway Port Jefferson, New York 11777
November 27, 2007 7 – 10 pm	Holiday Inn in Westbury (Long Island Room) 369 Old Country Road Carle Place, New York 11514
November 28, 2007 7 – 10 pm	Westin Stamford (The Grove) 1 Stamford Pl. Stamford, Connecticut 06902
November 29, 2007 1 – 4 pm	Holiday Inn New London (Morgan Ballroom) 269 N. Frontage Rd. New London, Connecticut 06320
November 29, 2007 7 – 10 pm	Yale University (Linsly-Chittenden Hall Room 102) 63 High Street New Haven, Connecticut 06511

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[1] http://www.nae.usace.army.mil/Missions/ProjectsTopics/LongIslandSoundDMMP.aspx

Issues or concerns that were identified during the Long Island Sound DMMP public scoping meetings are presented in Table 7-2. The last column of the table notes which sections of this PEIS or the DMMP address the major issues raised during public scoping. The table also identifies issues that are outside the scope of the PEIS and the DMMP.

Table 7-2. Issues Identified During the Long Island Sound DMMP Public Scoping Meetings.

Issue	Overarching Topic	PEIS Section or How Topic Was Addressed
Concern over loss of recreational facility access points over the past decade	Recreational Access	This is a local issue that cannot be addressed in the PEIS.
Recommendation for the formation of a state/ USACE advisory committee to assist with public involvement and communication during the process	Advisory Committee	A Technical Working Group was formed to assist in public involvement and communication.
Critical to create infrastructure for dewatering dredged material in order to maximize beneficial use of the material	Beneficial Reuse – Dewatering	Chapter 3 - Alternatives
Importance of identifying funding sources for beneficial use projects, and both the Federal and state levels	Beneficial Reuse – Funding	A report was developed identifying state and local programs and restrictions.
Lack of economical options for placement of unsuitable material. Recommendation that USACE and other Federal agencies (U.S. Department of State, EPA) look more closely for ways to create marketable products from dredged material.	Beneficial Reuse – Products	Chapter 4 - Alternatives
Identification of the upstream sources of contaminants reaching Long Island Sound (e.g., farms, fertilizers, nitrates, etc.).	Source Elimination	Appendix E of the DMMP
Facility closures due to the lack of adequate water depths combined with the cost of testing and the ability to dredged and place material on an economically affordable basis.	Vessel Access, Economics (Testing and Dredging)	The USACE developed information related to the cost of testing for various sized dredging projects. Testing requirements are established under regulatory guidelines/ regulations and cannot be addressed in the PEIS.
Limited availability of cap material, except for large USACE or commercial project(s), and difficult logistics involved with placing cap material immediately when needed due to various permit conditions, including timing of the projects.	Cap Material	Requirements for capping dredged material are a regulatory issue and the availability of cap material isn't an issue that can be dealt with in this PEIS.
The approach to ascertaining the true needs, affordable options, and reasonable and meaningful alternatives was lost during the designation process.	Alternatives	Chapter 3 - Alternatives

Table 7-2. Issues Identified During the LIS DMMP Public Scoping Meetings (continued).

Issue	Overarching Topic	PEIS Section or How Topic Was Addressed
Recommendation that the DMMP and PEIS consider all options for handling dredged material, including what the material is, what might be in it, and whether alternative sites other than the Sound exist.	Alternatives	Chapter 3 - Alternatives
Comment that agencies must ensure safe and timely management of the region's dredged material, while meeting the need for safe and economically viable navigation for water-based commerce, transportation, national security, and other public purposes.	Alternatives	Chapter 3 - Alternatives
Recommendation that the development of the DMMP follow an open process where public comment is welcomed.	Public Comment	Public involvement process (Chapter 7 – Public Involvement)
Recommendation that the DMMP should focus on beneficial use options and alternatives to dumping.	Alternatives	Chapter 3 - Alternatives
Recommendation that the DMMP should identify future projects that can reuse dredged material.	Alternatives	Chapter 3 - Alternatives
Concern over current policies regarding capping of dredged material and what will be permitted to be placed at long-term disposal sites	Capping	Policies related to cap requirements are state policies that cannot be addressed in this PEIS.
Comment that the most important goal for the DMMP is to view dredged material as a resource rather than a waste product.	Beneficial Reuse	Chapter 3 - Alternatives
Recommendation that the DMMP act as a tool and guide for beneficial reuse, identify the beneficial reuse options, and ensure proper infrastructure and funding	Beneficial Reuse	Chapter 3 - Alternatives
Recommendation to explore alternatives to open-water placement sites in Long Island Sound: 1) Upland placement 2) Placement beyond the continental shelf 3) Placement in open and/or closed landfills 4) Beneficial reuse, including a. Asphalt, cement, and other aggregates (roadway sub-base) b. Brownfield remediation c. Use at closed mines and quarries d. Agricultural use e. Beach placement (sand replacement)	Alternatives	Chapter 3 - Alternatives
Concern that there does not appear to be an environmentally substantive reason to create long-term placement sites in the Long Island Sound where none exist today.	Alternatives (Open-Water Placement)	This PEIS does not evaluate or propose the creation of additional open-water placement sites.
Economic impact to local economy by designating	Economic,	The economic importance of

Table 7-2. Issues Identified During the LIS DMMP Public Scoping Meetings (continued).

Issue	Overarching Topic	PEIS Section or How Topic Was Addressed
long-term dredged material placement sites in the Sound instead of allowing the short-term authority of USACE to expire.	Alternatives (Open-Water Placement)	the various navigation facilities was identified by the USACE in a separate report.
Concern that EPA's approval of dredged material placement sites within Long Island Sound directly conflicts with the EPA-approved reduction in the TMDL for nitrogen into the Sound.	Water Quality, Alternatives (Open-Water Placement)	This is an issue for EPA and cannot be addressed in the PEIS.
Concern that EPA's proposal to designate long-term placement sites within the Long Island Sound estuary appears to contravene both the CWA and MPRSA, which direct EPA to utilize open ocean sites (beyond the continental shelf) wherever feasible.	Consistency with Regulations, Alternatives (Open-Water Placement)	This is an issue for EPA and cannot be addressed in the PEIS.
Concern that most of the dredged material projected to be placed in the Sound for the next 20 years will originate from six Connecticut harbors that contain sediment laced with elevated heavy metals and PCB contamination.	Environmental Consequences, Sediment Quality	Chapter 5 – Environmental Consequences
Recommendation that the DMMP identify all feasible and environmentally responsible protocols for dredged material management and the opportunity for communities on Long Island Sound to be at the cutting edge of new technologies and evolving economic realities.	Alternatives	Chapter 3 - Alternatives
Concern that lack of dredging will negatively affect employment levels, cost of living, population levels, and quality of life (road congestion and environmental damage) in Connecticut.	Economics	Chapter 5 – Environmental Consequences
Comment that open-water placement of suitable dredged material is a necessary and viable option upon which the future of most of Connecticut's ports and harbors depend, including but not limited to dredged material for structural and non-structural fill and other beneficial beach nourishment and aquatic uses.	Alternatives	Chapter 3 - Alternatives
Recommendation that when using long-term placement sites in the Sound to place material, there not be any capping of dredged material allowed for any project, especially highly contaminated material.	Capping	This is an issue for the regulatory agencies and cannot be addressed in the PEIS.
Incorporation of additional opportunities for public comment into the development of the DMMP, increased transparency of the process, release of supporting materials in a timely manner, enhancement of public education efforts regarding	Public Involvement	Chapter 7 – Public Involvement

Table 7-2. Issues Identified During the LIS DMMP Public Scoping Meetings (continued).

Issue	Overarching Topic	PEIS Section or How Topic Was Addressed
alternatives to open-water placement.		
Enhancement of efforts to limit source pollution and excess sedimentation, thereby reducing the volume of and contamination levels of the dredged materials.	Source Elimination	This is a state responsibility that is beyond the scope of the PEIS.
Identification and utilization of viable alternatives to open-water placement.	Alternatives	Chapter 3 - Alternatives
Generation of realistic and accurate numbers for dredging needs throughout the Sound.	Needs	Chapter 2 – Dredging and Dredged Material Characteristics
Characterization and maintenance of an accurate GIS database of the sediment quality in the major embayments around the Sound.	Sediment Quality	Chapter 2 – Dredging and Dredged Material Characteristics
Air quality – increases from increased truck traffic when local ports cannot be used by deep draft vessels to bring in commodities.	Air Quality	Chapter 5 – Environmental Consequences
Recommendation that the DMMP and PEIS consider land reclamation, especially filling of lands waterward of the high tide line with dredged materials, as an acceptable alternative.	Alternatives	Chapter 3 - Alternatives
Dredging – differences in frequency and need (New York vs. Connecticut harbors).	Needs	Chapter 2 – Dredging and Dredged Material Characteristics
Economic development – Oil movement via barge versus truck, increased truck traffic, model used to justify dredging.	Economic	Chapter 5 – Environmental Consequences
Request for public education regarding contaminants in dredged sediment and its impact on food chain – currently overdramatized.	Public Education	Public involvement process (Chapter 7 – Public Involvement)
Upland placement of dredged material – who has the responsibility of monitoring upland placement sites and who pays for the monitoring.	Long-term monitoring – upland	This is a state regulatory matter that cannot be addressed in the PEIS.
Impacts to adjoining property owners of an upland placement site used for dredged material.	Impacts - Upland	Chapter 5 – Environmental Consequences
Recommendation that the dredging needs survey be as inclusive as possible and capture more than just large dredging projects.	Needs	Chapter 2 – Dredging and Dredged Material Characteristics
Lack of cap material and approach to address projects that require capping.	Cap	This is a state regulatory matter that cannot be addressed in the PEIS.
Consideration of improvement dredging such as harbor deepening (in addition to maintenance dredging).	Need	Chapter 2 – Dredging and Dredged Material Characteristics
Impact/benefit to air quality from moving freight by ship and rail rather than by truck. (Connecticut)	Air Quality	Air quality is addressed as it relates to dredged material placement alternatives. Air

Table 7-2. Issues Identified During the LIS DMMP Public Scoping Meetings (continued).

Issue	Overarching Topic	PEIS Section or How Topic Was Addressed
		quality related to methods of transportation of freight is beyond the scope of this PEIS.
Difficulty of using upland placement alternatives due to lack of locations for upland placement (Fairfield County)	Alternatives	Chapter 3 - Alternatives
Benefits of using processed dredged material as fill for development in Fairfield County, where fill is not currently available and needs to be imported.	Beneficial Reuse – Fill Material	Chapter 3 - Alternatives
Enforcement of existing soil erosion regulations to keep areas from re-silting.	Source Elimination	This is a state regulatory matter that cannot be addressed in the PEIS.

7.1.3 Working Group Meetings

A volunteer public Working Group was formed in 2011 comprising representatives from Federal, state, regional, and local agencies, and various stakeholder organizations which have an interest in the management of dredged material in Long Island Sound (Table 7-3). The Working Group served as a liaison between the project development team and stakeholders. The group met five times between March 29, 2011, and January 17, 2013. The meetings were arranged using an open forum discussion, and all who were interested were welcome.

The first Working Group meeting was held on March 29, 2011, in Bridgeport, Connecticut. Meeting topics included overviews of the Long Island Sound DMMP and of the DMMP Working Group. Results of studies conducted to date and a discussion on the multi-decision criteria model being prepared by the USACE Engineer Research and Development Center (ERDC) were also addressed. Thirty-nine individuals were present, including contractor support and Federal agency personnel (Appendix A).

The second Working Group meeting took place on April 26, 2011, in Port Jefferson, New York. Meeting topics included background on the Long Island Sound DMMP and determination of the suitability of dredged material for placement. The USACE ERDC discussed the approach to the multi-criteria decision analysis that was being conducted. Thirty-three individuals attended this meeting, including contractor support and Federal agency personnel (Appendix A).

Table 7-3. Members of the Long Island Sound DMMP Working Group.

Working Group Member	Working Group Member
Long Island Sound Study Citizens Advisory Committee	Long Island Sound Councils and Assembly
Connecticut Commercial Lobstermen's Association	Connecticut Department of Transportation
Long Island Sound Lobstermen's Association	Connecticut Department of Agriculture Division of Aquaculture
West End Long Island Sound Lobstermen's Association	Connecticut Harbor Management Association
Audubon Society Connecticut	Pfizer
Audubon Society New York	Connecticut Maritime Coalition
Citizen's Campaign for the Environment	New York Marine Trades
Connecticut Fund for the Environment/ Save the Sound	New London Port Authority
Connecticut River Watershed Council	New Haven Port Authority
Fishers Island Conservancy	Bridgeport Port Authority
River Alliance of Connecticut	Norwalk Maritime Authority
Surfrider Connecticut	Connecticut Marine Trades Association
Surfrider Eastern Long Island Sound	Connecticut Charter Party Boat Association
The Nature Conservancy	New York Coalition for Recreational Fishing
Housatonic Valley Association	Recreational Fishing Alliance
Connecticut Maritime Commission	Connecticut Department of Energy and Environmental Protection
Connecticut Pilots Commission	

The third Working Group meeting was held on June 7, 2011, in Bridgeport, Connecticut. Meeting topics included discussion of worksheet responses and updated criteria and sub-criteria, case studies, and mapping of criteria and sub-criteria associated with the multi-criteria decision analysis. Forty-two individuals attended, including contractor support and Federal agency personnel (Appendix A).

The fourth Working Group meeting was held on October 6, 2011, in Port Jefferson, New York. Meeting topics focused on the multi-criteria decision analysis, including finalizing evaluation metrics and classification of alternatives, preparation of the stakeholder interview process, and the review of the technical assessment process for alternatives. Twenty-nine people attended, including contractor support and Federal agency personnel (Appendix A).

The fifth Working Group meeting was held January 17, 2013, in Bridgeport, Connecticut. Meeting topics included a DMMP process overview and update, summary of the multi-criteria decision analysis stakeholder interview participation and results, and review of the concept for the multi-criteria decision analysis process. Thirty-three people were in attendance, including contractor support and federal Agency personnel (Appendix A).

Information on each of these meetings can be found at www.lisdmmp.com.

7.1.4 Stakeholder Elicitation for Long Island Sound DMMP

In order to identify stakeholder values on evaluation factors for potential dredged material management alternatives as part of the Long Island Sound DMMP, the USACE NAE partnered with members of the ERDC Risk and Decision Science Team to organize a stakeholder engagement exercise.

During a series of meetings with the DMMP Working Group, the stakeholders were tasked with collaboratively building a decision model. The resulting model included several general alternatives, criteria, sub-criteria, and metrics relevant to stakeholder interests in the Long Island Sound region. Individual interviews were also conducted to elicit judgments regarding the importance of the developed criteria such as environmental media, ecological receptors, economics, and human welfare in relation to the alternatives.

Through interviews and surveys, each representative of a stakeholder organization was able to contribute the organization's view of the relative value/utility of different environmental impacts, health risks, social benefits, economic costs, and other high-level criteria in the context of dredged material placement. The elicitation process was conducted to fairly and transparently integrate divergent stakeholder views in a way that let all participants voice their preferences and concerns without one voice or viewpoint dominating the discussion.

Results showed that, in general, stakeholders tended to agree that all criteria were at least somewhat important; however, a few notable outliers weighted the economics criterion extremely heavily (Appendix A). On average, there was strong relative agreement among the diverse stakeholder group.

Results will be incorporated in the NAE's updated DMMP to guide long-term sediment management in Long Island Sound.

Multi-criteria decision analysis, in particular, is a robust means by which rational and transparent resource allocation decisions can be made while considering stakeholder views. The use of formal decision analytical tools can efficiently augment the prioritization of dredged material placement sites in such a way that is transparent, scalable, analytically rigorous, and defensible.

7.1.5 Newsletters

The USACE also sent out periodic newsletters to people on the project mailing list that would provide project updates on efforts that had been completed and what upcoming efforts were being conducted. The newsletters also provided links to websites where project information was available for review. Newsletters were distributed in January 2010, August 2012, April 2014, and October 2014.

7.2 REFERENCES

EPA, 2004. *Final Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York.*, s.l.: U.S. Environmental Protection Agency in cooperation with the U.S. Army Corps of Engineers. April 2014.

EPA, 2008. *Long Island Sound Dredged Material Management Plan, Public Scoping Meeting Summary Report. ,* s.l.: EPA Contract No. 68-C-03-041, Work Assignment No. 4-43. Prepared by Battelle. February 15, 2008.

USACE, 1988. *Procedures for Implementing NEPA,* Washington, D.C: Regulation No. 200-2-2, March 4, 1988.

8 AGENCY COORDINATION AND COMPLIANCE

The NAE of USACE's North Atlantic Division (NAD) is the lead agency for the Long Island Sound DMMP. The NAE and USACE-NAN are developing the DMMP in coordination with EPA Regions 1 and 2 and NOAA; the New York state agencies NYSDOS and NYSDEC; the Connecticut state agencies CTDEEP and CTDOT; and the Rhode Island regulatory and management agency RI CRMC. As the lead agency, the USACE has the primary responsibility of preparing the Draft and Final Long Island Sound DMMP and PEIS.

The USACE has worked closely with the coordinating agencies in the preparation of the Draft DMMP and will continue to do so during the preparation of the Final DMMP. Activities associated with that coordination are outlined in the DMMP. Agency coordination for the Long Island Sound PEIS has been, and will continue to be, conducted during the preparation of the Draft and Final PEIS.

The Long Island Sound DMMP/PEIS screening evaluated hundreds of potential alternatives for each USACE Navigation Project and other Federal agency projects. The PEIS identifies the 10 most viable alternatives for dredged material placement available to each Federal project. Although these possible alternatives have been identified, actual usage has not been analyzed and a preferred alternative has not been selected. Those actions will be performed and documented in future project-specific NEPA documents. At that time, project-specific coordination and consultations will be required for threatened and endangered species, EFH, and CZM as described below. Additional coordination may be required to determine project-specific compliance with other Federal laws, regulations, and programs discussed below.

8.1 COOPERATING AGENCY REQUEST

A cooperating agency is any Federal or state agency or Tribe not serving as a lead agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major Federal action. There are no cooperating agencies with regard to this Long Island Sound PEIS.

8.2 THREATENED AND ENDANGERED SPECIES CONSULTATION

The USACE will conduct threatened and endangered species consultations with the NMFS and USFWS during preparation of project-specific NEPA evaluations. When doing so, USACE will request information on 1) the presence of Federally listed species considered to be endangered, threatened, or of special concern, and 2) designated critical habitat associated with each alternative. Using the provided information, impacts to the species or critical habitat will be assessed and explained in the project-specific NEPA documents prepared by USACE.

In anticipation of the need to assess several common threatened, endangered, and species of concern that are sometimes present in Long Island Sound, potential impacts to threatened and endangered sea turtles, reptiles, whales, fish, and birds have been assessed in this PEIS. These species are discussed in several sections of Chapter 4. Information provided herein may be referenced in project-specific NEPA documents when applicable.

8.3 ESSENTIAL FISH HABITAT CONSULTATION

Many marine habitats are critical to the productivity and sustainability of marine fisheries. The 1996 amendments to the Magnuson-Stevens Act require that an EFH consultation be conducted for any activity that may adversely affect important habitats of Federally managed marine and anadromous fish species. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). “Waters” in the above definition refers to the physical, chemical, and biological properties of aquatic areas that are currently being used or have historically been used by fish. “Substrate” refers to sediment, hard bottom, or other underwater structures and their biological communities. The term “necessary” indicates that the habitat is required to sustain the fishery and support the fish species’ contribution to a healthy ecosystem. EFH can be designated for four life stages—eggs, larvae, juveniles, and adults.

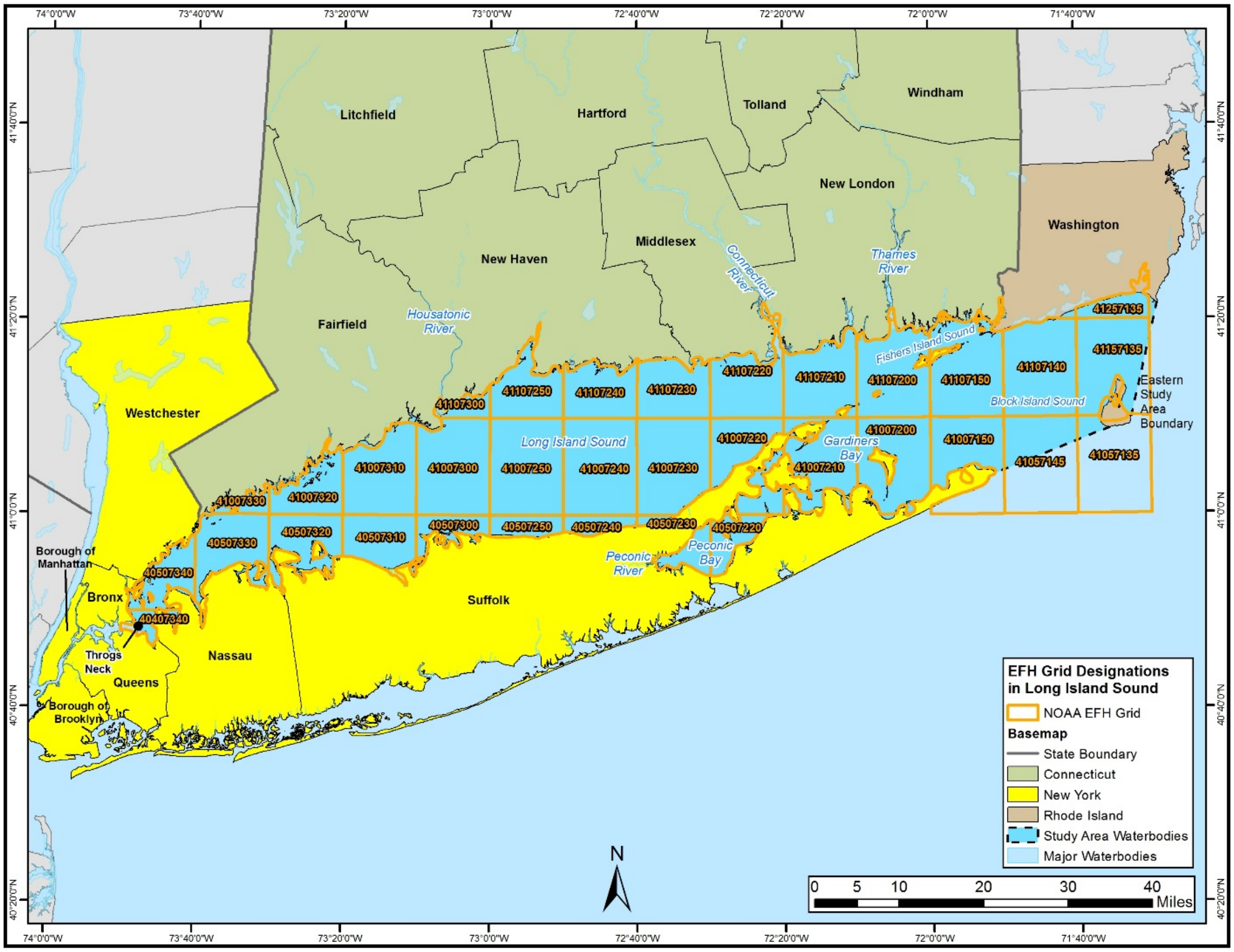
For each site-specific project, an individual EFH consultation will occur between the Corps and NMFS. This includes the preparation of an EFH assessment and will include EFH conservation recommendations by NMFS to avoid and minimize any adverse impacts to EFH. NMFS designates EFH for many species in association with a mapped grid of 10- by 10-minute squares covering all marine habitat along the U.S. coast. Long Island Sound lies within 30 of these squares (Figure 8-1). Information from the 10- by 10-minute squares, provided through the NMFS EFH website, was compiled and included in Sections 5.9 and 5.10 of this PEIS. Upon preparation of project-specific NEPA documents, USACE will consult the NMFS EFH website to determine which species are associated with the 10- by 10-minute squares where alternatives occur. If any changes have occurred in identified species or life stages, additional information on those species will need to be included; otherwise, information on impacts to species provided herein may be referenced in project-specific NEPA documents.

8.4 COASTAL ZONE MANAGEMENT STATEMENT OF COMPLIANCE

The CZM Act of 1972 established a national program to encourage coastal states to develop and implement CZM plans. Section 307 of the CZM Act, as amended, addresses proposed Federal activities within or outside the coastal zone that may have a reasonably foreseeable effect on land or water use or on natural resource of the coastal zone. Section 307 requires the Federal agencies to ensure that those activities are conducted in a manner which is consistent, to the maximum extent practicable, with the enforceable policies of approved state coastal management programs.

Although potential alternatives have been identified for each Federal project, a preferred alternative has not been chosen. CZM compliance will need to be obtained for each project when a project-specific NEPA document is prepared. Depending on the location of the project and the preferred alternatives, compliance with Connecticut, New York, and possibly Rhode Island may be necessary. The following agencies make CZM determinations for each state:

- Connecticut – Connecticut Department of Energy and Environmental Protection, Office of Long Island Sound
- New York – New York State Department of State
- Rhode Island – Rhode Island Coastal Resources Management Program



Source: NOAA (2014).

Figure 8-1. 10- by 10-Minute Grids Defining EFH Within Long Island Sound.

8.5 ENVIRONMENTAL COMPLIANCE

This section describes the Federal laws, regulations, and programs that are relevant to the alternatives discussed in this PEIS. Chapter 3 also addresses the legal requirements of some of these laws and regulations. Additional details, as well as a list of Federal, state, and local agency points of contact, are provided in USACE (2011). Compliance with these laws and regulations will need to be addressed on a project-specific basis.

Federal Statutes

1. American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: Consultation with the Indian nations/tribes that may be affected by a project's proposed action will be conducted upon development of each project-specific NEPA document to ensure that the action does not interfere with their rights to traditional religious practices.

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

Compliance: The DMMP is a programmatic plan under which uniquely (or, individually) authorized, permitted, and funded projects (federal actions) are implemented. As outlined in Section 4.17, a GC applicability analysis will be needed for individual projects related to the LIS DMMP that occur in a designated NAAQS nonattainment or maintenance area, and a conformity determination will be needed for those projects that are not de minimis, included in the applicable SIP, or exempt (for example navigation maintenance dredging (40 CFR §153(c)(2)(ix)). The GC applicability analysis and those projects that include activities within New York that are required to conduct a conformity determination will be coordinated with the RAT. As needed, EPA Region 2 will coordinate with Region 1 depending on a project's location that encompasses both Regions' jurisdictional boundaries. Since the projects associated with the LIS DMMP are in the planning stage and not currently ready to undergo GC evaluation nor NEPA assessment on a project-by-project basis, the project specific consequences will be determined during each project's GC and NEPA assessments. When the coordinated GC evaluation process determines that a project that includes activities within New York requires mitigation, the mitigation program will be coordinated through the RAT and the project's applicable annual emissions will be offset completely through various mechanisms established by the RAT.

3. Clean Water Act, as amended, 33 U.S.C. 1251 et seq.

Compliance: Future non-Federal projects involving the open-water placement of less than 25,000 CY of dredged material will require a Section 404 permit under the CWA. A state WQC pursuant to Section 401 of this Act will also be required. Federal projects or non-Federal projects involving more than 25,000 CY of material will also need to satisfy the standards of Section 404 of the CWA and will be subject to the Section 401 certification process.

4. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1431 et seq.

Compliance: For each project, a CZM consistency determination shall be provided for review and concurrence that the proposed action is "consistent to the maximum extent practicable with the enforceable policies of [the] approved State CZM programs" 16 U.S.C. § 1456 (c)(1)(A).

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

Compliance: The preferred alternative chosen for each project will need to be reviewed by the NMFS and USFWS to determine whether any endangered or threatened species under their respective jurisdictions, or critical habitat of such species, may be affected by the project, and whether there will be any requirement for formal consultation pursuant to Section 7 of the ESA.

6. Estuary Protection Act, 16 U.S.C. 1221 et seq.

Compliance: Estuaries, their natural resources, and their importance for commercial and industrial development have been considered in evaluating alternative courses of action in this

PEIS. In addition, development of the Long Island Sound DMMP is being coordinated with the National Estuary Program for Long Island Sound.

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

Compliance: The NMFS, the USFWS, and the fish and wildlife agencies of Connecticut, New York, and Rhode Island should be consulted on a project-specific basis for their recommendations on species that should be investigated based on the alternatives assessed and chosen for that project. General information on several commercially and recreationally important species and on endangered and threatened species is included in this PEIS. The information provided herein, including information on impacts to species, may be referenced in project-specific NEPA documents.

8. Magnuson-Stevens Fishery Conservation and Management Act, as amended, 16 U.S.C. 1801 et seq.

Compliance: Consultation with the NMFS and preparation of an EFH assessment in compliance with the Magnuson-Stevens Act will be necessary for each project based on the alternatives assessed and the preferred alternatives. General information on species and habitat identified in the 10- by 10- minutes squares prepared by NMFS is included in this PEIS (NOAA, 2014). The information provided herein, including information on impacts to species, may be referenced in the project specific NEPA documents.

9. Marine Mammal Protection Act of 1972, 16 U.S.C. 1361.

Compliance: Coordination with the NMFS and the USFWS will be necessary to determine whether any marine mammals under their respective jurisdictions may be affected by a project. General information on endangered and threatened whales and other marine mammals previously found in Long Island Sound is included in this PEIS. The information provided herein, including information on impacts to species, may be referenced in project-specific NEPA documents.

10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1401 et seq.

Compliance: Pursuant to MPRSA 106(f), commonly referred to as the “Ambro Amendment,” placement of dredged material in Long Island Sound from Federal projects (i.e., those carried out under the USACE Civil Works program or under the actions of other Federal agencies) or from non-Federal projects involving more than 25,000 CY of dredged material is subject to the requirements of MPRSA Section 103. MPRSA provides for the permitting process to control the ocean placement of dredged material. Therefore, projects involving transportation of dredged material through or within Long Island Sound for the purpose of placement must be evaluated for potential contaminant-related impacts following the criteria established by EPA (40 CFR 227 and 228). The procedures for evaluating the impacts are contained in the *Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual* (EPA and USACE, 1991). The requirements of this Act are discussed more fully in Chapter 3 of this PEIS.

11. Migratory Bird Treaty Act of 1918, 18 U.S.C.

Compliance: Coordination with USFWS will be necessary to determine whether any migratory birds will be impacted by a proposed project. General information on the types and potential habitat of migratory birds found in the Long Island Sound area is included in Chapter 5 of this PEIS. The information provided herein, including information on impacts to species, may be referenced in project-specific NEPA documents.

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

Compliance: To comply with NEPA, USACE prepared this PEIS in conjunction with the Long Island Sound DMMP. USACE published the Notice of Intent to develop a PEIS for the Long Island Sound DMMP in the Federal Register on August 31, 2007 (72 FR 50332). By following a programmatic approach to assessing these impacts, decision makers will be able to evaluate different dredged material placement options with full knowledge of the potential environmental consequences. The PEIS is an umbrella document that considers generic impacts of options. In the future, as specific alternatives are identified to implement a given management option, specific project- and alternative-focused NEPA documents and permits will utilize the information presented in this PEIS to address implementation of a given option at a specific location..

13. National Historic Preservation Act of 1966, 16 U.S.C. 470.

Compliance: Use of the WLDS and CLDS open-water alternatives was deemed to have no impact to historical/archaeological resources. The basis for the determination is explained in EPA (2004). Project-specific NEPA documents proposing the use of those locations should reference the information contained in that EIS.

Use of other sites, including nearshore, upland, and brownfield locations, should be coordinated with the SHPOs in Connecticut, New York, and Rhode Island to determine whether historic properties will be affected by a proposed project. Federal Historic Preservation Officers and interested Indian nations/tribes should also be consulted regarding possible effects on historic/archaeological resources.

14. Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3002.

Compliance: Interested Indian nations/tribes should be consulted when considering alternative courses of action for a specific project.

15. Preservation of Historic and Archaeological Data Act of 1974, 16 U.S.C. 469.

Compliance: Each project-specific NEPA document must consider whether its proposed action will lead to future damage to resources covered by this Act and determine that the project will not damage archeological, historic, scientific, or prehistoric resources. If there is an unexpected discovery of resources covered by this act, EPA will notify the National Park Service Departmental Consulting Archaeologist.

16. Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.

Compliance: The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is the principal Federal law in the United States governing the disposal of solid waste and hazardous waste. The Hazardous Waste Identification Rule under RCRA excludes dredged material from RCRA hazardous waste requirements if the wastes are managed under an appropriate permit under the MPRSA or the CWA.

17. Rivers and Harbors Act of 1899

The Rivers and Harbors Appropriation Act of 1899 applies to projects and activities in navigable waters and harbor and river improvements. This act provided for a number of regulatory authorities, the implementation of which has evolved over time. However, only Section 10 of the Rivers and Harbors Act is relevant to the USACE regulatory program with regard to dredged material placement.

Compliance: Depending on the proposed activities, a Rivers and Harbors Act Section 10 permit may be required. This permit is applicable for the following activities:

> *33 U.S.C. 403. Construction of bridges, causeways, dams or dikes generally; exemptions*
>
> That the creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States is hereby prohibited; and it shall not be lawful to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, or other structures in any port, roadstead, haven, harbor, canal, navigable river, or other water of the United States, outside established harbor lines, or where no harbor lines have been established, except on plans recommended by the Chief of Engineers and authorized by the Secretary of War; and it shall not be lawful to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of, any port, roadstead, haven, harbor, canal, lake, harbor of refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of War prior to beginning the same.

If required, USACE will coordinate with other Federal, state, and local agencies before making a final determination. Additional information on the Rivers and Harbors Act can be found in EPA (2012) and USACE (2015).

18. Federal Highway Act of 1956

The Federal-Aid Highway Act of 1956 authorized the Interstate and Defense Highway System to preserve the nation’s infrastructure and keep trucks and buses moving efficiently. The Act established the Federal Highway Administration (FHWA) to set Federal standards for vehicle size and weight and to certify state compliance with the Federal standards. The FHWA has relevance to all projects that would involve transport of dredged material on roadways to upland sites for placement and has similar applicability to Federal, state, local, and private projects.

Compliance: The FHWA and the appropriate state DOT are responsible for enforcing and setting standards that would be related to dredged material transport. Additional information on this Act can be found at FHWA (2015).

19. Federal Railway Administration (Department of Transportation Act of 1966)

The Federal Railroad Administration (FRA) was created by the Department of Transportation Act of 1966 with a range of goals, including promulgating and enforcing rail safety regulations, consolidating government support of rail transportation activities, and promoting environmentally sound rail transport. Should dredged material be transported to an upland site by rail, the FRA would have oversight responsibility, providing comment on transport plans and specifications.

Compliance: Administration of rail-related work is provided by the FRA within the U.S. Department of Transportation. Additional information on the FRA can be found at FRA (2015).

Executive Orders

The following are EOs that should be considered on a project-specific basis:

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

Compliance: This EO has been incorporated into the National Historic Preservation Act of 1980. Coordination with the SHPOs in the state of Connecticut, New York, or Rhode Island (depending on the locations involved) signifies compliance with this order.

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

Compliance: Coordination and consultation with the Indian Tribal Governments with an interest in the study area signifies compliance with this EO.

3. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 11 February 1994.

Compliance: Each project will evaluate the potential adverse risks to human health from the proposed project to minority and low-income populations to determine that there are no disproportionately high and adverse health or environmental effects to these populations.

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

Compliance: Each project will evaluate the potential adverse risks to children's health to determine that there are no expected disproportionately high, adverse health or safety threats to children from the proposed action.

5. Executive Order 12962, Recreational Fisheries, 9 June 1995.

Compliance: Each project will consider the goals of this EO to ensure that the proposed action will not have disproportionately high or adverse effects on recreational fisheries.

6. Executive Order 13158, Marine Protected Areas.

Compliance: Each project will consider the location of any MPAs when evaluating placement alternatives for a proposed project and ensure that the action will avoid harm to the natural and cultural resources protected by any designated MPAs.

7. Executive Order 12088, Federal Compliance with Pollution Control Standards.

Compliance: Each project will consider the goals of this EO to determine that the proposed action is in compliance with this order.

8. Executive Order 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes. (National Ocean Council)

Compliance: Each project will consider the goals of this EO to determine that the proposed action is in compliance with this order.

9. Executive Oder 13112, Invasive Species.

Compliance: Each project will consider the goals of this EO to determine that the proposed action is in compliance with this order.

10. Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

Compliance: Each project will consider the goals of this EO to determine that the proposed action is in compliance with this order.

Executive Memorandum

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

Compliance: Consultation with the Federally recognized Indian Tribes signifies compliance with this memorandum.

8.6 REFERENCES

EPA and USACE, 1991. *Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual,* Washington, DC: U.S. Environmental Protection Agency and U.S. Army Corps of Engineers.

EPA, 2004. *Final Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York,* s.l.: U.S. Environmental Protection Agency. April 2004. Report + appendices.

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